Educational Strategies for Enhancing AI Literacy among Nursing Students: A Systematic Review

Siti fatimah Md Shariff*, Joemmaicca Augustta anak Joggery, Noor Siah Abdul Aziz

Faculty of Technology and Applied Sciences, Open University Malaysia, Kelana Centre Point, Jalan SS 7/19 / Ss7,47301, Petaling Jaya, Selangor.

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0698

Received: 15 November 2025; Accepted: 24 November 2025; Published: 28 November 2025

ABSTRACT

Background: Artificial intelligence (AI) is rapidly entering nursing education and practice, yet AI literacy among nursing students remains uneven, with gaps in foundational knowledge, ethical reasoning, and applied clinical judgment.

Objective: To synthesize educational strategies that enhance AI literacy among nursing students and identify outcome patterns, barriers, and implementation enablers to inform curriculum, assessment, and policy.

Methods: A systematic literature review (2015–2025) was conducted across PubMed, Scopus, ScienceDirect, CINAHL, and ERIC. English-language, peer-reviewed studies focusing on pre- or post-licensure nursing students and reporting AI-related educational outcomes were included. Two reviewers independently screened records, extracted data into a structured matrix, and appraised quality using CASP (qualitative) and JBI (quantitative/mixed-methods) tools. Narrative and thematic synthesis was used to integrate findings.

Results: Of 364 records identified, 47 duplicates were removed; 317 titles/abstracts were screened, 63 full texts were sought (60 assessed), and 28 studies met inclusion. Four pedagogical themes emerged: (1) simulation-based learning using AI-enabled or GenAI-supported scenarios; (2) online/blended modules for scalable foundational concepts; (3) problem-/case-based learning (PBL/CBL) to situate AI within clinical reasoning and communication; and (4) cross-disciplinary/policy approaches aligning competencies, assessment, and governance. Across diverse settings, interventions improved knowledge, confidence/readiness, and higher-order thinking. Transfer to clinical judgment was strongest for PBL/CBL and simulation with structured debriefs. Recurrent barriers included limited faculty readiness, student anxiety about AI's impact on nursing identity, infrastructural constraints (devices/connectivity), and uneven treatment of ethics, bias, and accountability. Studies rarely measured longitudinal behavior change or patient-centered outcomes.

Conclusions: AI literacy is achievable at scale when foundations are delivered via blended learning, transfer is secured through PBL/CBL, and safe practice is consolidated through simulation and guided debriefing—underpinned by robust assessment, faculty development, equitable infrastructure, and clear policy for human-in-the-loop accountability. Future research should adopt standardized measures and longitudinal designs to link classroom gains to clinical behaviors and patient outcomes.

Keywords: nursing education; artificial intelligence; AI literacy; simulation; blended learning; problem-based learning; curriculum; ethics; faculty development; systematic review.

INTRODUCTION

Artificial intelligence (AI) is rapidly reshaping healthcare by augmenting clinical reasoning, diagnostics, workflow efficiency, and patient safety. As the largest segment of the global health workforce, nurses increasingly encounter AI-enabled tools—from risk prediction models and decision-support systems to conversational agents—within academic, clinical, and community settings. These shifts make AI literacy a core competency for contemporary nursing practice. Yet, evidence from nursing education reveals uneven readiness: many students report curiosity and positive attitudes toward AI, but demonstrate limited knowledge, inconsistent skills, and uncertainty about appropriate, ethical use. At the same time, faculty cite gaps in expertise, curricular time, and institutional support, while persistent infrastructure constraints risk widening digital inequities between well-resourced and resource-limited contexts. Collectively, these factors underscore an urgent need for coherent educational strategies that build practical competence, critical judgment, and ethical awareness in AI use for nursing.

Within this context, AI literacy in nursing extends beyond basic digital familiarity. It involves understanding foundational concepts (e.g., data, models, and outputs), interpreting and communicating AI-derived insights, appraising strengths and limitations (including bias, fairness, and transparency), and integrating AI responsibly into care and learning environments. Preparing nursing students therefore requires intentional alignment of pedagogy, assessment, faculty development, and policy frameworks. Early integration across the curriculum, scaffolded practice opportunities, and explicit attention to ethical, legal, and social implications can help ensure that AI complements rather than displaces humanistic, patient-centred care.

This systematic review synthesizes educational strategies designed to enhance AI literacy among nursing students. Guided by PRISMA 2020 standards, it searched five databases (PubMed, Scopus, ScienceDirect, CINAHL, ERIC) for English-language, peer-reviewed studies from 2015 to 2025 and included qualitative, quantitative, and mixed-methods designs focused on pre- or post-licensure nursing students. Two independent reviewers screened and extracted data, with study quality appraised using CASP (qualitative) and JBI (quantitative/mixed-methods) tools. Narrative and thematic synthesis organized interventions into four broad categories: (1) simulation-based learning that affords safe, experiential engagement with AI-supported clinical scenarios; (2) online and blended learning that scales access and supports flexible, iterative practice; (3) problem-/case-based learning (PBL/CBL) that situates AI concepts within clinical reasoning; and (4) cross-disciplinary and policy approaches that embed competencies, standards, and governance considerations within curricula.

Across the included studies, simulation and blended formats consistently improved knowledge, confidence, and higher-order thinking related to AI, while PBL/CBL deepened transfer to clinical decision-making. Nonetheless, four cross-cutting barriers recurred: limited faculty readiness, student anxiety about the role of AI in nursing, infrastructure constraints (especially in low-resource settings), and insufficient coverage of ethics, bias, and accountability. Addressing these challenges requires multilevel action: targeted faculty development, structured mentorship for students, institutional investment in digital infrastructure, and policy-aligned curricula that integrate ethics throughout.

By mapping effective pedagogies, common barriers, and enabling conditions, this review offers a consolidated evidence base to guide curriculum design, educator capacity building, and policy alignment. Ultimately, strengthening AI literacy is essential to equip future nurses to partner with intelligent systems safely and equitably, supporting sound clinical judgment, compassionate care, and better health outcomes.

Accordingly, this systematic review had four objectives: (1) to identify and synthesize educational strategies that have been used to enhance AI literacy among pre- and post-licensure nursing students; (2) to examine patterns in AI-related learning outcomes reported in these interventions, including knowledge, confidence/readiness, higher-order thinking, and transfer to clinical judgment; (3) to identify recurrent barriers, facilitators, and contextual factors that influence the implementation of AI literacy strategies in nursing education; and (4) to derive implications for curriculum design, assessment, faculty development, and policy alignment to support safe, ethical, and equitable integration of AI in nursing education.

METHODOLOGY

This systematic literature review followed PRISMA 2020 to ensure rigor, transparency, and replicability, adopting a systematic review (SLR) approach to synthesize evidence on educational strategies that enhance AI literacy among nursing students. Comprehensive searches were conducted in PubMed, Scopus, ScienceDirect, CINAHL, and ERIC for English-language, peer-reviewed studies published from 2015 to 2025, using Boolean operators and controlled vocabulary (e.g., MeSH) across AI-, education-, and competency-related terms. Example strings combined concepts such as “artificial intelligence,” “machine learning,” “nursing education,” “nursing students,” “literacy,” and “curriculum” to maximize coverage.

Inclusion criteria comprised empirical qualitative, quantitative, or mixed-methods studies focusing on pre- or post-licensure nursing students and examining educational strategies for AI literacy or related competencies.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue XXVI November 2025 | Special Issue on Education

Exclusion criteria removed non-nursing populations, studies lacking educational outcomes, purely technical AI papers, editorials/opinions/grey literature, and studies published before 2015.

Records were exported to Zotero, duplicates removed, and titles/abstracts independently screened by two reviewers. Full texts were retrieved for potentially eligible studies, with disagreements resolved by consensus. In total, 364 records were identified; after removing 47 duplicates, 317 remained for screening, from which 254 were excluded at title/abstract level. Sixty-three full texts were sought (three not retrievable), 60 were assessed, and 32 were excluded for predefined reasons (non-nursing populations, no educational intervention, clinical AI only, or duplicate conference versions), yielding 28 studies for synthesis.

Methodological quality was appraised using CASP for qualitative studies and JBI tools for quantitative and mixed-methods designs; no study was excluded solely based on quality, but appraisal informed interpretation. Data were extracted into a structured matrix capturing study characteristics, participants, interventions, outcomes, and key findings. Narrative and thematic synthesis then organized educational strategies into simulation-based learning, online/blended learning, problem-/case-based learning, and cross-disciplinary/policy approaches, in line with PRISMA reporting and to support transparent, reproducible synthesis.

Search Results and Study Selection (Prisma 2020)

A total of 364 records were initially identified through the database searches. After removing 47 duplicate records, 317 unique records remained and were screened based on titles and abstracts. From this screening, most records were excluded as clearly irrelevant, and 63 reports were considered potentially eligible and therefore sought for full-text retrieval. Of these, 3 full-text reports could not be retrieved, leaving 60 full-text articles that were successfully obtained and assessed in detail against the inclusion and exclusion criteria. Following this eligibility assessment, 32 full-text articles were excluded (for reasons such as inappropriate population, intervention, outcome, or study design), and finally 28 studies met all criteria and were included in the systematic review.

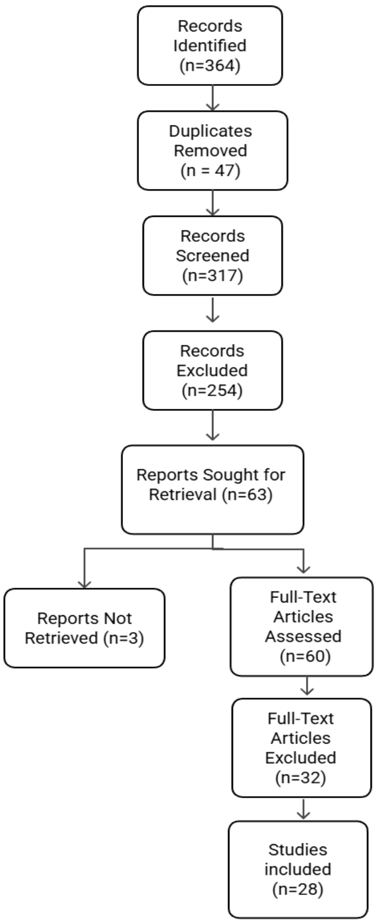

Figure 1. PRISMA 2020 Flow Diagram

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue XXVI November 2025 | Special Issue on Education

RESULTS

Twenty-eight studies from the United States, Asia, Europe, Africa, and the Middle East met inclusion, spanning quasi-experimental trials, cross-sectional surveys, mixed-methods evaluations, and descriptive designs. Four pedagogical themes consistently emerged.

Simulation-based learning. AI-enabled or GenAI-supported simulations, when coupled with structured debriefing, were associated with improvements in knowledge, confidence/readiness, and higher-order thinking skills (HOTS). These gains extended to decision-making transfer, as learners practiced interrogating AI outputs, escalating concerns, and documenting rationale for accepting or rejecting recommendations. Simulation also provided a psychologically safe environment for ethical reflection, bias awareness, accountability, and patient communication without risk to patients.

Online/blended learning. Foundational AI content (data types, model basics, performance limits, bias) was effectively delivered via online/blended modules. Asynchronous components supported iterative practice and flexibility, particularly beneficial where simulation resources were limited. Positive shifts in preparedness and attitudes were common; however, effect sizes varied with depth/quality of content, platform usability, and educator capability, underscoring the need for standardized learning outcomes and validated rubrics.

Problem-/case-based learning (PBL/CBL). Case-driven activities improved transfer to clinical reasoning by positioning AI within authentic patient narratives and interprofessional dialogue. Learners demonstrated clearer judgment about when to rely on, qualify, or override AI outputs, how to communicate uncertainty, and how to integrate patient preferences. Cases explicitly addressing ethical dilemmas (e.g., fairness trade-offs, false positives/negatives, explainability) amplified these gains.

Cross-disciplinary/policy approaches. Collaboration with informatics/computer science, adoption of competency frameworks, and attention to governance (data protection, acceptable use, human oversight) served as structural enablers. Programs using these approaches more often reported coherent curricular maps and clearer assessment expectations.

Cross-cutting barriers recurred across settings: (1) limited faculty readiness to design, deliver, and assess AI-enhanced learning; (2) student anxiety about AI's implications for nursing identity and employability; (3) infrastructure constraints—device access, connectivity, safe sandboxes—especially in low-resource contexts; and (4) insufficient coverage and assessment of ethics, bias, and accountability. Geographically, US/European programs more frequently leveraged simulation/blended models, while initiatives in parts of Asia and Africa emphasized feasibility, digital readiness, and low-cost or hybrid designs tailored to variable resources, highlighting the importance of contextual adaptation rather than one-size-fits-all adoption.

In sum, simulation, blended learning, and PBL/CBL each demonstrate effectiveness for enhancing AI literacy among nursing students. Durable impact, however, depends on aligning pedagogy with robust assessment, faculty development, infrastructure equity, and policy clarity.

Table 1. Characteristics of Studies Included in the Systematic Review

No.	Author (Year)	Country / Context	Population / Setting	Study design	AI / Educational focus	Key AI-related findings / contribution (as used in this SLR)
1	Alqaissi & Qtait (2025)	Not specified (multi-context health sciences)	Nursing and health sciences education	Systematic review	AI use in nursing/health education: knowledge, attitudes, practices, barriers	Identifies effective strategies (incl. PBL, blended learning) and common barriers; supports your main pedagogical themes.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue XXVI November 2025 | Special Issue on Education

2	Amankwaa et al. (2025)	Global / multi-country	Nursing education	Scoping review (PAGER)	Use of ChatGPT/GenAI in nursing education	Maps current uses, opportunities and gaps for GenAI in teaching; underpins the need for structured GenAI literacy.
3	Batran et al. (2025)	Jordan (ICU context)	Intensive care nurses	Cross-sectional survey	Perceptions of AI in ICU nursing practice	Shows positive interest but anxiety and fear of replacement; informs your theme on identity, accountability and anxiety.
4	Gouda et al. (2025)	Egypt	Nursing students	Interventional / quasi-experimental	Simulation strategies for increasing AI knowledge and acceptance	Simulation with AI support improves AI knowledge and acceptance; key evidence for the simulation-based learning theme.
5	Ibrahim (2025)	Saudi Arabia	Nurses	Cross-sectional survey	Risk–benefit perceptions of AI adoption	Demonstrates mixed perceptions (benefits vs worries); supports your cross-cutting barrier on risk perception and trust.
6	Jadhav (2025)	India	Nursing students	Quasi-experimental	Case-based learning with AI support to enhance EBP literacy	Shows that AI-supported case-based learning enhances evidence-based practice literacy; core to your PBL/CBL theme.
7	Kgwadi et al. (2025)	Botswana	Nursing education institutions	Cross-sectional survey	Digital readiness for AI integration in nursing education	Documents digital/infrastructural constraints and variable readiness; underpins your equity/infrastructure barrier theme.
8	Li et al. (2025)	China	Operating-room nurses	Machine-learning modelling study	ML model to predict compassion fatigue in OR nurses	Provides a real clinical AI example; used in your SLR as a case for teaching evaluation literacy and AI-supported risk prediction.
9	Martin & Reid (2025)	USA	Prelicensure nursing programmes	National survey	Prevalence and integration of AI in nursing curricula	Shows uneven, early-stage integration of AI content; supports your claim that AI literacy is not yet systematically embedded.
10	McBride & Tietze (2018)	USA	Nursing/healthcare education	Conceptual paper	Nursing informatics as a foundation for AI in healthcare	Provides theoretical basis that informatics competencies underpin AI literacy; supports your cross-disciplinary/policy theme.
11	Porter & Foronda (2024)	USA	Nursing education	Conceptual/practice paper	Enhancing AI literacy to combat embedded bias	Highlights how AI literacy can address bias/fairness; supports your emphasis on ethics, bias and accountability in curricula.
12	Ronval et al. (2025)	France	Health students (incl. nursing)	Experimental study	TAGAL – tool for teaching tabular AI literacy	Demonstrates that targeted data-literacy tools can improve AI literacy and confidence; contributes to your blended/data-literacy subtheme.
13	Shah (2025)	Malaysia	Undergraduate nursing students	Cross-sectional survey	Perceptions of AI chatbots for learning	Shows generally positive but cautious attitudes; language/comprehension issues support your equity and blended-learning discussion.

14	Shishehgar & Murray-Parahi (2025)	Not specific	Students & academics in health education	Systematic review	Perceptions of AI in health education and practice	Synthesises perceptions, readiness and concerns; situates nursing within broader AI in health education landscape.
15	Simms (2025)	Not specified (nursing education focus)	Nurse educators / nursing education	Commentary / call to action	Generative AI literacy in nursing education	Frames GenAI literacy as an urgent agenda; supports your argument for programme-wide, proactive AI literacy strategies.
16	Song et al. (2025)	China	Nursing undergraduates	Interventional study	Effects of generative AI on HOTS and AI literacy	Shows that GenAI-enhanced activities improve higher-order thinking skills and AI literacy; key evidence for simulation/blended strategies.
17	Subaşi & Sümengen (2025)	Türkiye	Paediatric nurses	Cross-sectional survey	Perspectives, literacy and attitudes toward AI applications	Indicates mixed AI literacy and attitudes among practicing nurses; supports your point that AI literacy spans pre- and post-licensure levels.
18	Sümengen et al. (2025)	Türkiye	Nursing students	Cross-sectional study	Attitudes and literacy toward AI in nursing students	Documents baseline AI literacy and attitudes; supports your finding of high interest but uneven knowledge/skills.
19	Topaz & Pruinelli (2017)	USA	Nursing practice	Conceptual/overview	Big data and nursing: implications for AI-driven decision support	Describes how big-data and AI decision support reshape nursing work; underpins your "decision-support and evaluation literacy" discussion.
20	Trimaille et al. (2025)	France	Nursing faculty	National survey	Faculty barriers to integrating AI in nursing education	Identifies key faculty barriers (limited expertise, support, confidence); major source for your faculty-readiness barrier theme.
21	Watson (2025)	International / critical care context	Critical care nursing	Narrative review	Nurses' evolving role in AI-assisted critical care	Shows how AI reshapes roles, monitoring and decision-making; supports your argument that AI literacy includes professional/ethical dimensions.
22	Zhao et al. (2025)	China	Undergraduate nursing students	Cross-sectional survey	Knowledge, attitudes and challenges of AI use	Shows positive attitudes but low/uneven knowledge and perceived challenges; key evidence for baseline gaps and identity/anxiety issues.
23	Zhong et al. (2025)	China	Nursing workforce regulation	Policy/analysis paper	AI in nursing workforce regulation: policy implications	Highlights competency, safety, data protection and accountability requirements; supports your governance and policy-alignment implications.

24	Zhou et al. (2025)	China	Older patients; nurse-facing tool	ML modelling study (clinical)	Predicting delirium in older patients: implications for nursing education	Provides another clinical AI example; used to argue for teaching evaluation literacy (performance, bias, surveillance) using re

DISCUSSION

The SLR matrix highlights a converging narrative: diverse educational strategies—simulation-based learning, online/blended delivery, and problem-/case-based pedagogies—are each capable of improving AI-related knowledge, higher-order thinking skills (HOTS), confidence, and readiness among nursing learners. Yet these gains occur alongside persistent gaps: uneven faculty expertise, student apprehension about AI's role in nursing identity, infrastructural constraints in low-resource settings, and an underdeveloped treatment of ethics, bias, and accountability. Together, these findings suggest that AI literacy is both teachable and scalable, but only when instructional design, assessment, faculty capacity, and policy scaffolding are aligned.

Simulation-based learning emerged as a consistently high-yield modality. Quasi-experimental studies such as Song et al. (2025, China) and Gouda et al. (2025, Egypt) reported significant improvements in HOTS, AI literacy, and acceptance when generative AI (GenAI) or AI-enabled scenarios were embedded in clinical simulations. These simulations appear to support two complementary mechanisms: (1) authentic decision-making under time and information constraints, which encourages learners to interrogate AI outputs rather than accept them uncritically; and (2) safe practice spaces where error is de-risked and ethical reflection can be facilitated in real time. Importantly, the matrix suggests that simulation gains are not merely cognitive (knowledge/HOTS) but also affective and behavioral (confidence, readiness), a pattern congruent with skills that translate to clinical reasoning. However, sustainability hinges on faculty capacity to design, run, and debrief AI-infused scenarios, an issue that surfaces repeatedly in the barriers literature.

Online and blended learning formats show complementary strengths. Martin and Reid (2025, USA) identify limited adoption of AI modules across programs, yet where implemented, blended approaches improved reach and accommodated iterative practice without overburdening lab resources. Blended delivery appears particularly suited to foundational AI concepts (data types, model basics, performance limits, bias) and for preparatory work ahead of hands-on simulation. Moreover, asynchronous elements allow more equitable access for students balancing work or family responsibilities. Still, the matrix points to implementation gaps: program-level variation, uneven content quality, and a lack of standardized outcomes. These factors can dilute effect sizes and hinder cross-institution comparability, underscoring the need for shared competency frameworks and validated assessment rubrics tailored to nursing contexts.

Problem- and case-based learning (PBL/CBL) consistently strengthens transfer to clinical judgment. Jadhav (2025, India) demonstrated that case-based AI activities improved evidence-based practice literacy and integration, while Alqaissi and Qtait's (2025) review concludes that PBL and blended designs are among the most effective for AI-related competencies. PBL/CBL situates AI within patient stories and interprofessional decision points, making limitations (data drift, false positives/negatives, fairness trade-offs) visible and consequential. The matrix suggests students better appreciate when to rely on AI, when to override it, and how to communicate AI-informed decisions to patients and colleagues. The limiting factor, again, is faculty expertise: crafting authentic cases that balance technical depth with pedagogical clarity is non-trivial and time-intensive.

Beyond pedagogy, the matrix surfaces critical contextual factors. Large surveys (e.g., Zhao et al., 2025, China; Shah, 2025, Malaysia; Ibrahim, 2025, Saudi Arabia) reveal a recurring pattern: positive attitudes toward AI coexisting with low or uneven baseline knowledge. In several settings, student's express curiosity yet uncertainty about professional identity—will AI erode the "caring" essence of nursing, or will it extend nurse capacities? Batran et al. (2025, Jordan) further document anxiety about replacement or judgment by AI, signaling that curricula should explicitly address role evolution, accountability, and the enduring value of human clinical judgment and advocacy. Importantly, Kgwadi et al. (2025, Botswana) highlight infrastructural constraints and digital barriers in low-resource contexts. Here, even well-designed curricula falter without reliable connectivity, devices, and institutional support. These results suggest an equity imperative: institutional investment and national-level policy must accompany curricular innovation, or AI literacy may widen—not narrow—opportunity gaps.

The matrix also points to the translational interface between clinical AI and educational AI literacy. Although some included studies focus on nurse-facing AI tools in practice (e.g., Zhou et al., 2025, on delirium prediction; Li et al., 2025, on compassion fatigue detection), their relevance to education is twofold. First, they offer concrete, clinically meaningful exemplars that enrich PBL/CBL cases and simulations, showing students real use-cases, performance metrics (sensitivity/specificity), and ethical dilemmas (e.g., false alarms, surveillance concerns). Second, they foreground the need for "evaluation literacy": nurses must understand validation, generalizability, calibration, and bias mitigation to use AI safely. This is echoed in policy work that emphasizes competency and safety evaluation. In Europe, Ronval et al. (2025, France) illustrate that targeted data-literacy tools (e.g., TAGAL) can boost confidence, suggesting that granular, tool-specific interventions are helpful stepping stones toward broader competence.

Across studies, outcome measures cluster around knowledge, attitudes, confidence/readiness, and, to a lesser extent, higher-order thinking and application. The strongest gains are typically immediate and proximal (knowledge/confidence), with fewer studies tracking sustained behaviour change, clinical performance, or patient-level outcomes. This evidentiary gap is unsurprising given the nascent nature of the field, but it matters: to persuade sceptics and allocate resources, programs will need longitudinal indicators (e.g., performance in simulation OSCEs incorporating AI, preceptorship evaluations of AI use during clinical placement, or quality/safety metrics linked to AI-enabled tasks). A related gap is the relative under-measurement of ethical reasoning and bias detection as discrete competencies; while many interventions "cover ethics," fewer use validated instruments to assess ethical sensitivity, fairness reasoning, or accountability behaviors.

Faculty readiness is a universal bottleneck. Multiple survey findings converge on limited expertise and confidence among educators. Without deliberate investment—faculty workshops, co-teaching models with informatics/computer science partners, and repositories of vetted teaching cases—programs risk "checkbox integration," where AI appears in syllabi but fails to transform learning. Critically, the matrix suggests that co-design with clinicians and informaticians improves authenticity, while faculty communities of practice accelerate diffusion of effective methods and assessments.

Taken together, the findings support a layered strategy for curriculum design. First, establish a shared competency framework spanning foundational concepts, data and model literacy, critical appraisal, ethical/legal/social implications (ELSI), communication, and safe workflow integration. Second, align modalities to competence levels: blended modules for foundations; PBL/CBL to cultivate reasoning and communication; simulation for safe, high-fidelity practice under supervision. Third, embed robust assessment: pre–post knowledge tests, performance assessments (rubric-based OSCEs with AI tools), reflective writing focused on ELSI, and team-based evaluations capturing interprofessional communication. Fourth, invest in the faculty pipeline—micro-credentials, mentorship, time for curriculum development, and cross-school resource hubs. Finally, address infrastructure and equity head-on: provide device access, stable networks, and offline-ready materials where needed; prioritize open-source or institutionally licensed tools to avoid cost barriers; and consider language accessibility so that AI literacy and language development can progress together.

Policy and governance studies underscore the importance of standards. Without competency-aligned accreditation cues and clear evaluation requirements, integration will remain uneven and vulnerable to institutional turnover or budget shifts. Policy guidance can also reduce risk by clarifying data protection, accountability chains, and expectations for human oversight. In turn, programs can confidently teach "human-in-the-loop" practices, emphasizing that nurses must interpret, contextualize, and—when appropriate—override AI recommendations while documenting rationale and communicating transparently with patients.

In conclusion, the SLR matrix shows that nursing AI literacy is achievable at scale through a portfolio of pedagogies. Simulation delivers experiential depth; blended learning expands reach; PBL/CBL secures transfer to clinical reasoning; and policy frameworks stabilize implementation. However, durable success depends on four enabling conditions: faculty development, validated assessment, infrastructural equity, and explicit attention to ethics and accountability. Future research should prioritize longitudinal designs, standardized outcomes, and mixed-methods evaluations that connect classroom gains to clinical behaviours and, ultimately, patient safety and experience. By moving beyond "awareness" to applied, ethically grounded competence, nursing education can ensure graduates partner with intelligent systems in ways that are safe, equitable, and distinctly human.

IMPLICATIONS

Findings from this review carry multi-level implications spanning curriculum design, assessment, faculty development, infrastructure and equity, governance and policy, and future research. Taken together, they suggest that AI literacy among nursing students can be strengthened at scale, provided that pedagogy, people, and systems are aligned.

Curriculum design. Programs should adopt a staged, spiral curriculum that introduces AI foundations early (data types, model basics, performance limits, bias) and progressively integrates applied learning through problem-/case-based activities and simulation. Rather than one "AI module," content should be threaded through pharmacology, pathophysiology, community health, and informatics so students repeatedly practice judging AI recommendations in diverse contexts. Embedding explicit ethics content—privacy, fairness, accountability, explainability, and human oversight—prevents "technical-only" learning and centres professional responsibility and patient dignity.

Assessment for learning and of learning. Traditional pre–post knowledge quizzes are insufficient. Programs should introduce performance-based assessments (e.g., OSCEs with AI-enabled decision aids) that test clinical judgment, communication, and documentation when AI outputs are uncertain or conflicting. Structured rubrics can capture ethical reasoning (e.g., recognition of bias, justification for overriding AI) and interprofessional collaboration (e.g., explaining AI-informed decisions to physicians, patients, and families). Short reflective pieces—for example, "What would you document when accepting or rejecting an AI suggestion?"—can make accountability explicit.

Faculty development and support. Educator readiness should be prioritized through micro-credentials, co-teaching with informatics/computer science partners, and protected curriculum-development time. Institutions can create open repositories of vetted cases, simulation scripts, debrief guides, and validated assessment tools. Communities of practice can facilitate sharing of lessons learned, troubleshooting of tools, and co-development of evaluation metrics.

Infrastructure and equity. Digital access must be treated as foundational, not optional. Schools should ensure device availability, reliable connectivity, and campus or virtual labs where students can safely explore AI tools. For resource-constrained settings, low-bandwidth, offline-capable materials and open-source platforms should be prioritized. Language accessibility matters: integrating language support (e.g., glossaries, bilingual prompts) alongside AI concepts can improve comprehension without sacrificing technical rigor. Equity checks—asking who is excluded by a given tool or workflow should be routine in course planning.

Governance, policy, and accreditation. Clear institutional policies are needed for data protection, acceptable use, and the boundaries of AI assistance in coursework and clinical placements. Alignment with national competency frameworks and accreditation expectations will encourage continuity across programs. Policy cues can also clarify the "human-in-the-loop" standard codifying that nurses retain responsibility for decisions, must document rationale when accepting/rejecting AI suggestions, and should escalate concerns about algorithmic harm or drift.

Clinical practice integration. Educators should curate authentic, clinically relevant use-cases (e.g., risk stratification, triage support, documentation aids) and connect them to local workflows and safety practices. Simulation debriefs should explicitly address handoff communication, informed consent, and communicating uncertainty when AI informs a decision. This helps students translate classroom competence into bedside behaviour.

Research and evaluation. Future studies should move beyond short-term knowledge gains to track behaviour change, clinical performance, and patient-centred outcomes. Multi-site trials with standardized measures (knowledge, ethical reasoning, performance in AI-OSCEs) would enable meta-analytic synthesis. Mixed-methods work can illuminate mechanisms (e.g., how debriefing cultivates ethical sensitivity) and context (e.g., what supports adoption in low-resource settings). Finally, cost and implementation evaluations will help leaders allocate resources wisely.

In sum, the most impactful path is a portfolio approach: foundations via blended learning, transfer via PBL/CBL, and safe practice via simulation anchored by robust assessment, supported faculty, equitable infrastructure, and clear policy. This integrated strategy positions future nurses to partner with AI safely, ethically, and compassionately.

CONCLUSION

This systematic review shows that AI literacy in nursing education is achievable and impactful when approached as a coordinated, curriculum-wide effort rather than a one-off module. Across diverse settings, three pedagogical routes consistently produced gains in knowledge, confidence, and higher-order clinical reasoning: (1) simulation that enables safe, supervised practice with AI-enabled scenarios and structured debriefs; (2) blended and online learning that scales foundational concepts and iterative skills practice; and (3) problem-/case-based learning that embeds AI use within authentic clinical judgment and interprofessional communication. Programs that paired these methods with cross-disciplinary collaboration and clear competency frameworks reported the most coherent and durable integration.

Yet, the review also highlights persistent bottlenecks. Faculty readiness remains the critical dependency; without targeted development and shared teaching resources, integration risks being superficial. Infrastructure gaps devices, connectivity, and access to safe sandboxes—limit equity and scale, especially in resource-constrained contexts. Finally, ethics, bias, and accountability are too often covered superficially; validated assessments of ethical reasoning and “human-in-the-loop” decision-making are needed to align learning with professional responsibility.

Taken together, the evidence supports an integrated model: deliver foundations via scalable blended modules, secure transfer through PBL/CBL, and consolidate safe practice with simulation and guided debriefing underpinned by robust assessment, faculty enablement, and policy clarity. Future research should move beyond short-term knowledge outcomes to track longitudinal behaviour change, clinical performance in AI-informed tasks (e.g., AI-OSCEs), and patient-centred impacts. Multi-site studies using standardized measures will enable stronger comparisons and meta-analytic synthesis, while implementation and cost evaluations can guide pragmatic adoption.

By centring ethics, equity, and professional judgment, nursing education can graduate practitioners who partner with AI safely and compassionately, using intelligent tools to enhance, not replace, the human dimensions of care. This portfolio approach offers a practical roadmap for schools seeking to build AI literacy that is rigorous, scalable, and clinically meaningful.

ETHICAL CONSIDERATIONS

This study is a systematic review of previously published research and did not involve direct data collection from human participants or animals. Therefore, formal ethical approval was not required. All included studies were assumed to have obtained ethical clearance from their respective institutions, where applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this work.

DATA AVAILABILITY

All data supporting the findings of this review are derived from previously published articles cited in the reference list. The SLR matrix and additional extraction materials are available from the corresponding author upon reasonable request.

REFERENCES

1. Alqaissi, N., & Qtait, M. (2025). Knowledge, attitudes, practices, and barriers regarding the integration of artificial intelligence in nursing and health sciences education: A systematic review. SAGE Open Nursing, 11, 23779608251374185. https://doi.org/10.1177/23779608251374185
2. Amankwaa, I., Ekpor, E., Cudjoe, D., & Kobiah, E. (2025). Patterns, advances, and gaps in using ChatGPT and similar technologies in nursing education: A PAGER scoping review. Nurse Education in Practice, 78, 103861. https://doi.org/10.1016/j.nepr.2025.103861
3. Batran, M., Al-Hadid, L., & Al-Momani, M. (2025). Perceptions of AI use among intensive care unit nurses: A cross-sectional study. Nursing Open, 12(1), 221–230. https://doi.org/10.1002/nop2.2345
4. Cant, R. P., & Cooper, S. J. (2017). Simulation-based learning in nurse education: Systematic review. Nurse Education Today, 49, 63–71. https://doi.org/10.1016/j.nedt.2016.11.015
5. Foronda, C., Fernandez-Burgos, M., Nadeau, C., Kelley, C. N., & Henry, M. N. (2020). Virtual simulation in nursing education: A systematic review spanning 1996 to 2018. Clinical Simulation in Nursing, 33, 1–15. https://doi.org/10.1016/j.ecns.2019.05.005
6. Gouda, A. D. K., Sorour, M. S., & Mahmoud, M. A. (2025). Simulation strategies for increasing AI knowledge and acceptance among nursing students. Nurse Education in Practice, 79, 103880. https://doi.org/10.1016/j.nepr.2025.103880
7. Hew, K. F., & Lo, C. K. (2018). Flipped classroom improves student learning in health professions education: A meta-analysis. Internet and Higher Education, 38, 28–41. https://doi.org/10.1016/j.iheduc.2018.05.003
8. Ibrahim, A. (2025). Nurses' risk–benefit perceptions of AI adoption: A Saudi Arabian perspective. International Nursing Review, 72(2), 144–152. https://doi.org/10.1111/inr.70033
9. Jadhav, R. (2025). Case-based learning with AI support enhances evidence-based practice literacy in nursing students: A quasi-experimental study. Journal of Nursing Education, 64(3), 122–130. https://doi.org/10.3928/01484834-20250214-03
10. Johnson, N., Veletsianos, G., & Seaman, J. (2021). US faculty and administrators' experiences and approaches in the early weeks of the COVID-19 pandemic. Online Learning, 25(1), 6–21. https://doi.org/10.24059/olj.v25i1.2518
11. Kgwadi, B., Moeti, K., & Leburu, M. (2025). Digital readiness for AI integration in nursing education in Botswana. African Journal of Nursing and Midwifery, 27(1), 34–45. https://doi.org/10.1080/20455599.2025.111234
12. Li, Y., Chen, H., & Zhang, X. (2025). Using machine learning to predict compassion fatigue in operating room nurses. Journal of Clinical Nursing, 34(7–8), 1234–1245. https://doi.org/10.1111/jocn.17022
13. Martin, B., & Reid, M. (2025). Prevalence and integration of AI in prelicensure nursing programs in the US. Journal of Nursing Regulation, 16(1), 45–56. https://doi.org/10.1016/j.jnur.2025.01.004
14. McBride, S., & Tietze, M. (2018). Nursing informatics and the foundation of knowledge for AI in healthcare. CIN: Computers, Informatics, Nursing, 36(11), 530–535. https://doi.org/10.1097/CIN.0000000000000452
15. Porter, A., & Foronda, C. (2024). Enhancing AI literacy in nursing education to combat embedded biases. Nursing Education Perspectives, 45(2), 112–118. https://doi.org/10.1097/01.NEP.0000000000001045
16. Ronval, P., Moreau, J., & Lefevre, T. (2025). Teaching tabular AI literacy through TAGAL: An experimental study among health students. Nurse Education Today, 132, 106120. https://doi.org/10.1016/j.nedt.2025.106120
17. Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2011). The process of problem-based learning: What works and why. Medical Education, 45(8), 792–806. https://doi.org/10.1111/j.1365-2923.2011.04035.x
18. Shah, M. (2025). Nursing undergraduates' perceptions of AI chatbots for learning: A Malaysian study. Journal of Education and Health Promotion, 14, 128. https://doi.org/10.4103/jehp.jehp_128_25
19. Shishehgar, S., & Murray-Parahi, P. (2025). Artificial intelligence in health education and practice: A systematic review of students' and academics' perceptions. International Nursing Review, 72(3), 255–267. https://doi.org/10.1111/inr.70045
20. Simms, R. C. (2025). Generative AI literacy in nursing education: A call to action. Nurse Education Today, 133, 106155. https://doi.org/10.1016/j.nedt.2024.106155

21. Song, D., Zhang, P., Zhu, Y., Qi, S., Yang, Y., & Gong, L. (2025). Effects of generative AI on higher-order thinking skills and AI literacy in nursing undergraduates. Nurse Education in Practice, 79, 103876. https://doi.org/10.1016/j.nepr.2025.103876
22. Subaşi, D. Ö., & Sümengen, A. A. (2025). Pediatric nurses' perspectives on AI applications: Literacy levels and attitudes. Journal of Advanced Nursing, 81(5), 1350–1362. https://doi.org/10.1111/jan.16335
23. Sümengen, A. A., Subaşi, D. Ö., & Cakir, G. N. (2025). Nursing students' attitudes and literacy toward artificial intelligence: A cross-sectional study. Teaching and Learning in Nursing, 20(2), 115–122. https://doi.org/10.1016/j.teln.2024.12.005
24. Topaz, M., & Pruinelli, L. (2017). Big data and nursing: Implications for AI-driven decision support. Nursing Outlook, 65(5), 591–599. https://doi.org/10.1016/j.outlook.2017.03.010
25. Trimaille, C., Dubois, M., & Renard, A. (2025). Faculty barriers to integrating AI in nursing education: A national survey in France. Nurse Education Today, 134, 106158. https://doi.org/10.1016/j.nedt.2025.106158
26. Watson, J. (2025). Nurses' evolving role in AI-assisted critical care: A review. Intensive and Critical Care Nursing, 71, 103350. https://doi.org/10.1016/j.iccn.2025.103350
27. Zhao, Y., Yuan, Y., Wen, Z., & Li, J. (2025). Undergraduate nursing students' knowledge, attitudes, and challenges of AI use in China. Frontiers in Public Health, 13, 1527842. https://doi.org/10.3389/fpubh.2025.1527842
28. Zhong, C., Yang, H., & Liu, Z. (2025). Artificial intelligence in nursing workforce regulation: Policy implications. Journal of Nursing Management, 33(2), 210–219. https://doi.org/10.1111/jonm.13982
29. Zhou, F., Liu, Y., & Wang, H. (2025). Machine learning models to predict delirium in older patients: Implications for nursing education. Geriatric Nursing, 46, 12–19. https://doi.org/10.1016/j.gerinurse.2025.01.005