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AI in Nursing Education: Preparing Future Nurses for a Tech-Integrated Workforce

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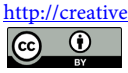

Abstract

Artificial intelligence (AI) is rapidly integrated into nursing education, reshaping how nurses learn on the wards in complex clinical environments. This article examines the potential of AI-augmented simulation to improve clinical skills, including clinical competency, decision-making, and readiness for high-risk clinical interactions. In contrast to typical simulation-based learning scenarios, AI delivers adaptive, real-time learning experiences that are scalable and realistic, and that promote clinical reasoning, rare-case exposure, and customized assessment. As the field integrates AI into healthcare (diagnosis, workflow management, and patient care support), nursing students will need to demonstrate skill in the responsible and ethical deployment of these technologies. This includes both the principles around how AI tools should work and their integration into clinical judgment and patient-centered care. To this end, we recommend that nursing education promote enhanced AI literacy so that future nurses are better prepared to understand what algorithmic outputs look like, acknowledge their limitations, and advocate for safe, equitable patient outcomes. Ultimately, AI-enhanced education must be one step toward a prepared and flexible nursing workforce to meet today's challenges.

Keywords

Artificial Intelligence, Simulation-Based Learning, AI Literacy

1. Introduction

Traditional simulation refers to established, non-AI-based educational methods that use standardized scenarios, manikins, role-play, or scripted case studies to teach clinical skills. These simulations provide structured opportunities for learn-

ers to practice assessment, communication, and technical procedures in controlled environments. Although effective for skill acquisition, traditional simulation typically lacks adaptive case progression, real-time personalization, and algorithmic decision support, making it less reflective of the data-rich environments nurses encounter in contemporary practice (Flo et al., 2021). Simulation, in the traditional sense, is the process of conducting structured, scenario-based activities to model an actual system or environment. These simulations are based on established rules, linear, predictable processes, and static assumptions to enable learners (or decision-makers) to practice skills, investigate responses, or analyze outcomes without the risk of applying what they see in the real world. In various industries (healthcare, aviation, and military training), the simulation typically involves physical equipment, scripted scenarios, and instructor-led debriefing to help cement learning. Its merit is that it offers stable, repeatable experiences on which foundational competence develops, but its rigidity may prevent its adaptability and, consequently, the complexity of human behavior it may accurately describe.

This paper is a perspective piece that consolidates emerging findings and expert opinion on the role of AI-augmented simulation in nursing education. The databases searched were CINAHL, PubMed, and Scopus, specifically to identify literature through term filters for artificial intelligence, simulation, and nursing education. We used relevance, recency, and contribution to current debates on AI integration in clinical training to determine eligibility for inclusion.

To guide this perspective, the analysis is organized around three central questions that frame the review and establish the analytical direction for subsequent sections:

1) How does AI-augmented simulation enhance clinical reasoning, competency development, and learner engagement compared with traditional simulation approaches?

2) In what ways does AI-enhanced simulation prepare nursing students for emerging AI-driven clinical environments, including predictive analytics and intelligent monitoring systems?

3) What pedagogical, ethical, and practical considerations should nursing programs address when integrating AI-based simulation into prelicensure and advanced practice curricula?

A key limitation of the reviewed evidence is the heterogeneity of findings in available studies, which vary greatly in design, scope, and technological sophistication. Most existing literature evaluating AI-enhanced simulation is also preliminary, and some conclusions within this umbrella depend on broader work on digital, virtual, or adaptive simulation rather than on direct evaluations of AI-specific tools in nursing education. These findings warrant careful interpretation, and future empirical work is warranted to systematically evaluate AI-based simulation technologies to better understand how they uniquely contribute to competency development and clinical preparedness.

2. AI-Based Simulation

Over the last few years, the infusion of artificial intelligence (AI) into nursing education has expanded tremendously. This provides an unprecedented opportunity to optimize clinical training and competency, and to enhance clinical learning and teaching. As existing healthcare systems become increasingly sophisticated, nursing programs have focused on preparing the future nursing workforce to work in high-risk, fast-paced clinical environments. Adaptive, realistic, and scalable AI–driven simulation is viewed as a solution to conventional pedagogy. AI-enhanced simulation facilitates not only better learning and academic outcomes for students but also uniquely offers advantages over classical simulation techniques, including clinical reasoning, rare-event exposure, and personalized feedback (Foronda et al., 2020; Mishra et al., 2023; Flo et al., 2021). Subsequently, we present evidence for AI in nursing education and compare it with conventional simulation modalities.

Artificial intelligence (AI) is revolutionizing healthcare today, fundamentally altering the way we diagnose illnesses, document treatments, forecast patient outcomes, and manage complex clinical workflows. With the rise of AI as used by hospitals and health systems to increase productivity, decrease mistakes in care, and assist with evidence-based decision-making at the bedside, it is clear that skill is going to need to evolve to the normal level of being able to perform medical clinical practice (Topaz & Pruinelli, 2020).

As these technologies become part of the care routine, nurses, the largest category in the healthcare workforce, must be prepared to engage ethically with AI-powered systems. Only then can they be successful. As a result, the education level of nursing students in AI-enhanced practice is among the most important factors. Students will now be practicing in clinical settings where predictive analytics, automated documentation systems, and intelligent monitoring tools are common aspects of patient care. A lack of foundational AI literacy might render these graduates unable to interpret algorithmic outputs, navigate limitations, and advocate for patients regarding risks or inequities posed by technology (Birkholz et al, 2025).

Artificial intelligence-based clinical simulations in nursing education are disrupting the field through interactive, personalized learning experiences and environments designed for today's clinical settings. AI (Artificial Intelligence) enhanced simulation is an augmented simulation of an artificially intelligent learning environment, a type of clinical training that integrates artificial intelligence technologies into simulated learning environments to yield adaptive, relevant, realistic, and data-driven settings. Such systems use AI to personalize feedback, adjust case complexity in real time, expose learners to high-risk or infrequent events, and help build skills in clinical reasoning and decision-making (Foronda et al., 2020; Mishra et al., 2023). AI-enhanced simulation offers dynamic, scalable, and individualized learning experiences mirroring the complexity of modern AI-enabled healthcare settings. It represents a substantial step up from traditional simulation approaches.

AI algorithms implemented in adaptive learning applications help deliver educational tasks with varying levels of difficulty and clinical complexity based on students' performance, enabling a culture of competency-based, learner-centered pedagogical practices. In doing so, these systems are designed to identify existing knowledge gaps, streamline learning tracks, and deliver guided feedback that enhances sophisticated clinical reasoning and skill acquisition. AI-driven platforms also support mastery learning by tailoring personalized engagement for each learner within the simulation and enabling them to gain confidence in clinical judgment at their own pace.

By taking the process one step further, AI-based clinical simulations provide opportunities for students to revisit their learning scenarios, rehearse their work, and progressively strengthen their mastery of more difficult skills. At the same time, this step-by-step learning sequence mitigates performance anxiety in high-stakes clinical scenarios, helping to create a safe space for experimentation. By allowing students to learn from mistakes in an environment with no real-world consequences, AI-enhanced simulations reinforce clinical judgment, adaptability, and preparedness.

More than anything else, AI-based clinical simulation helps accelerate the era of data-driven, technology-backed nursing education. With individualized learning, real-time feedback, and immersive scenario design, these systems connect academic preparation to clinical practice. AI-driven simulations not only enhance learning outcomes but also equip nursing students with the clinical and digital skills needed to practice in a growing, information-rich, and technology-intensive healthcare landscape.

Furthermore, these technologies greatly enhance the realism and adaptability of simulation experiences. AI can change patient conditions in real time, introduce unforeseen complications as needed, and simulate clinical situations that are difficult to reproduce in a typical clinical setting. This variation prepares them to respond optimally to sudden shocks and aids their development of critical thinking in an unforgiving environment. Given how rapidly healthcare settings are changing, exposure to different, realistic simulations is essential for shaping diverse, adaptive, and resilient nursing professionals.

3. Traditional-Based Simulation

At the same time, expanding on this comparison with conventional simulation highlights the complementary value that AI offers to traditional models. Traditional simulation provides structure and predictability for basic skill acquisition, but does not offer the real-time, dynamic, and responsive data-driven system of AI-driven platforms. This model extends traditional simulation into teaching and learning through real-time algorithmic adjustments, agile case progression, and personalized feedback from AI systems, which aligns well with real-time, emerging clinical environments that are more current and dynamic. These features allow learners to engage with unlikely occurrences, changes in patient conditions

on the fly, and individualized remediation trajectories that simulations based on manikins or scripted activities cannot deliver reliably.

Nonetheless, traditional simulation remains a pillar across these aspects, where competencies require physical presence, tactile engagement, and real-time interpersonal interaction. Manikins, standardized patients, and in-person team-based simulations are high-quality training methods that facilitate the embodied learning process vital to psychomotor skills, procedural competence, and interprofessional communication. Such activities develop situational awareness, shared decision-making, and collaborative problem-solving in ways that AI-based platforms cannot fully complement. Thus, although the benefits of AI-enabled simulation in fostering cognitive, analytical, and adaptive skills are considerable, traditional simulations remain a cornerstone of nursing education for the pragmatic, relational, and team-based aspects of clinical practice.

This paper describes a perspective piece integrating newly emerging evidence found in the conversation and professional expertise on the possible value of AI-augmented simulation within the nursing educational environment. To facilitate this understanding, targeted literature was searched in the databases (CINAHL, PubMed, Scopus) using specific terms related to AI, simulation, and nursing education. Sources were selected for their significance, their timeliness, and their contribution to existing discussions on AI inclusion in a clinical training setting.

Over the last few years, the infusion of artificial intelligence into nursing education has expanded rapidly, creating an unprecedented opportunity to optimize clinical training, strengthen competency development, and enhance both teaching and learning. As healthcare systems become increasingly sophisticated, nursing programs have intensified their efforts to prepare students for high-risk, fast-paced clinical environments. Adaptive, realistic, and scalable AI-driven simulation has emerged as a promising response to the limitations of conventional pedagogy. AI-enhanced simulation not only improves learning and academic outcomes but also offers distinct advantages over classical simulation techniques, including enhanced clinical reasoning, exposure to rare events, and personalized feedback (Foronda et al., 2020; Mishra et al., 2023; Flo et al., 2021). These developments underscore the need to evaluate how AI-based simulation compares with traditional modalities and how it can be integrated effectively into nursing curricula.

Simultaneously, artificial intelligence is transforming healthcare delivery more broadly, fundamentally altering how clinicians diagnose illnesses, document treatments, forecast patient outcomes, and manage complex workflows. Hospitals and health systems increasingly rely on AI to increase productivity, reduce errors, and support evidence-based decision-making at the bedside. As these technologies become embedded in routine care, nurses must be prepared to engage ethically and competently with AI-powered systems. Nursing students will soon practice in environments where predictive analytics, automated documentation systems, and intelligent monitoring tools are standard components of patient care.

Without foundational AI literacy, graduates may struggle to interpret algorithmic outputs, recognize limitations, or advocate for patients when technology introduces risks or inequities (Booth et al., 2021). Nursing programs, therefore, need to prepare students not only to understand how AI tools function but also to integrate them into clinical judgment, communication, and patient-centered care.

Within this rapidly evolving landscape, AI-augmented simulation represents a critical educational strategy that bridges emerging clinical technologies with the competencies required for safe, ethical nursing practice. By exposing students to realistic, data-driven scenarios, AI-enhanced simulation supports the development of clinical reasoning, adaptability, and technological fluency, skills essential for the future nursing workforce.

4. The Evolving Role of AI in Healthcare and Nursing

Nursing education must evolve, given the pace of technological change, to include structured AI competencies, simulation-based learning, and approaches to address institutional constraints, including faculty preparedness, ethical issues, and accreditation gaps. These modifications are necessary to prepare graduates to engage in a fully technological clinical future in which AI will be increasingly integral to practice. Nursing education needs to mature with AI competencies, simulation-based learning, and strategies to break past institutional barriers, and graduates need to be trained for a cutting-edge clinical environment that incorporates technology.

AI-based technologies are embedded across various areas of health infrastructure, including clinical practice and general organizational activity. AI algorithms assist clinicians in clinical decision support by analyzing trends and patterns in medical data, flagging early warning signs of deterioration, and providing evidence-based recommendations. Predictive analytics software identifies future risks, including sepsis, falls, and readmissions, enabling proactive, preventive care. Using AI-assisted charting in documentation systems supports natural language processing, making charting easier and more efficient, while advanced patient monitoring systems can assess patient data in real time to detect physiological abnormalities more quickly than traditional methods (Topaz & Pruinelli, 2020). These uses demonstrate how AI improves accuracy, efficiency, and responsiveness at the clinical practice level.

As AI becomes an increasingly important part of clinical care, nurses' roles and responsibilities are changing. Now, a new set of algorithms requires nurses to translate their outputs, validate AI-derived recommendations, and put them into comprehensive clinical judgments. This transformation requires developing new skills in data literacy, informatics, ethics, and technology-supported communication. Birkholz et al. (2025) point out, however, that nurses must appreciate the benefits and constraints of applying AI systems (including their potential to improve patient care goals and the limitations of their implementation) to deliver safe, equitable, and patient-centered care.

AI does not usurp nursing expertise but rather underscores the importance of critical thinking, clinical monitoring, and advocacy, skills that are human- and professional-centric. Such shifts highlight the need to integrate evolving technologies into nursing curricula. For modern nursing education, which emphasizes foundational clinical knowledge and manual skills, AI literacy, simulation-based training, and exposure to digital health tools should be integrated. In the absence of curricular alignment, potential postgraduate students may enter practice ill-equipped to meet the technology-based needs of today's healthcare settings. Educating nurses through the integration of AI equips them to work effectively with AI, maintain patient safety, and develop a profession of innovation.

5. Core Competencies Nurses Need for AI-Enhanced Practice

As artificial intelligence becomes increasingly integrated into clinical decision support systems, nurses must develop strong data literacy and informatics competence to engage effectively with these tools. Data literacy can be defined as the fundamental knowledge, skills, and dispositions necessary for clinical practice to better understand how clinical data are produced, organized, and used to inform algorithmic outputs. It comprises understanding AI-driven recommendations, assessing the quality and limitations of the underlying data, recognizing potential biases, and using AI-generated information ethically, informed by clinical judgment and patient-centered care (Birkholz et al., 2025). Data literacy is a core aspect of AI literacy and is therefore relevant in nursing education, as it equips students to handle predictive analytics, automated documentation systems, and intelligent monitoring tools that are now central to modern clinical practice Nurses need to be able to audit the quality of available data and identify missing or biased data, as well as their effect on AI recommendations (Topaz & Pruinelli, 2020). Without this baseline education, nursing clinicians can sometimes be more dependent on algorithm-generated recommendations than needed, and miscomprehend those that do not align with the patient's presentation. However, in addition to their value, insight from AI-generated outputs should be interpreted using clinical judgment. Rather than issuing definitive diagnoses, nurses should incorporate evidence-based practice into their everyday routine based on patient history, assessment results, and evidence-based practice (Ball Dunlap et al., 2024). By cultivating interpretive capabilities, AI will enable nurses to assist patients and providers through AI-based applications without supplanting professional rationality. If nurses are aware of the benefits and drawbacks of AI, they can verify suggestions, communicate evidence-based information to patients and nursing personnel, and promote its appropriate use in actual settings.

As artificial intelligence (AI) increasingly penetrates clinical decision support systems, the relevance of data literacy and informatics knowledge to nursing practice has reached new heights. Data literacy requires an understanding of how clinical data is generated, structured, and then turned into algorithmic outputs at the clinical level to inform decisions about patient care. For nurses, critical analysis of

these processes as they occur must ensure that there are checks on the data themselves; it should examine any evidence that hints at shortcomings or anomalies and investigate how these factors affect AI-generated suggestions (Topaz & Pruinelli, 2020). If clinicians are left without such expertise, they may rely too heavily on automated results or interpret recommendations in ways that fail to make sense in the patient's own picture or in light of the actual clinical condition. Equally important is to place AI insights within professional clinical judgment. Rather than being the key decision makers, the role is to facilitate the integration of AI tools into nursing practice alongside patient history, assessment findings, and evidence-based guidelines (Ball Dunlap et al., 2024).

By cultivating interpretive capabilities, AI will enable nursing to assist patients and providers through AI-based applications without supplanting professional rationality. If nurses are aware of the benefits and drawbacks of AI, they can verify suggestions, communicate evidence-based information to patients and nursing personnel, and promote its appropriate use in actual settings.

In addition, incorporating AI into clinical workflows brings key concerns surrounding accountability, transparency, and patient trust. Nurses are the central intermediaries between technology and patient care, and they need to provide clear, relevant explanations to patients and, by extension, the multidisciplinary team involved in AI-guided decision-making. It is not just about being good technically, but also about understanding communication and ethics. Since AI systems can also replicate existing biases in the healthcare data we make sense of, nurses are on the front lines in detecting and confronting disparities that can adversely affect patient outcomes. In this regard, informatics capability is more than technical capabilities; it is part of critical thinking, ethical reasoning, and advocacy. Adopting these competencies for AI will empower nurses to help ensure AI technologies are used responsibly to facilitate equitable, safe, and patient-focused practice, while maintaining professional nursing judgment as the standard for care.

5.1. Ethical and Legal Reasoning

Nurses face several difficult ethical and legal issues when applying AI in health care. These issues are patient privacy, bias, transparency, and accountability. These issues include privacy, bias, transparency, ethical principles, and regulatory implications, which nurses must consider and implement. It is vital that the nurse understands data governance for AI systems to operate with large volumes of sensitive patient data, safeguard patient information, and uphold ethical data governance principles, privacy laws, and the institutional policies that guide the AI care technology (World Health Organization (WHO), 2021).

Despite the proliferation of data systems, ensuring the confidentiality of patients' data remains an important ethical principle for all systems. Algorithmic bias is another basic ethical challenge. AI tools trained on data such as these, with limited representation of certain populations, can have the unintended conse-

quence of perpetuating health disparities. Nurses need to be trained to recognize potential bias, question whether they are fair, and advocate for equitable care provision (Booth et al., 2021). Building on ethical considerations, principlism, care ethics, and utilitarian analysis, the authors develop holistic theoretical frameworks to identify factors that support or prohibit AI integration. Such frameworks will hold nurses accountable, promote patient autonomy, and help ensure that AI-supported decisions remain in accordance with nursing and ethical standards (El-Banna et al., 2025).

5.2. Human-AI Collaboration Skills

When Integrated with humans, AI collaboration requires nurses to balance technological understanding with holistic, patient-centered care. Although AI may augment clinical decision-making by identifying patterns and predicting risks, nurses need clinical judgment and the ability to assess when and why to rely on AI recommendations, and whether and how to override them in line with patient-specific factors. This competency is designed to ensure that AI complements, rather than replaces, the nurse's knowledge and to underscore the significant role human assessment plays in the safe delivery of ethical care (Birkholz et al., 2025). For this reason, it is also essential to communicate with patients about AI-supported decisions.

Patients may be apprehensive about how AI will affect their care, and nurses need to be able to explain algorithmic recommendations in more easily understandable language. By communicating with these systems, the patient gains trust and collaborative decision-making, enabling him to understand the importance of technology in his course of treatment (Flo et al., 2021). Therefore, nurses can engage with AI systems while maintaining relational humanistic aspects of nursing practice by integrating clinical expertise, technological literacy, and communication skills.

Human-AI collaboration requires the nurse to draw on technological insight while taking care of the patient. Even if AI's impact may make clinical reasoning easier by detecting patterns and flagging risks, nurses are responsible for applying clinical judgment and deciding when AI-generated recommendations are justified and when to override them for a particular patient. This skill facilitates an approach that ensures AI augments rather than replaces the expertise of the nurse, reinforcing the centrality of human judgment in safe, ethical care (Birkholz et al., 2025). Nurses constantly apply their intuition, experience, and direct patient interaction in complex clinical scenarios where an individual patient's condition cannot always be perfectly fit to the predicted algorithm. In terms of the critical thinking skills that should accompany the use of AI, the role is enabling rather than prescriptive.

Communication of AI-generated decisions to patients is important not only for transparency but also for establishing trust. As AI use in healthcare increases, patients are increasingly concerned about its potential to affect their diagnoses and

treatments. Nurses work towards this goal by communicating the reasoning behind AI-generated recommendations in a comprehensible, patient-comprehensible context (Flo et al., 2021). Communication helps establish trust, supports shared decision-making, and encourages patients to play more active roles in their own care. Demystifying AI processes and, therefore, easing concerns about depersonalization is a good move, a step towards ensuring that patients are seen, heard, and valued in the technology-driven nursing environment.

Nurses are trained to be aware of potential ethical concerns in AI use, particularly regarding its ethical implications and potential biases. And AI systems are only as good as the data on which they are trained, and without proper oversight, they can reproduce existing disparities in health care. We must therefore remain constantly alert to the biases or incompleteness of AI outputs and advocate for equitable patient care. This responsibility includes, but is not limited to, protecting patient information and ensuring that AI tools are used in a confidential, discreet, and professional manner. Nurses could ensure that AI applications align with core nursing values by integrating ethical reasoning and technological skills.

Lastly, there is a need for continuous learning and training for nurses and nursing professionals as AI technologies continue to develop. This will require lifelong learning for them to be skilled in the application and interpretation of AI. This includes acquiring digital health, informatics, and teaming capabilities with other disciplines in the healthcare environment, data scientists, and healthcare technologists. Nurses can work efficiently with AI systems by drawing on clinical and technical proficiency, strong technological competence, ethical sensitivity, and effective communication, while maintaining the relational and human core values. Finally, this equilibrium ensures that as innovation advances, care is offered without sacrificing the compassion and judgment that characterize the field of nursing, and vice versa.

6. Simulation-Based Learning Using AI

Simulation-based learning (SBL) involves immersive practice and training in a real-world environment, where learners apply what they learn, practice skills, and solve problems using the information they acquire. It is utilized in healthcare, aviation, the military, business, and education, where the difference between theoretical learning and the application of the material. Practical testing and evaluation of real-world performance should not have a major impact. SBL emulates real situations, whether through role-playing, computer-based simulations, high-fidelity hardware, or simulated reality, enabling students to learn the subject in a hands-on, experiential way without the risks of mistakes in real life. According to various studies, simulation increases critical thinking, decision-making, skill retention, and confidence, as students can make mistakes and receive immediate feedback.

Based on Kolb's Experiential Learning Theory, SBL enables a cycle of experience, reflection, conceptualization, and application, enhancing skills acquisition

in complex circumstances "Suitable" simulation-based learning is characterised by clear goals, real-life situations, hands-on experience, structured feedback, and focused critiques that assist students in connecting the learning process to results and transferring skills to the operational world. Simulation-based learning (SBL) is a teaching technique that involves placing students in direct contact with a real-life setting, where they gain practical, experiential learning to apply what they know develop new skills, and apply them in a real-world setting. In fields such as healthcare, aviation, military training, business, and education, this method is common, and it has been extremely effective in bridging the gap between academic studies and the real world.

Through role-playing, computer-based simulations, high-fidelity mannequins, or virtual reality simulations, SBL allows the simulation of real-life situations and so for practice without errors in real life. This strategy is particularly useful in educational and vocational practice. This safe learning environment enables students to try things out, make mistakes, and hone their skills, thereby improving their readiness for professional, high-stakes environments. One of the most important benefits of simulation learning is its role in developing one's critical thinking, clinical reasoning, and decision-making skills. Learners learn to break down problems, take action, and respond quickly as more scenarios are presented. Fast feedback and targeted debriefing reinforce learning by helping students reflect on how well they did and where they did not, and by linking what they learned to the implications for application.

Accordingly, SBL has been shown to promote greater retention of acquired skills and enhance participants' confidence, thereby helping learners achieve competence in very challenging environments where accuracy and nimbleness are significant. The validity of SBL is strongly supported by Kolb's Experiential Learning Theory, which posits that learning occurs in a cycle of four steps: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Simulation is the "experience" part, while structured debriefing prompts reflection and conceptual understanding. By using these insights in subsequent simulations or real-world activities, learners further solidify their knowledge and enable deeper learning. This is especially useful for the healthcare education field, where practitioners must navigate clinical scenarios in highly dynamic environments, in which cognitive, technical, and interpersonal abilities must be interwoven in an iterative model.

High-quality simulation-based learning is characterized by clearly defined expectations, realistic scenarios, engaging activities, active learner collaboration, and structured feedback structures that enable learning. Good simulations are deliberately designed to reflect the challenges of the real world and therefore help learners apply new learning in practice situations. Debriefing sessions conducted as part of the process of making informed decisions during simulation education play a key role; they can help learners reflect critically on their choices and recognize the costs of their decisions. By connecting learning experiences to quantifia-

ble outcomes, SBL underpins the development of competencies and ensures that knowledge is not only learned but also applied effectively.

Technological developments are making simulation-based learning even more powerful, with artificial intelligence (AI) and adaptive systems being among the most promising technologies. To further personalize experiences, AI-empowered simulations adapt the model's complexity to learners' performance, provide regular, immediate feedback, and help identify specific skill deficiencies. At this granular level of customization, learners become involved in activities, and training is personalized so they can focus on one thing at a time. Thereby, simulation-based learning is emerging as an effective and versatile educational model, equipping learners to function competently in intricate, real-world applications with safety, quality, and continuous improvement.

6.1. AI-Enhanced Clinical Simulations

The use of AI-powered clinical simulation is transforming nursing education by enabling personalized, interactive learning experiences that align with contemporary healthcare practice. AI-enhanced simulation provides training programs that employ artificial intelligence to modify the application in a simulated clinical environment, offering an adaptive, engaging, and data-driven practice environment. Such systems, which use AI, are designed to customize feedback, dynamically adjust case complexity in real time, provide learners with exposure to rare or high-risk events, and foster the development of clinical reasoning and decision-making functions (Foronda et al., 2020; Mishra et al., 2023). AI-enhanced simulation is a significant departure from existing simulation models, providing dynamic, scalable, and personalized learning solutions that accurately reflect the current AI-enabled healthcare environment. An adaptive learning system that allows students to adjust the difficulty of activities and their clinical complexity based on their performance, enabling competency-based and learner-centered learning.

They recognize knowledge gaps to map out learning pathways and provide feedback that reinforces advanced clinical thinking and skill-building. AI-driven platforms also facilitate mastery learning by personalizing each learner's engagement with a simulation and enabling them to develop at a pace that builds their confidence in clinical judgment. AI simulations also foster mastery learning because learners can learn individually. Then they can revisit these scenarios, rerun them, and feel empowered to attempt and master tougher cases. In high-stakes clinical settings, the self-paced progression enhances understanding with less performance anxiety.

By enabling students to learn from mistakes without fear of real-world consequences, AI-enhanced simulations create a safe environment for experimentation that solidifies clinical judgment and readiness. It dramatically enhances the realism and responsiveness of simulation experiences. AI can adjust patient conditions in response to dynamic changes, introduce unanticipated emergencies, and create a wide range of clinical scenarios that are difficult to replicate in conventional envi-

ronments. The variability equips students to respond successfully to environmental unknowns and reinforces their capacity to think critically in high-stress situations.

Modern health care environments are constantly changing, and exposure to various realistic simulation scenarios can be crucial to producing a student nurse who is flexible and hardy. And most importantly, AI-initiated clinical simulations are a major step toward data-driven and tech-enabled education. Employing this blend of personalized education, real-time feedback, and context-based scenario design, these systems connect academic education to on-the-ground deployment. Consequently, AI-driven simulations benefit both the learning and clinical teaching of students and help prepare nursing students for practical placements and the clinical and digital skills required for real-time patient care, given the rapid developments in healthcare technologies.

Second, AI-based simulation tools support mastery learning through enabling students to "learn at their own speed" and "gain knowledge and confidence." Before students can move on to a more complex task, they need to re-read scenarios and practice the same scenario multiple times. That kind of self-paced enrichment builds on, and builds off, what learners know or can do, while mitigating performance anxiety, particularly in high-stress clinical environments. AI simulations allow students to learn from mistakes without facing the consequences of their errors in the real world, expand their experimentation and growth, and improve their medical judgment and preparation.

Furthermore, the use of these approaches adds realism and flexibility to the simulation condition. AI can rapidly adapt to complex patient care and simulate clinical settings that cannot be handled in traditional contexts. This discrepancy is also preparing students to respond differently to the situations they encounter and to think critically under pressure. Given that all health care settings are constantly adapting and advancing, a variety of realistic, diverse simulations are required to build a resourceful, strong nursing workforce.

Ultimately, AI clinical simulation is a crucial achievement in data-oriented, technology-enabled teaching. Such systems also bring together academic and clinical fields through personalized learning, instant reactions, and highly immersive simulated cases. Simulations empowered by artificial intelligence not only improve learning outcomes, preparing nursing students to become proficient in information technology-heavy work environments and in meeting the clinical skill demands of such institutions, but also help meet the clinical skill demands of such institutions.

6.2. Virtual Patients and Conversational AI for Communication Training

There has been a greater development in communication training from virtual patients and conversational AI, which is also critical. These AI-enabled avatars can demonstrate clinical interview styles and emotional responses, communication barriers, and patient behaviors, allowing students to practice therapeutic conversations in a safe and culturally responsive environment Flo et al., (2021) argue that

virtual patients enhance realism and immersion and give learners the opportunity to repeatedly engage with the same topic, all without the limitations imposed by faculty academic schedules in simulated labs. Conversational AI also offers real-time, contextually specific feedback to help students develop their communication skills and become leaders in patient-centered care.

These trends demonstrate the need for AI supported simulator implementation in nursing education. Mishra et al. (2023) argue that AI-enhanced simulation environments improve technical and communication skills while preparing students for work in technology-driven clinical settings, where digital tools are increasingly prominent in patient care. By incorporating adaptive learning environments, virtual patients, and conversational AI, nursing programs can offer growing access to scalable, adaptable, and practical training. At the end of the day, AI-augmented simulations add to clinical readiness, equitable access to high-quality learning, and the workforce's ability to engage with the challenges of contemporary healthcare.

In addition, virtual patient platforms cultivate realism and immersion by offering repeated exposure to the same clinical scenarios and enabling learners to adapt their communication strategies over time. In contrast, AI-driven systems provide scalable, flexible learning opportunities accessible on demand at any time, whereas other simulations are limited by faculty availability or physical resources (Flo et al., 2021).

The practice of the strategy and skill can be repeated throughout the whole course, which helps individual students master the skill and encourages them to learn from their mistakes, with feedback applied in future interactions. Furthermore, the use of conversational AI systems can provide immediately contextualized information to help students improve their responses, tone, and clinical reasoning during patient interactions. In this way, a real-time feedback loop accelerates learning and develops both communication competence and clinical judgment.

Finally, conversational AI fosters leadership and decision-making skills by placing students in active roles in patient-centered care situations. Students have to understand patients' responses and adjust their communication approach to make appropriate choices based on clinical expertise and empathy. This interaction not only helps students recognize their responsibility but also equips them to work effectively with interdisciplinary teams in a collaborative environment.

Communication is the foundation of effective and safe nursing practice, and an AI-driven tool can be used to develop these competencies in a structured yet flexible environment. These advances signal the growing demand for AI-augmented simulations within nursing education. In essence, as highlighted by Mishra et al. (2023), artificial intelligence-supported simulation environments provide the knowledge needed to teach technical and communication skills and to prepare students to work in an increasingly tech-enabled clinical setting, in which digital tools are a core component of patient care. Integrating with adaptive learning platforms, virtual patients, and conversational AI enables nursing programs to make

learning and training packages more scalable, accessible, and tailored. It also caters to various learning needs within a high-quality education.

In sum, AI-driven simulations increase clinical readiness by improving students' training in an evolving healthcare environment. They ensure equal access to quality training, particularly for students without direct access to traditional simulation tools. At the same time, they equip the new nurse workforce to think critically and competently about new technologies. Integrating technical competence with communication skills and ethical considerations, AI-enhanced education positions nurses to meet the ever-changing demands of contemporary healthcare and helps keep them focused on patient-centered care.

6.3. Benefits for Nursing Education

Simulation enhanced with AI enables nursing students to practice high-risk, low-frequency clinical scenarios that would be difficult or unsafe to recreate in real life. Using virtual and AI-powered simulations, learners can experience multiple complex scenarios such as cardiac arrest, sepsis, or neonatal emergencies without risking patient harm. Foronda et al. (2020) revealed that virtual simulation significantly improves learners' confidence and preparedness by providing exposure to rare events in a psychologically safe environment (Flo et al., 2021). Indicated that, as in the aforementioned report, students appreciate opportunities to make mistakes, reflect, and try again, and develop their clinical reasoning and decision-making skills.

These immersive experiences connect academic learning to hands-on clinical practice. Artificial intelligence (AI)-powered simulation enables nursing students to practice high-risk, low-frequency clinical situations that would otherwise be challenging, if not impossible, to replicate in practice due to cost or safety concerns. Through a virtual, AI-based simulation platform, students can rehearse patient care in complex, high-stakes situations (e.g., cardiac arrest, sepsis, or neonatal emergencies) with a lower risk of patient harm. This offers students the ability to practice acquiring the technical skills of making timely and appropriate decisions, applying clinical knowledge, and adapting to rapidly changing situations in an immersive environment, not the "normal" model. Over time, exposure to these scenarios allows users to learn what to do now and build confidence in emergencies that may not be part of traditional clinical placements.

One significant advantage of AI-enriched simulation is its ability to enhance learner confidence and readiness by incorporating rare but important events. Virtual simulation practice has been shown to greatly enhance students' preparedness for clinical practice by enabling them to "manage high-stakes situations" in a psychologically safe space (Foronda et al., 2020). In the context of clinical competence, learning through experimentation and risk-taking occurs, as does active problem-solving, both of which are important aspects of development. In this kind of environment, students can fail without fear of real-world repercussions, learn from their mistakes, and reflect on their solutions to new situations, thereby developing better learning and resilience.

AI-based simulations also help develop clinical reasoning and decision-making skills through practice and iterative feedback. Subjects go through the same problem over and over again, use new techniques, and get help with their decisions. Repetition in processing these experiences strengthens cognitive processing and facilitates pattern detection, intervention prioritization, and timely decision-making in a high-pressure situation. As Flo et al. (2021), observe, students appreciate the prospect of repetitive practice to develop self-confidence and the opportunity to be in a nurturing environment, both of which enhance their critical thinking.

This iterative learning method brings theory and practice together. In addition, the realistic clinical environment in AI-enhanced simulations makes practical classroom learning much more grounded in simulated experiences that feel quite real. These simulations facilitate real-world learning by creating lessons based on real-world situations, dynamic patient feedback, and in-system decision-making. Such realism not only promotes engagement but also prepares students to apply their skills in real-world clinical scenarios. In healthcare situations where these practices require sustained high levels of ability, it is essential that the healthcare system challenge training requires high competence and high adaptability.

AI-assisted simulation ultimately represents great promise for education, serving as an educational tool that enhances clinical readiness by combining experiential learning with technological innovation, making it the ultimate educational mechanism. It has the advantage of teaching nursing students vital competencies in a safe, controlled environment and preparing them to effectively manage increasingly complex, unpredictable clinical situations. It bridges the gap between theory and practice. With simulations like these, we build a nursing crew that is confident, competent, and adaptable to meet the needs of today's health care environment.

7. Comparison to the Traditional Simulation Techniques

A paper that makes evidence synthesis or effectiveness claims must demonstrate methodological transparency so that its conclusions can be independently verified. When authors state that they "present evidence," they are implicitly asserting that the findings are grounded in a systematic and traceable process rather than anecdotal interpretation. Reproducibility depends on clearly documenting how the evidence was gathered, evaluated, and integrated. Without this transparency, readers cannot determine whether the conclusions are supported by a rigorous process or whether they might change if the review were repeated by another researcher.

To achieve reproducibility, the paper must outline a detailed search strategy that specifies the keywords, Boolean operators, and conceptual frameworks used to locate relevant studies. This includes naming the databases searched, such as PubMed, CINAHL, PsycINFO, or Web of Science, and providing the exact date ranges covered. These elements allow other researchers to replicate the search and confirm whether the same body of literature emerges. A well-constructed search strategy also demonstrates that the authors attempted to capture the full scope of available evidence rather than selectively choosing sources that support a predetermined conclusion.

Equally important are the inclusion and exclusion criteria, which define the boundaries of the evidence considered. By articulating criteria such as study design, population characteristics, publication type, or methodological quality thresholds, the authors show how they determined which studies were appropriate for synthesis. These criteria prevent subjective filtering and ensure that another researcher applying the same rules would select the same set of studies. When combined with a transparent screening process, these methodological details strengthen the reliability of the synthesis and reduce bias.

Together, the search strategy, database selection, date parameters, and inclusion criteria form the backbone of a reproducible review methodology. When these components are explicitly described, the paper's effectiveness claims become verifiable because the pathway from raw evidence to final conclusions is fully traceable. This level of transparency not only enhances the credibility of the findings but also aligns the paper with established standards for evidence-based practice and systematic inquiry.

AI in nursing education can offer highly personalized instruction that, in turn, provides valuable feedback and continuous competency tracking, which is not possible in most traditional classroom settings. Artificial Intelligence (AI)-based solutions that combine data analytics and adaptive algorithms can monitor student learning and continuously enhance the learning environment.

This kind of personalization ensures that learners receive focused attention aligned with their competencies, strengths, and needs, making skill acquisition more affordable and relevant. A key feature of AI-based learning platforms is their ability to analyze student progress, outcomes, and clinical progress in real time. Such systems assist in diagnosing weaknesses in clinical reasoning, decision-making, and technical skills, providing a focus point and enabling immediate intervention.

For instance, AI simulation systems are capable of detecting trends (online student responses to questions) and error detection, thereby offering appropriate feedback towards a student's progress (Mishra et al., 2023). Feedback of this nature is particularly valuable in nursing education, where critical thinking and sound clinical reasoning lie at the heart of safe and effective patient care. In addition, AI-driven analytics helps educators monitor learners' performance at both the individual and cohort levels.

Incorporating performance data allows educators to spot trends and evaluate the efficacy of instructional strategies in achieving competency standards. This data-informed approach will tend to lead to more targeted curriculum planning and more specific interventions for students whom these efforts aim to reach. It will also increase accountability in learning because it provides more concrete evidence that kids are achieving and making progress.

Moreover, AI-driven personalized education encourages a more student-centered learning environment. Students work through at their own pace, revisit difficult content, return to challenging material, and receive ongoing feedback to reinforce their skills. By enabling greater autonomy, engagement, and ownership in

their learning journey. It also supports learners of all learning styles and backgrounds, making education more inclusive and accessible.

At the end of the day, AI in nursing school is a revolution toward personalized learning that utilizes data. Focused competency monitoring and feedback mechanisms alongside the ability to perform individual/cohort-level analysis make it possible for AI to prepare nurses in the future to work in healthcare complex environments. This process not only leads to higher educational achievement but also better equips nursing graduates to provide optimal patient-focused care in an era of constantly changing technology.

8. Comparison of AI-Enhanced Simulation and Traditional Simulation in Nursing Education

AI-enhanced simulation expands cognitive and analytical learning while traditional simulation remains indispensable for hands-on and interpersonal competencies. Together, they form a complementary model for preparing nurses for AI-enabled clinical environments.

Table 1. Comparison of AI-enhanced simulation and traditional simulation in nursing education.

Dimension	Traditional Simulation	AI-Enhanced Simulation
Scenario Adaptivity	Static, pre-scripted scenarios; limited ability to adjust complexity in real time.	Dynamic, algorithm-driven scenario modification based on learner performance; real-time escalation or de-escalation.
Feedback Mechanisms	Instructor-led debriefing; feedback quality varies by facilitator expertise.	Automated, data-driven feedback using NLP, LLMs, and performance analytics; consistent and individualized.
Exposure to Rare or High-Risk Events	Limited by faculty time, resources, and manikin capabilities.	AI can repeatedly and safely generate rare, complex, or rapidly evolving clinical events.
Clinical Reasoning Development	Strong for foundational reasoning but constrained by scenario variability.	Enhanced through adaptive case progression, predictive modeling, and structured decision-support feedback.
Psychomotor Skill Development	Essential for hands-on procedures, tactile learning, and physical assessment.	Limited; AI simulations excel cognitively but cannot replace tactile or procedural skill acquisition.
Team Communication & Interprofessional Training	Strong for in-person collaboration, communication, and shared decision-making.	Emerging AI-based virtual patients and chatbots support communication practice but lack the full dynamics of a team.
Scalability & Resource Requirements	Resource-intensive (manikins, faculty, physical space).	Highly scalable; accessible remotely; supports large cohorts with consistent quality.
Learner Evaluation	Subjective evaluation; dependent on facilitator observation.	AI-assisted evaluation aligned with INACSL standards; objective, multi-metric performance analytics.
Alignment with INACSL Standards	Strong alignment with Design, Facilitation, and Operations.	Strong alignment with Design, Evaluation, and Facilitation; gaps in Sim-IPE and Professional Development (per scoping review).
Ethical & Long-Term Outcome Evidence	Well-established.	Limited; few studies address long-term outcomes or ethical considerations (per scoping review).

Table Note: This table synthesizes conceptual differences between traditional simulation modalities and AI-enhanced simulation based on emerging evidence in simulation-based education and AI integration.

9. Evidence of the Effectiveness of AI in Nursing Education

Emerging evidence reveals that artificial intelligence (AI)-driven simulation remarkably improves learning results in nursing education. In contrast to traditional static simulation models, AI systems create dynamic, adaptive learning environments that evolve in response to student actions and decisions. With these systems, we have a much more interactive and immersive experience in which the learner's input directly affects the sequence of clinical scenarios. Consequently, students enter into a more realistic and challenging (and more cognitively demanding) simulation that accurately portrays the difficulties of actual practice.

AI-enhanced simulation expands cognitive and analytical learning while traditional simulation remains indispensable for hands-on and interpersonal competencies. Together, they form a complementary model for preparing nurses for AI-enabled clinical environments.

AI-enabled simulations also encourage involvement and immediate, real-time feedback, both of which are essential for learning. By constantly evaluating students' behavior, these systems deliver personalized feedback on the spot and support learners through long-term, sophisticated decision-making. This personalized engagement not only increases engagement level but also helps to foster a more profound understanding as students respond to being challenged to question the world around them and the clinical situation.

Unlike classic simulation models, which are based on written courses or predetermined procedures, AI-empowered systems enable students to respond to personalized learning. There is evidence to date that the effectiveness of such advanced therapeutic modalities on some high-level clinical skills is also increased. For example, (Mishra et al., 2023) found that clinical reasoning of nursing students while completing AI-based clinical simulations was significantly enhanced, with earlier recognition of patient deterioration, and greater decision-making accuracy as a result of learning AI. These findings coincide with a broader study on virtual simulation, which found that technology-based learning environments improve learner confidence, knowledge retention, and preparation for clinical practice (Foronda et al., 2020). Taken together, the above outcomes highlighted the potential of applying AI to educational simulations.

In addition, AI-based simulation platforms provide regular exposure to advanced, high-stress clinical scenarios that require rapid judgment and intervention. It is important that the repetitive use of methods continues to develop skills in areas such as patient monitoring, care prioritization, and timely clinical intervention. If students practice these skills in a safe, controlled environment, they develop confidence and hone their skills without risking harm to their patients. Having the chance to review challenges and seek feedback aids the learning cycle and encourages the development of a sound clinical skill set.

A major improvement in nursing education can be seen in the implementation of both teaching and learning elements, and in the role AI plays in simulation-based learning, the learning process is significantly improved. The AI simulation

can enhance students' knowledge and prepare them for this new era of medical knowledge by combining adaptability, on-the-fly feedback, and immersive AI-based scenarios. These tools not only facilitate learning outcomes but also equip future nurses with the critical thinking, clinical judgment, and decision-making skills required to deliver safe patient care in ever more complex clinical situations.

9.1. Research Demonstrating Improved Learning Outcomes with AI-Driven Simulation

When assessing the benefits of AI-driven and traditional simulation approaches, the literature identifies several advantages that positively impact the quality of education. Traditional manikin-based simulations have proven useful for psychomotor skill acquisition, but are constrained by limited flexibility in how they respond to learner performance and provide tailored feedback. On the other hand, AI-enhanced simulations can adjust the scenario's difficulty, generate patient responses based on students' actions, and provide immediate, personalized feedback, which can lead to deeper learning (Mishra et al., 2023; Flo et al., 2021).

qualitative review of virtual simulation experiences also underpins this dichotomy, concluding that students value flexibility, psychological safety, and the capacity to practice again and again offered by virtual and AI-supported simulations. This enables learners to fine-tune their clinical decisions without time pressure, resource scarcity, or performance anxiety, which typically result from conventional simulation labs.

In general, the evidence demonstrates that AI-driven simulation is useful and may have advantages over traditional simulation, particularly in enhancing cognitive and decision-making skills. The fact that AI can deliver very realistic, responsive, and tailored learning spaces that fit individual, highly contextualized learning environments supports students' clinical reasoning and prepares them for the complexity of today's healthcare world. Conventional simulations are still vital for training practical skills, but these experiences are augmented with AI-assisted tools, enhancing their utility by aiding diagnostic thinking, situational awareness, and the capacity to accommodate high-risk or uncommon clinical scenarios. With the progression of research, AI is being seen as a powerful instrument for transforming nursing education as a whole, as it accelerates the quality, access, and scalability of nursing education in the face of technology (Foronda et al., 2020; Mishra et al., 2023; Flo et al., 2021).

9.2. From Background to Evidence

AI-driven simulation has therefore gained increasing interest among nursing programs as a method to enhance clinical training and address the limitations of the traditional simulation environments. Although manikin-based and static virtual simulations have long served as foundational tools for skill development, they often lack the flexibility and personalized feedback necessary for deeper cognitive learning. AI-powered systems, on the other hand, introduce dynamic scenario

progression, real-time performance analysis, and personalized remediation pathways that align with modern competency-based education models. These distinctions lay the groundwork for an analysis of the growing body of evidence demonstrating the effectiveness of AI-enhanced simulation in improving learning outcomes and preparing students for complex clinical practice.

As nursing programs search for new methods to enhance clinical education content, artificial intelligence-driven simulation is gaining popularity to address gaps in traditional simulation environments and improve the clinical experience. While manikins and static virtual simulations have served as building blocks for teaching technical skills for as long as they have existed, they are often inflexible or lack personalized feedback, preventing students from developing their cognitive skills more deeply. These traditionally applied strategies were not necessarily appropriate for the complexities and variability of contemporary clinical practice, where fast decision-making and critical thinking in the field are required. AI-based simulation designs provide real-time learning environments that adapt based on students' performance. Therefore, these systems enable scenario advancement that adapts to learners' activities in real-time and make clinical encounters more realistic and dynamic.

AI platforms can be embedded with live performance assessments and feedback to help students' clinical decision-making through continuous monitoring and data analytics. This kind of responsiveness supports better learning as students can realize they have made mistakes, reflect on their reasoning, and reconsider how to remedy them. AI-driven simulations lead the way for customized remediation pathways consistent with competency-based education models. This way, students who display deficiencies in knowledge or clinical judgment can be further refined, and the ensuing learning experiences work to correct those particular deficiencies. This customized delivery process is conducive, on the one hand, to mastery learning through guiding students into mastery before proceeding to higher-level cases. It encourages a student who is more active and responsive in developing their skills.

Advanced AI, for example, can integrate various dimensions of clinical practice (e.g., technical skills, clinical reasoning, and decision-making under pressure) as a supplementary skill in simulations. In contrast to static simulations, often conducted with static scripts, AI-assisted systems can introduce variability, uncertainty, and unexpected complications that more closely resemble conditions in practice in the healthcare setting. This complexity also forces students to think about what matters, what interventions (and adaptations) to make, and to respond to the needs of changing conditions, enhancing their readiness for the real world of health care.

These differences provide a solid basis for reviewing this emerging research on AI-enabled simulation in nursing education. AI-driven, adaptive, real-time feedback, and personalized instruction are changing how clinical competencies are developed and evaluated. Most excitingly, including AI-enabled simulation will

enable nursing students to work most effectively in challenging clinical environments, prepare them more effectively, efficiently, and quickly for complex clinical situations, deliver safe, effective, patient-centric care, and prepare them for tomorrow's changing healthcare professional world.

10. Faculty Preparedness and Training Gaps

Faculty preparedness remains one of the most significant barriers to integrating artificial intelligence. The most challenging barrier, faculty preparedness continues to play a large part in the integration of AI in nursing education. For many nursing faculty, the lack of formal training in teaching AI, data science, and informatics contributes to their limited confidence in and ability to effectively teach new and emerging technologies. Faculty without core competencies in algorithmic processes, data literacy, and digital health tools may find it difficult to guide their students to critically evaluate clinical decisions made by AI (Booth et al., 2021). This void highlights the necessity for structured professional development in the form of workshops, micro-credentials, and interdisciplinary working with departments such as computer science and health informatics. Faculty development is necessary to prepare educators to navigate the rapidly changing digital environment and model effective use of technology for learners (Fawaz & Hamdan Mansour, 2021). Interprofessional collaboration not only enhances faculty specialization but also ensures AI teaching aligns with existing industry practices and ethical demands. In the absence of purposeful commitment to training faculty, the digital skills gap can be further entrenched, and students' preparedness for a technology-fueled workforce will be stunted in nursing.

Faculty preparedness is one of the greatest barriers to the effective implementation of AI in nursing education. Most nursing staff are untrained in AI, data science, or health informatics, which could affect their confidence in teaching new technologies to students. Since educators do not fully understand how algorithms work or how to interpret data or digital health tools, they may be unable to lead young adults in critically assessing AI-facilitated clinical decisions and in making connections between patient care practice and its consequences (Booth et al., 2021). Not only is this gap resulting in less effective delivery, but for students, it could leave them ill-prepared for healthcare positions in which AI is becoming a more central role in an ordinary day of clinical practice. To do so, there needs to be intentional focus on creating structured professional development opportunities.

Workshops, micro-credentials, and continuing education programs can support faculty in developing critical competencies in AI and related areas. And interdisciplinary collaboration with departments such as computer science, data analytics, and health informatics can also enhance faculty knowledge and perspectives on integrating AI into nursing curricula. Fawaz and Hamdan Mansour (2021) assert that ongoing faculty development is essential for preparing educators to navigate the changing digital landscape and to model effective and ethical

use of technology to support students. Collaborative efforts also enable AI instruction to be aligned with emerging industry and regulatory standards and best practices in patient care.

In addition, faculty readiness is necessary to advance equity and enhance the quality of nursing education in an age of technology. But if teachers are not prepared, their capacity for digital competencies will continue to lag, and this will be exacerbated by differences in institutions' access to resources. Adequate faculty are better able to design engaging learning experiences, be critical of AI tools, and help students learn to acquire both technical and ethical skills. With that, investing in faculty readiness equips nursing programs to harness the full value of AI while preparing graduates to participate confidently and responsibly in an increasingly complex integrated healthcare environment.

11. Curriculum Overload

While artificial intelligence in nursing education and practice has increased in significance, there are still limitations. In particular, for its use in information-based decision-making. Previous AI models rely almost exclusively on vast amounts of data to anticipate their behavior and train them. This collection of information is problematic, though. Its resemblance to real populations for whom such information is relevant and useful, regardless of social, economic, geographic, and cultural disparities, is questionable. If the data from these datasets are incomplete or biased, recommendations from AI systems might not generalize well across all patient populations and could sustain existing health care disparities. This also emphasizes the importance of training data used for AI systems being representative and inclusive, and consistently examined to ensure it is not biased.

The unequal access to AI at the school or university level is another implementation challenge and also contributes to the lack of available data. The larger nursing programs (which often offer baccalaureate and graduate degrees supported by AI-driven tools) have considerable financial, infrastructure, and grant support baked into their core activities for adopting these tools. Alternative programs, including the associate degree and practical nursing (LPN) programs, usually find it challenging to secure funding and navigate the logistics at these schools. As a result, AI adoption in nursing education remains uneven, and few programs currently use AI technologies, with a projected decline in the coming years. That imbalance sparks troubling equity questions: students with limited resources are less likely than their peers to be adequately resourced to take advantage of digital skillsets that would be necessary for the future, especially in one that involves healthcare.

These challenges are also relevant to the quality and representativeness of the data for use in AI systems. When such AI is developed and tested in large, affluent schools and in a particular area, the data generated may represent only a sliver of the entire population, increasing outcome bias. Instead, the key lies in actively diversifying data sources and deploying rigorous evaluation frameworks to expose

and mitigate bias in AI technologies. Knowledge of limitations and ways to mitigate them, as well as the design and use of AI systems that promote accessible, respectful, and diverse healthcare practices, will guide instructors' and developers' endeavors. Reflectively and critically reflecting on how we use AI is therefore essential to achieve a balance between the immense positive impacts of AI on nursing education and patient care, and the unintended adverse impacts on health and safety, which AI may have on the other.

12. Barriers to Integrating AI Literacy into Nursing Programs

One of the main hurdles to infusing AI literacy is the lack of accreditation standards. Despite the fact that both the American Association of Colleges of Nursing (AACN) and the Accreditation Commission for Education in Nursing (ACEN) acknowledge that practice advances through the integration of technology, they have not developed uniform competencies when it comes to AI, nor defined standards for AI literacy (AI literacy) as program outcomes. The Essentials Framework, created by AACN and incorporating informatics and data-driven practice, has not integrated such AI-related knowledge, skills, or attitudes among nursing graduates (American Association of Colleges of Nursing (AACN), 2021). This lack of homogeneous competencies leads to uneven curricula, assessments, and faculty preparation courses across programs. It also suggests that AI literacy development is often fragmented and unevenly disseminated across institutions, with a lack of national policy for AI literacy, relying on local knowledge, resources, and faculty comfort levels.

Artificial intelligence (AI) literacy is increasingly seen as essential to ensure that the next generation of nurses is equipped for data-driven, technology-assisted clinical care in nursing school. But extensive ethical, legal, and accreditation-related obstacles have blocked wide dissemination. Perhaps the most important concerns are the ethical considerations surrounding AI systems that process sensitive patient information. Nursing programs are subject to rigorous privacy regulations (such as HIPAA), which impose substantial limitations on access to genuine clinical data for educational purposes. Although high-quality datasets are required for many AI tools to learn, sharing or simulating patient information poses a risk of privacy violations and unauthorized data exposure (Birkholz et al., 2025). In addition, algorithmic bias raises the risk of AI systems providing unfair or potentially risky suggestions for specific demographic groups, thus further intensifying health inequities in nursing education and implementation. It is such ethical dilemmas that generate an understandable hesitation for faculty tasked with delivering safe, fair, and culturally sensitive teaching.

Legal and regulatory constraints are limiting the integration of AI literacy into nursing curricula. As AI technologies advance rapidly, outpacing healthcare regulations, some educators have been left without a clear understanding of what constitutes a legally permissible use of AI for teaching, simulation, or clinical de-

cision-support training. If the output of AI systems can lead to student misunderstandings, clinical errors, or inaccurate documentation practices, institutions need to evaluate their liability risk as well (Haleem et al., 2022). In simulation-based learning, the danger of this scenario becomes all too real; it is often suggested that the use of AI-enhanced tools may blur the lines between educational assistance and clinical decision-making. Without clear regulation, many nursing programs have been conservative in their approach, avoiding involvement and minimizing (or delaying) the use of AI tools due to potential legal liability.

One of the significant barriers to integrating AI literacy is the absence of accreditation standards. While the American Association of Colleges of Nursing (AACN) and the Accreditation Commission for Education in Nursing (ACEN) recognize that practice advances with the integration of technology, they have yet to define standardized competencies in AI and to outline AI literacy standards (AI literacy) as part of the program outcomes. The Essentials Framework, developed by AACN and integrating informatics and data-driven practice, does not cover the kinds of AI-related knowledge, skills, or attitudes among nursing graduates (American Association of Colleges of Nursing (AACN), 2021). This lack of standardized competencies results in inconsistent curriculum development, assessment policies, and faculty training pathways across programs. This also indicates that AI literacy development is frequently dispersed and unevenly implemented from institution to institution, without being nationally mandated, depending on local knowledge and resource bases and faculty comfort levels.

In combination, these ethical, legal, and accreditation constraints contribute to an environment resistant to innovation in nursing education. Programs need to accept that they must protect patients, students, and institutions without causing unintended adverse outcomes to seize the transformative power of AI-driven learning. Without regulatory parameters, competency frameworks, and ethical considerations in place, AI literacy is adopted slowly and unevenly across nursing programs. Only by creating joint responsibilities among educators, accrediting bodies, policymakers, and technology innovators will the incorporation of AI be made accountable and aligned with professional ethics and regulatory principles.

12.1. Ethical, Legal, and Accreditation Constraints

Ethical, legal, and accreditation challenges stand as barriers to incorporating artificial intelligence (AI) literacy into nursing education. One of the main concerns is privacy: specifically, where and how the patient's sensitive personal information can be entrusted to safe hands and protected. Beyond issues of privacy and bias, the development of AI technologies has outpaced the evolution of established legal and regulatory approaches. It generates confusion among educational institutions seeking to apply or adopt AI in their organizations while maintaining adherence to academic standards and the law. As a result, nursing schools may be reluctant to implement AI-driven technologies, mainly due to legal risks associated with their own inventions and potential side effects. This uncertainty can impede novel

thinking and hinder the adoption of tools that complement learning and clinical preparedness. Hence, institutions have to navigate a challenging environment in which technological advances often outpace the policies that govern them.

The difficulty deepens due to the general dearth of standardization of AI competencies within most nursing accreditation frameworks. In the absence of explicit expectations regarding the knowledge and skills nursing graduates should have in artificial intelligence (AI), educators may struggle to rationalize updates to curricula or investments in more AI-augmented learning contexts (World Health Organization (WHO), 2021). A lack of this clarity could lead to differences in how AI is taught across institutions and ultimately reduce students' preparedness. Achieving standardized competencies and alignment with accreditation standards will be a necessary precursor to rapid technological advancement in nursing education. Finally, the ethical, legal, and accreditation hurdles must be overcome to ensure the responsible and effective adoption of AI in nursing education and practice.

12.2. Concerns about Data Privacy, Algorithmic Bias, and Regulatory Compliance

Data privacy, algorithmic bias, and regulatory compliance concerns are major barriers to the infusion of artificial intelligence (AI) into nursing education. Data on AI-enhanced learning tools often come from large datasets that may contain sensitive patient data, thereby raising significant privacy and confidentiality concerns. The use of data should adhere to prescribed legal and ethical guidelines for nursing programs, but many educational agencies do not provide clear guidance on how to embed AI-enabled solutions in educational settings without risk (Booth et al., 2021). This uncertainty could hinder adoption and use; it might stifle educators' capacity to fully implement AI technologies while safeguarding patient trust and data security.

Algorithmic bias adds further complexity to the use of AI for learning and practice in nursing education. AI is trained on current datasets, which may not be representative of diverse populations; as a result, this may bias clinical recommendations for underrepresented or underserved patients. These biases can exacerbate existing healthcare inequalities and adversely affect patient care outcomes when not properly addressed. Accordingly, educators should engage in critical reflection, critically assess AI tools, help students critically evaluate such systems, and teach students to make sense of what they think their AI systems can do (and what they cannot). This critical consciousness is essential to being prepared, as we read the next generation of nurses to detect potential biases and apply AI outputs to our clinical decision-making in a responsible manner.

To address the above-mentioned issues, there is an emerging need for regulatory guidance, standardized best-practice guidelines, and regular collaboration among educators, policymakers, regulators, and providers in health education. Such work will be fundamental to ensuring that AI is embedded in nursing edu-

cation in a way that meets ethical, compliant, and aligned expectations and is consistent with efforts to improve patient care outcomes.

12.3. The Lack of Standardized AI Competencies in Accreditation Frameworks

Another obstacle to the integration of artificial intelligence (AI) in nursing education is the absence of standard AI competencies within accreditation systems, which hinders the consistent and meaningful adoption of AI literacy across curricula, as program implementation varies. While global public health agencies recommend digital transformation in the health sector, accreditors have not established clear expectations for the AI-related knowledge, skills, and attitudes that nursing graduates should possess. Thus, the lack of clear rules creates uncertainty for educators, leaving open questions about how widely AI content should be integrated into curricula and how student-level competency and knowledge can be measured.

According to the World Health Organization (WHO) (2021), there is an urgent need for increased digital and informatics competency among the nursing workforce. It acknowledges that educational systems have yet to effectively implement these competencies in practice. In the absence of well-defined standards or policies, nursing programs may struggle to justify curriculum redesign, secure institutional support, or allocate resources to advance AI-based digital learning activities. The upshot is that AI is being brought into nursing education, but some institutions are expanding rapidly, while others fall behind. Such inconsistency impacts not only curricula but also graduates' readiness to enter increasingly technology-led healthcare environments.

Furthermore, non-standardized competencies lead to different iterations of knowledge across schools, largely dependent on technological infrastructure and, more importantly, on resources. According to Fawaz and Hamdan Mansour (2021), ambiguous regulations and assumptions contribute to uneven use of digital tools, thereby further widening the gap in educational quality and access. That's been the outcome of unequal adoption of digital resources, which has widened the divide in educational standards and access to opportunities. Standardized AI competencies are therefore critical for the equitable preparation of nursing students and for integrating education with the increasingly dynamic needs of modern healthcare. This education could contribute to a more future-ready workforce, more adequately able to use AI responsibly in clinical practice by setting a well-defined objective that specifies expectations and integrates AI-learning values and practices into accreditation standards.

12.4. Resource and Infrastructure Limitations

Further, the lack of resources and insufficient infrastructure does not stimulate the diffusion of AI technology in nursing education. AI-led simulation platforms, virtual patient platforms, and next-gen analytics tools are costly, and most nursing

institutions, especially those with fewer resources, cannot afford to invest. Fawaz and Hamdan Mansour (2021) further explain this gap by comparing institutional financing and technical preparedness across institutions, which drive the disparity in access to digital learning technologies and could ultimately reinforce the resource-rich versus resource-poor gap. AI tools are also being introduced into institutions, with some critical challenges, such as old hardware, poor bandwidth, and minimal IT support, keeping them from integration in those places that adopt these technologies. The difference may create divergent aspects of nursing education, with AI-supported learning simply available to certain types of students.

Collectively, these ethical, legal, accreditation, and resource-related barriers illustrate the complexities of embedding AI literacy in nursing education. Integrating AI in a responsible and equitable manner to address these issues will require a partnership among educators, accrediting agencies, governmental stakeholders, service providers, and policymakers. We think, if not collectively addressed, that nursing education programs will be unable to equip emerging graduates with the skills that prepare them for technologically complex modern medicine: i.e., for having to prepare graduates for uncertainty; a lack of preparedness could be an underserved need for newly graduated nursing graduates, or a barrier to utilization of AI tech itself as a major lever by which to leverage benefits of this healthcare revolution.

The limited resources and infrastructure make it difficult for nursing to adopt artificial intelligence (AI). Investment in AI-powered simulation systems, virtual patient systems, and advanced insight technologies entails substantial upfront software outlay, system maintenance, and upgrades. Most institutions, particularly those with insufficient funding, are having difficulty allocating these resources to technologies (Fawaz & Hamdan Mansour, 2021). This means that AI adoption in nursing education is uneven, with highly resourced programs able to integrate sophisticated tools and under-resourced institutions unable to do so.

It presents several challenges to the implementation of an AI-based educational tool, and beyond financial constraints, multiple obstacles, given the disparity in technological infrastructure. In addition to existing infrastructure, institutions might not even have the hardware, internet bandwidth, or technical support to enable these innovations. Old equipment, constrained bandwidth, and limited access to IT specialists can severely hinder the effectiveness and scalability of AI-oriented learning applications. Such infrastructural challenges affect not only the quality of the operation but also lead to a disjointed and unreliable student process. Consequently, these resource and infrastructural discrepancies contribute significantly to the inequitable access of nursing students to AI-augmented learning.

Limited opportunities to engage with advanced simulation tools and digital technologies within institutions with limited technology resources may place students at a disadvantage in developing digital and clinical skills. Closing these gaps will also require strategic investment, institutional buy-in, and collaborative ef-

forts to expand the range of AI technologies available. In this regard, by focusing on the fair allocation of resources and the development of infrastructure, nursing education programs will enable all students to respond effectively to technology-dominated healthcare sectors and, as a result, be on the front lines of the evolution of technology-based nursing education.

12.5. Unequal Access to Technology across Institutions

Notably, the World Health Organization (WHO) (2021) stresses that unequal access to digital technologies is one of the most pressing challenges facing the world, with implications for the emerging nursing workforce. While digital tools and artificial intelligence (AI) are becoming an ever-present feature of healthcare systems, differences in access to these technologies can restrict educational opportunities for nursing students. Underperforming institutions may struggle to expose their graduates to more advanced AI-augmented learning environments, and graduates may be poorly prepared to interact with technology in advanced clinical settings.

This gap illustrates a wider problem of digital inequality and workforce readiness in present-day healthcare. Such a gap is part and parcel of the widening digital divide in nursing education, including the current divide between well-resourced institutions and those with fewer resources. Students in low-technology programs might not be able to acquire essential skills in data literacy, informatics, and AI in clinical decision-making. It is also important to note that this kind of disparity could have serious repercussions for individual health care and the entire field of health equity.

The challenges that must therefore be addressed in the areas of resourcing and infrastructure are absolutely critical if nursing students, irrespective of their unique educational contexts, are to have equal opportunities to develop the AI-related qualifications necessary to practice as professionals. Strategic investments should be made in digital infrastructure and accessibility in educational technology, as well as in partnership strategies among institutions. For equitable allocation of resources and access to digital learning tools, support also needs to be provided at the policy level and joint global efforts created. Focusing on all-inclusive technology use, with equal support for learning, is key to developing a more diverse and empowered nursing workforce to accommodate a more computerized healthcare environment.

13. Strategies for Advancing AI Integration in Nursing Education

Reform of nursing education curricula to include artificial intelligence (AI) is a deliberate, competency-based process that requires curriculum revision to integrate AI literacy across foundational, clinical, and leadership domains. Rather than AI as a standalone academic topic, curricula should incorporate digital health concepts that cut across core content areas such as anatomy, pharmacology, health

assessment, population health, and leadership. This cross-cutting approach also enables students to achieve a holistic view of how AI integrates with patient care and broader health systems. Embedding AI throughout the curriculum should prepare learners in nursing programs to apply technology in a wider range of clinical settings, leading to a more comprehensive, practice-ready educational design.

Incorporating AI skills across several disciplines helps students conceptualize the implications of AI in clinical decision-making, documentation, predictive analytics, and patient monitoring (Topaz & Pruinelli, 2020). It encourages the development of critical skills such as data literacy, ethical reasoning, and human-AI collaboration, all of which are essential for success in an era of increasingly technology-driven healthcare settings. These competencies, being practiced in different courses, further promote learning and enable students to relate theoretical knowledge to real-world applications. In an environment where AI will continue to influence how healthcare is delivered, nurses need to be prepared not only to use these tools but also to critically consider their outputs and limits.

Additionally, preparing the next generation of nurses requires adopting an educational paradigm fully aligned with the digital transformation of our healthcare system. As Birkholz et al. (2025) emphasize, nursing education needs to prepare students to interpret, critique, and safely implement AI-powered insights in clinical practice. This entails promoting critical thinking, adaptability, and ethical reasoning skills to ensure that AI complements, rather than supersedes, professional judgment. From a wide-ranging, competency-based perspective on AI integration, nursing programs can ensure their graduates not only have expertise with the technology but also the ability to practice safe, effective, compassionate care in an ever more complex, data-driven medical world.

13.1. Mapping Skill Sets and Redesigning the Curriculum

A targeted, competency-based redesign of nursing curricula with an emphasis on the use of artificial intelligence needs to incorporate AI literacy into initial, clinical, and leadership courses. It is not enough to treat AI as an isolated unit; training programs must incorporate digital health pedagogy across anatomy, pharmacology, assessment, population health, and leadership to help students learn the art of using AI. Embedding such concepts in the curriculum will better prepare learners to understand how AI influences clinical decision-making, documentation, predictive analytics, and patient monitoring in clinical practice areas (Topaz & Pruinelli, 2020). Integrating AI competencies into the curriculum further builds skills in data literacy, ethical reasoning, and human-AI collaboration that nursing graduates need as care delivery continues to utilize technology in this realm. As Birkholz et al. (2025) indicate, the future of the nursing workforce will depend on a curriculum that is compatible with the digital transformation of the healthcare environment, enabling students to safely and effectively interpret, evaluate, and follow up on AI recommendations.

Secondly, the second part of any new curriculum development is to align AI training in relation to the American Association of Colleges of Nursing (AACN)

Essentials (2021) and International Digital Health Frameworks, especially emphasizing informatics, data science, ethics, and systems-level thinking as core professionals' key competencies, a cornerstone of what makes or breaks AI professional competencies. In the AACN Essentials, all nursing education departments are to use digital health and decision support technologies embedded throughout the curriculum, including competency mapping of course objectives to national (American Association of Colleges of Nursing (AACN), 2021). The Global Frameworks (World Health Organization (WHO), 2021) also emphasize the need for nurses who can assess AI tools for safety, transparency, and equity. It would maintain its commitment to accreditation standards while teaching graduates how to navigate this developing technology of the future in a curriculum adapted to the field. Such AI education, aligned with these standards, would provide a solid foundation for a consistent, future-ready curriculum for nursing programs and serve as the backbone of regulatory compliance and patient care.

13.2. Redesigning the Curriculum, Mapping, and Competency Presentation

Altering nursing curricula to support the use of artificial intelligence requires a strategic, competency-based approach that embeds AI literacy throughout core, clinical, and leadership curricula. To ensure students achieve AI proficiency, programs should incorporate the principles of digital health into anatomy, pharmacology, assessment, population health, and leadership courses, and not as distinct components. This integration allows students to understand how AI affects clinical decision-making, documentation, predictive analytics, and patient monitoring at the practice scale (Topaz & Pruinelli, 2020). Furthermore, such curriculum infusion of AI competencies underlines the necessity of the students to acquire 'data literacy, ethical reasoning, and human AI collaboration' skills, skills that the field demands of graduates of nursing as technology integrates more into the routine care provider, as care delivery becomes increasingly informed by new systems of AI. As Birkholz et al. (2025) argue, we must adapt what we teach to a digitally advancing health care environment, which requires students to be equipped with competencies to interpret, critically appraise, and utilize AI-facilitated insights in a secure and efficient manner. An additional critical area for redesigning the curriculum will be to bridge AI teaching to the American Association of Colleges of Nursing (AACN) Essentials (2021) and the global digital health community framework by emphasizing informatics, data science, ethics, and systems-level thinking as key competencies for professional delivery of care.

The AACN Essentials support the integration of digital health platforms and decision-support technologies across all stages of nursing education and emphasize the critical importance of strategic competency mapping to align program objectives and priorities with national expectations. International standards (e.g., the World Health Organization (WHO)'s 2021 guide) also highlight the need for nurses to be equipped to evaluate AI tools for their safety, transparency, and eq-

uity. Incorporating curricula that address these objectives will enable programs to monitor compliance with accreditation standards and ensure that students are appropriately trained to investigate these emerging technologies responsibly. By placing AI education within a body of knowledge that resonates with nursing students' experiences and work settings, nursing and other nursing-related programs are positioned to develop curricula that are coherent, meet regulatory requirements, and provide good patient care.

13.3. Curriculum Redesign and Competency Mapping

Designing nursing curricula to incorporate artificial intelligence requires a competency-based approach to embedding AI literacy across foundational, clinical, and leadership courses. Instead of seeing AI as a separate module, programs should build digital health through integrating anatomy, pharmacology, assessment, population health, and leadership coursework, so all students master it as they progress. Such incorporation provides students with an opportunity to observe firsthand the influence of AI on clinical decision-making, documentation, predictive analytics, and patient monitoring (Topaz & Pruinelli, 2020). Integration of AI-related training opportunities into the curriculum would also support the development of data literacy, ethical thinking, and human-AI teamwork, essential capacities for nursing graduates as technology becomes an increasingly embedded part of the care delivery experience. As Birkholz et al. (2025) contend, preparing the future nursing workforce entails aligning professional content with the realities of a digitally transforming healthcare landscape in which students can safely and effectively comprehend, evaluate, and apply AI-enhanced information.

A second important factor in curriculum redesign is AI teaching that aligns its learning with both the American Association of Colleges of Nursing (AACN) Essentials (2021) and global digital health frameworks, and prioritizes informatics, data science, ethics, and systems-level thinking as key professional competencies. The AACN Essentials call for the use of technologies to enhance decision-making support and digital health across all nursing roles, as well as for codified curricular mapping of course outcomes and curriculum to national goals. International platforms, such as those of the World Health Organization (WHO) (2021), highlight the imperative need to educate nurses to evaluate AI tools in the context of safety, transparency, and equity. This is why aligning curricula with these standards is crucial: it ensures curricula meet accreditation criteria and graduates are trained to function responsibly with leading-edge technologies. By grounding AI education in professional practice frameworks, nursing education programs ought to create coherent, future-ready curricula that align with these measures within an evolving set of professional standards, thereby promoting regulatory compliance and quality of patient care.

13.4. Collaborations with Computer Science, Data Science, and Informatics Departments

Nursing programs and disciplines, including computer science, data science, and

informatics, need to work together more than ever as artificial intelligence (AI) radically changes the way healthcare is delivered. According to the American Association of Colleges of Nursing (AACN) (2021), current nursing education programs must train graduates to utilize new technologies to help accelerate clinical decision-making and improve patient outcomes. Utilizing technical units provides the opportunity for nursing faculty and students to collaborate with specialists in the domains of algorithm development, data structures, and computational modeling, all essential capabilities to improve nurses' clinical competence. Such partnerships enable novel tech advancements to be further translated for patient care. To this end, Topaz and Pruinelli (2020) describe how interdisciplinary collaboration is essential in achieving AI solutions that meet clinical needs while remaining ethical and sensitive to clinical practice in real-world healthcare settings. Working closely with computer scientists and other data scientists, nursing educators can share perspectives on clinical care that inform algorithm development to improve patient experience, with AI systems appropriately providing care for the diversity of patients, ensuring safety in service, and the realities of working in healthcare. This is also supported by the World Health Organization (WHO) (2021), which believes that equitable and sustainable digital health ecosystems aligned with the global health objectives will require a multi-sector collaborative environment.

Due to the increasing use of artificial intelligence (AI) in the healthcare industry, the need for interprofessional collaboration in nursing education (correlations with diverse disciplines, such as computer science, data science, and informatics) is growing in importance. American Association of Colleges of Nursing (AACN) (2021) emphasizes that contemporary nursing programs need to equip graduates with the ability to communicate with faculty and collaborate across disciplines to utilize new technologies and interventions that have the potential to improve clinical decision making and patient outcomes. Collaborations with technical departments allow nursing faculty and students to work alongside specialists skilled in algorithm development, data structures, and computational modeling, all of which increase nursing's clinical knowledge. The partnerships provide a link between technological advances and how patients use them in daily life.

Topaz & Pruinelli (2020) note that, to develop relevant AI tools that comply with ethical guidelines and tackle real health care challenges, interdisciplinary cooperation is needed. Working with computer and data scientists to create and implement AI systems, nursing educators can draw on clinical perspectives focused on patient diversity, safety, and practical workflow considerations for algorithmic design. The World Health Organization (WHO) (2021) corroborates this attitude and suggests that "cross-sector collaboration is essential in developing digital health ecosystems that are equitable, sustainable," and in support of "global health imperatives."

13.5. Faculty Development and Interprofessional Partnerships

Faculty development and interprofessional collaborative partnerships are key to

nursing programs' efforts to enhance the integration of artificial intelligence (AI) and data-driven technologies in both learning and practice. Partnerships between nursing faculty and experts in computer science, data science, and informatics on issues related to algorithm design, data structures, and computational modeling further facilitate learning opportunities. Such partnerships help bridge the divide between technology development and clinical implementation and provide a means to develop and evaluate AI-based tools relevant to how care is delivered in practice to real patients. By integrating digital health competencies that address the evolving healthcare landscape, interdisciplinary collaboration improves curricula (American Association of Colleges of Nursing (AACN), 2021).

Such partnerships also help create relevant and ethical, patient-centered AI tools. In relation to these critical lenses. Topaz and Pruinelli (2020) contend that only nurses can paint the important context surrounding workflow, patient diversity, and safety in a way that most technical disciplines do not. Nursing faculty collaborate with data scientists and informaticians who are helping to define transparent, equitable, and clinically informed AI systems. World Health Organization (WHO) (2021) reinforces the importance of cross-sector partnerships and states that digital transformation requires shared expertise to ensure the safe use, impact, and accessibility of technologies.

Furthermore, faculty education initiatives (such as workshops, microcredentials, and continuing education) enhance readiness for the adoption of AI in the nursing workforce. According to American Association of Colleges of Nursing (AACN) (2021), academic programs must develop digital fluency and data literacy to effectively teach students to use digital technologies for teaching and learning. Workshops and micro-credentials in a short, individual format have been developed to enable educators to learn in this area and to support learning opportunities that offer them a wide, personal perspective and insights into fundamental areas such as machine learning, data ethics, and clinical informatics. This technology and the applications that such programs provide ensure that faculty members can keep up with ever-shifting technology without a sustained lack of time as professionals, without meaning an absence from teaching or clinical duties.

Continuing education is likewise vital for long-term performance. As Topaz and Pruinelli (2020) also note, the pace of digital innovation requires continuous training for educators on their roles in supporting students' use of AI tools while maintaining confidence in their responsible use. Correspondingly, this necessitates sustained investment in developing and maintaining the human capital of the digital health workforce, so that faculty are ideally positioned to demonstrate the safe, ethical, and effective use of AI in clinical practice (World Health Organization (WHO), 2021). All of these work together to ensure that nursing programs are agile in technological areas and equipped to prepare graduates for a technology-driven health care future.

13.6. Faculty Workshops, Micro-Credentials, and Continuing Education

Faculty development workshops, micro-credentialing, and other continuing edu-

cation programs are essential for educators to successfully infuse artificial intelligence (AI) into nursing education and practice. With the increasing use of AI in healthcare, faculty must be able to incorporate ideas that build competencies in digital fluency, data literacy, and informatics into their teaching settings. According to American Association of Colleges of Nursing (AACN) (2021), faculty preparedness is critical to embedding AI principles into curricula and training students in clinical delivery in our current environment. Workplace easily accessible professional training opportunities, e.g., workshops and micro-credentialing programs, offer teachers flexibility in establishing the groundwork (from the likes of machine learning, data ethics, to clinical informatics) on the curriculum without taking long or hard courses.

Continuing student learning is equally as important to sustaining faculty competence in these technology-fuelled developments as facilitating access to such technology. AI and digital health solutions are constantly evolving at high velocity and require continuous learning and openness to change. Faculty can continue to develop their teaching knowledge and skills through ongoing professional development opportunities that focus on emerging technology and best practices as they teach in their classrooms. Topaz and Pruinelli (2020) highlight the role of continuous professional development in building competence with digital health technologies, empowering nursing staff to practice in a clinical setting increasingly driven by data. This lifelong learning not only enhances the quality of instruction but also enables evidence-based, technology-driven nursing practice in nursing education.

Moreover, global perspectives provide further evidence of the need for continued investment in digital health workforce training for educators and practitioners alike. The World Health Organization (WHO) (2021) emphasizes that the development and retention of digital competencies are essential for healthcare providers to apply AI effectively in practice. By ensuring faculty development focuses on organized, ongoing learning experiences, nursing programs can deepen their skills in teaching and learning with AI in a new-age workforce. At the end of the day, investing in faculty readiness will prepare educators to help students develop the technical, ethical, and clinical skills needed to cope with an ever-more sophisticated and technology-fuelled health care system.

13.7. Ethical and Responsible AI Frameworks

The curricula also can educate ethical responsibility in nursing curricula by focusing on how ethical nursing competencies are tied to the technical skills to be demonstrated by both new RNs and nursing graduates, in what future students in nursing would think and care for their patients, to train ethical choices, thereby creating graduates who will be able to make reasonable and responsible decisions (on a patient-centered healthcare system when needed) in open, transparent, and accountable ways. Finally, the inculcation of ethics in AI education ensures the use of artificial intelligence applications is equitable, i.e., that the use of artificial

intelligence is put to good use in an equitable manner, that is to say, it creates safety and trust in the healthcare system.

Using case studies and ethical simulations enables students to explore these issues firsthand and enhance their knowledge of AI-related ethical considerations. Such activities provide students with realistic cases to consider issues of algorithmic bias, data privacy, informed consent, and the implications of becoming overly dependent on automated decision support. The American Association of Colleges of Nursing (AACN) (2021) recommends using active learning techniques that enable students to apply ethical constructs in messy situations, thereby enhancing their competence as active conversants with new technologies in clinical practice. Ethical simulations also encourage reflective thinking: Students are prompted to consider how AI might affect patient autonomy, clinical judgment, and equity in care. Topaz and Pruinelli (2020) report that ethical discussions, structured on topics like these, are critical for future nurses to have the tools of critical thinking that enable them to assess and evaluate AI tools responsibly; or as reported by World Health Organization (WHO) (2021), digital health education should train healthcare practitioners to safeguard the fundamental human rights, transparency, and accountability that must be upheld when utilizing an AI-driven system to enhance care.

13.8. Training Students to Evaluate AI Systems for Safety, Equity, and Transparency

For AI-based tools to be applied safely and ethically in clinical settings, nursing students should be trained to critically evaluate them. Among nursing students, the American Association of Colleges of Nursing (AACN) (2021) describes core skills in ethics, data literacy, and technology assessment. By instructing students on how to vet AI systems for bias, transparency, and safety, they are taught how algorithms are arrived at and what the consequences of those decisions are for patient care. Data sources, modeling assumptions, and prospective differences in predictive performance across patient groups are considered components in this evaluation. AI systems trained on biased or incomplete data can unintentionally create and reinforce those gaps (Topaz & Pruinelli, 2020). They must see the full spectrum of what can be produced through such technologies and how best to protect the personal rights of patients involved. Such training is extremely important as it helps students understand the meaning and legitimacy of what AI produces, rather than receiving everything the AI says as gospel. Also, World Health Organization (WHO) (2021) highlights the need for ethical monitoring and transparency in digital health technologies, in which healthcare practitioners must be able to identify potential risks, advocate for patients, and implement AI responsibly.

13.9. Weaving in Case Studies and Ethical Analysis

Integrating ethics-focused courses into nursing education when they implement

AI enables students to tackle the most critical issues as they relate to algorithmic bias, data privacy, informed consent, and the wider impact of using automated decision-making tools. Integrating these fundamental issues into the curriculum enables students to investigate the ethical aspects of technological advances and their implications for patient care. This active learning model is also supported by the American Association of Colleges of Nursing (American Association of Colleges of Nursing (AACN), 2021), which advocates increasing students' awareness of ethical dilemmas and equipping them with strategies to address the complexities of technology integration in nursing practice.

Simulation-based ethics activities additionally help to extend this learning through self-reflection and reflective practice. Students are prompted through structured scenarios and facilitated discussion to think about the impact of artificial intelligence on clinical judgment, patient autonomy, and fairness in healthcare delivery. These circumstances enable students to think thoughtfully about real-life situations, examine competing viewpoints, apply critical thinking to scenarios, and consider the implications of ethical dilemmas. Engage in reflective, dialogue-based learning, as identified by Topaz and Pruinelli (2020), to develop the critical-thinking abilities needed to understand AI insights and apply them responsibly in healthcare.

In addition, the focus on ethics-based education is vital to ensuring that future nurses are trained to comply with professional standards and human rights in a rapidly digitized health care system. According to the World Health Organization (WHO) (2021), we need educational frameworks to equip healthcare professionals with the knowledge and accountability required to implement AI responsibly. The curricula also can teach ethical responsibility in nursing curricula and by focusing on how ethical nursing competencies are tied to the technical skills the new RNs and nursing graduates will demonstrate, that is, in what they want students in nursing, and future graduates would think and care for their patients, to train ethical choices, thereby creating graduates who will be able to make reasonable and responsible decisions (on a patient-centered healthcare system when needed), open, transparent and accountable. Last but not least, the inculcation of ethics in AI education ensures that the use of artificial intelligence applications is equitable, i.e., that it is put to good use in an equitable manner, thereby creating safety and trust in the healthcare system.

13.10. Institutional Leadership and Policy Support

Institutional leadership and policy support are key to the strategic implementation of artificial intelligence (AI) across nursing schools and healthcare institutions. Strategic planning ensures that integration is consistent with curriculum, accreditation, and workforce objectives over the long term. According to the American Association of Colleges of Nursing (AACN) (2021), it is essential for academic decision leaders to intentionally integrate digital health and data science competencies into nursing education to develop students prepared to practice in tech-

nology-rich clinical settings, such as hospital nursing. This necessitates clear priorities, governance structures, and ethical guidelines in leadership to underpin safe and responsible AI use. Topaz and Pruinelli (2020) also support the argument that leadership should focus on issues such as data governance, algorithmic transparency, and interdisciplinary collaboration to ensure AI tools are implemented in ways that enhance, rather than disrupt, clinical workflows. World Health Organization (WHO) (2021) emphasizes the need for strong leadership when implementing digital transformation in health.

Successful digital health transformation is predicated on strategic planning that links institutional objectives to national and global health priorities. Infrastructure investment and access are also key factors in institutional readiness for AI uptake. Nursing programs need a robust IT infrastructure that includes simulation platforms, secure data systems, and reliable digital tools to support AI-enabled teaching and learning. The American Association of Colleges of Nursing (AACN) (2021) argues that for all students, regardless of socioeconomic status or place of residence, access to technology must be fair and equitable so that all students acquire digital competencies (American Association of Colleges of Nursing (AACN) 2021). Without targeted investment, differential access to technology can lead to inequalities in clinical competency and workforce readiness. Similarly, World Health Organization (WHO) (2021) underscores that digital health action must be centered on equity, so that technological tools do not exacerbate existing disparities in health care access or education. Equitable access to AI tools, along with equitable workforce training and engagement (Topaz & Pruinelli, 2020), is essential to developing a nursing workforce able to interact with data-driven healthcare systems and to advocating for and ensuring fair, patient-centric AI integration, they argue.

13.10.1. Planning on Strategic AI Adoption

The American Association of Colleges of Nursing (AACN) (2021) mandates that academic leaders formulate well-defined strategic plans to integrate AI with curricular objectives, workforce requirements, and accreditation criteria. They describe institutional leadership as critical to guiding the strategic embedding of AI in nursing programs and healthcare organizations. Strategic planning to adopt AI not only supports its use but also ensures that its application is intentional, evidence-based, and aligned with longer-term educational change and the future, rather than fragmentation or reactivity. Topaz and Pruinelli (2020) highlight that leadership needs to design governance structures surrounding data governance, ethical supervision, and interdisciplinary collaboration as well. That is to say, creating policies to build support for safe AI use, protecting patient data, and making algorithmic decisions more transparent for patients. World Health Organization (WHO) (2021) highlights the importance of strong institutional governance, which is supported by the fact that strong digital health policy requires strong leadership, cooperation at all levels, coordinated leadership and effective collabo-

ration, stakeholder involvement, and linking these strategies to national and global health priorities (World Health Organization (WHO), 2021).

13.10.2. Infrastructure and Fair Access

The widespread incorporation of artificial intelligence (AI) into nursing education is only possible with major investments in the technology, a trained workforce, and access for all students. The lack of these fundamental components could make the deployment of AI systems-aided learning tools imprecise and ineffective. The American Association of Colleges of Nursing (American Association of Colleges of Nursing (AACN), 2021) reminds us that nursing education programs, for their part, need to provide students with tools, simulation systems, and data-driven resources for AI-based learning. Such resources are critical in building skills in clinical decision-making, data interpretation, technology use, and other clinical competencies.

There are varying degrees of exposure, leading to uneven development of digital competencies and clinical experience among students in the absence of sufficient infrastructure. Poor infrastructure leads to great discrepancies in how the students learn and integrate AI-derived skills. Low availability of consistent broadband connectivity, appropriate information security, or innovative digital platforms may impact the efficiency of AI-based education. The World Health Organization (WHO) (2021) suggests that a focus on equity should be core to digital health efforts to minimize the potential for new technologies to magnify existing disparities in schooling or healthcare provision. In the absence of resources to effectively integrate these technologies, students are challenged in acquiring the skills needed to function effectively in the era of enhanced technological contexts.

There is an urgent need to identify the challenges and address them through targeted investments in infrastructure and equitable access. Such efforts will include broadening broadband access, fortifying cybersecurity and data management protocols, and creating more inclusive digital platforms that facilitate learning across differences. Topaz and Pruinelli (2020) emphasize that equitable access to AI tools and education is necessary to prepare a nursing workforce adept at interacting with data-based healthcare systems and advocating for patient-centered uses of AI. Placing such an investment in nursing education will further guarantee that everyone who attends this school, regardless of the setting in which their education is placed, possesses the necessary skills to succeed in a competitive environment in which healthcare services are not only delivered, but also are able to make meaningful contributions to improved patient care.

14. Conclusion

By introducing continuous monitoring and data analytics, AI platforms can be embedded with live performance assessments and feedback to assist students in clinical decision-making. This kind of responsiveness contributes to enhanced learning by allowing students to recognize when they have made a mistake, reflect

on their reasoning, and reconsider how to fix it. AI-driven simulations lead the way for tailored remediation pathways aligned with competency-based education models. In this manner, students who exhibit deficiencies in knowledge or clinical judgment can be further refined, and subsequent learning experiences work to compensate for these deficiencies. In this way, this tailored delivery process facilitates mastery learning by leading the student toward mastery before moving on to higher-level cases. It also incentivizes students who are more active and responsive when learning.

More importantly, when considered alongside traditional simulation approaches, AI offers greater flexibility, personalized feedback, and competency tracking, making it especially well-suited to developing the cognitive and analytical skills crucial to modern nursing practice. While hands-on psychomotor training in traditional simulations is important for psychomotor learning from the very beginning, AI-based platforms support these experiences by bolstering diagnostic skills and preparing students for the many tasks expected in patient care. Indeed, as technology advances, AI has been viewed as an essential component of the future of nursing education, shaping the nature of nursing in general and education in particular from a clinical perspective, and will enable the preparation of talented clinicians, as well as those who are professionally trained.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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