

Teaching with intelligence; AI-enhanced pedagogies in nursing education A scoping review

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ABSTRACT

Aim: To map current evidence on AI integration in nursing education, identifying pedagogical applications, learning outcomes, future research directions.

Background: The integration of artificial intelligence (AI) into nursing education is expanding rapidly, offering opportunities to enhance learning. As the role of AI in healthcare expands, nursing education must evolve to prepare future nurses with the necessary knowledge and skills to effectively and ethically utilise these technologies.

Design: A scoping review following Arksey and O'Malley's framework.

Methods: PRISMA-ScR guidelines and a hybrid AI-human methodology was adopted to ensure transparency and rigour. Covidence software supported blinded dual screening and consensus tracking. Generative AI assisted in structured data extraction, with manual verification by four independent reviewers. Data were analysed through descriptive mapping and reflexive thematic synthesis using Braun and Clarkes Framework.

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Results: Nine studies (2023–2025) met the inclusion criteria, encompassing undergraduate, postgraduate and faculty contexts. AI tools including ChatGPT, MindMeld NLP and Deepgram were applied mainly as pedagogical enhancers providing simulation, adaptive feedback and reflective learning support. Five themes emerged: (1) knowledge and skills development; (2) self-efficacy and confidence building; (3) clinical reasoning and decision-making; (4) communication and empathy; and (5) engagement and pedagogical acceptability. Collectively, these studies demonstrated consistent improvements across cognitive, affective and behavioural learning domains.

Conclusion: AI serves as a pedagogical amplifier, augmenting learning through adaptive, reflective and emotionally intelligent interaction. When ethically governed and contextually embedded, AI supports higher-order thinking, empathy and learner engagement, advancing a human-centred vision for technology-enhanced nursing education.

1. Introduction

The rapid advancement of artificial intelligence (AI), is transforming various sectors and healthcare is no exception. AI applications are increasingly being integrated into clinical practice to enhance patient care, improve efficiency and support clinical decision making (Hoelscher and Pugh, 2025). As the role of AI in healthcare expands, nursing education must evolve to prepare future nurses with the necessary knowledge and skills to effectively and ethically utilise these technologies (Hoelscher and Pugh, 2025). This includes a developing a clear understanding of AI competencies required for modern nursing practice. While there is a growing body of literature on the use of AI in education, a comprehensive understanding of what constitutes as AI education for nurses and how these are being addressed in nursing education curriculum remains limited. Some of the AI technologies in use in nursing education currently include; Generative artificial intelligence (GenAI) (Chang and Su, 2025, Arkan et al., 2025, Shen et al., 2025), AI enhanced mixed reality training (Anthamatten and Holt, 2024; Benfatah et al., 2024; Sepanloo et al., 2025), AI driven educational tools (Hwang et al., 2024; Maguire and White, 2025), AI focused programmes (Abuadas et al., 2025).

Recent research explored the relationship between critical care nurses' AI-related attitudes, creative self-efficacy and clinical reasoning competency and found that positive attitudes toward AI play a crucial role in enhancing nurses' creative self-efficacy and clinical reasoning competency (Atalla et al., 2025). Given these findings in nurses working clinically, it is imperative that we as nurse educators foster positive perceptions of AI in our students and provide targeted training that will prepare nurses for AI-integrated clinical environments (Atalla et al., 2025). It is clear from the literature that healthcare organisations and nursing leaders need to create supportive environments that encourage AI adoption while preserving the principles of patient-centered care (Atalla et al., 2025). Finding this balance and a pathway for it through nursing competence, is the way forward. To find this balance there is another aspect to consider which is nursing educators' perspectives on the integration of artificial intelligence into academic settings (Khan Rony et al., 2025). A recent qualitative study from Bangladesh, India found that nursing educators recognised the potential of AI tools, such as adaptive learning platforms, virtual simulations and predictive analytics, to enhance teaching efficiency, personalize learning and engage students, however, barriers such as insufficient training, infrastructural challenges and ethical concerns related to data privacy, algorithmic bias and AI-driven decision making were highlighted (Khan Rony et al., 2025). Accumulating literature which has explored these assumed barriers within the real world through our scoping review may address these educators' concerns.

Students' perceptions of AI in nursing education are also important to consider. A recent study explored the impact of Generative AI (Gen AI) on nursing education, particularly its influence on students' performance in Palestinian higher education institutions (Khalif et al., 2025). An interesting finding from this work was the concept of student trust in AI and its impact on their performance. Results indicate that trust in AI significantly enhances students' perceived usefulness of Gen AI and their

academic performance, while AI competencies negatively affect performance, suggesting that familiarity with AI does not necessarily translate into improved learning outcomes (Khalif et al., 2025). These results highlight the need to foster trust in AI among nursing students while ensuring better integration and understanding of AI tools in the curriculum.

Despite the growing body of literature exploring artificial intelligence in nursing education, existing research remains fragmented across diverse technologies, educational approaches and outcome measures (Alrazeeni et al., 2026). Current studies tend to focus on specific AI tools (Khan Rony et al., 2025), individual educational interventions (Hwang et al., 2024; Maguire and White, 2025), or perceptions of AI among students and educators (Atalla et al., 2025 and Khalif et al., 2025), with limited synthesis of how AI competencies are being conceptualised and integrated across nursing curricula. Furthermore, there is a lack of comprehensive mapping of the pedagogical strategies, implementation challenges, ethical considerations and competency outcomes associated with AI integration in nursing education with recent reviews having explored AI integration in nursing education only (Alrazeeni et al., 2026). Consequently, a broader examination of the existing evidence base is required to clarify the current state of knowledge and identify gaps to guide future curriculum development, educational policy and research priorities.

A scoping review is a suitable methodology to examine existing literature, develop an understanding of key concepts and identify gaps in research (Arksey and O'Malley, 2005). This scoping review aims to systematically map the existing literature concerning the use of AI in nursing education. Specifically, the review will examine the types of AI technologies being used, the competencies and skills being developed, the pedagogical approaches employed and the challenges and opportunities associated with AI integration into nursing curricula. The findings will help inform future curriculum development, educational policy and research directions relating to AI preparedness in nursing education. As far as the authors are aware no comprehensive synthesis currently exists examining the competencies used in the integration of AI into Nursing Education and how these are being developed and operationalised in nursing education curricula.

2. Methods

2.1. Aim

The aim of this scoping review is to synthesise the existing literature on the integration of AI into nursing education curricula.

2.2. Objectives

The objectives are to:

1. Identify pedagogical approaches and teaching strategies used to integrate AI in nursing education.
2. Evaluate the components of AI based pedagogical approaches across studies.

3. Explore the competencies used in the integration of AI into nursing education.

3. Design

A scoping review was conducted according to the five-step framework proposed by Arksey and O'Malley (2005). The five steps followed included: 1. Identification of research objective; 2. Search/identification of applicable studies; 3. Selection of relevant studies; 4. Charting of the data; and 5. Collating, summarising and reporting of the results. A hybrid AI-assisted, researcher-led approach was adopted, whereby AI tools supported selected review activities (e.g., searching, screening and organising literature), while researchers retained responsibility for interpretation and final decision-making. The scoping review methodology was appropriate for mapping the literature and identifying gaps for future research. Reporting followed the PRISMA extension for Scoping Reviews (PRISMA-ScR) checklist (Tricco et al., 2018) (figure 1).

Step 1: Identification of research objective

The development of the scoping review question was guided by the PEO framework (Bettany-Saltikov, 2012), which includes Population, Exposure and Outcome. The framework also informed the eligibility criteria for the scoping review.

- **Population:** Nurse education (Nurse educators and students)
- **Exposure:** AI integration in nursing education through teaching strategies and pedagogical approaches
- **Outcome:** Competencies

3.1. Review Question

The review addressed the following question:

In nursing education (P), how are artificial intelligence (AI) competencies (E) integrated through pedagogical approaches and teaching strategies and what competencies (O) are reported as outcomes of this integration?

Step 2: Search applicable studies

The search was conducted by two of the three authors (KW, VR and JG) in collaboration with LN and BM. Ovid Medline was initially searched to determine the extent of available literature and identify relevant controlled vocabulary and MeSH terms. Titles and abstracts of key papers were also reviewed to identify topic-specific terms and phrases. Search concepts relating to Nursing, Education, Artificial Intelligence and Competencies were combined using Boolean operators (OR and AND), alongside quotation marks, truncation and proximity searching where appropriate to increase precision and sensitivity. The Medline strategy was subsequently translated to Embase, EBSCO CINAHL Ultimate, Web of Science, Cochrane Library, EBSCO APA PsycInfo and Scopus to ensure broad coverage of nursing, biomedical and interdisciplinary literature. No search filters were applied to minimise the risk of excluding potentially relevant studies. Eligibility criteria were developed according to the review question and PEO framework (Arksey and O'Malley, 2005). Non-peer-reviewed literature and studies published in languages other than English were excluded to ensure consistency and comprehension among the research team.

Step 3: Selection of relevant studies

All records were imported into Covidence (Veritas Health Innovation, Melbourne, Australia), which facilitated duplicate removal, blinded independent screening, conflict resolution and audit trail management (Harrison et al., 2020). Duplicate detection removed 347 records, leaving 437 unique studies for screening. Two large language model-based AI tools were used to support preliminary title and abstract screening using structured eligibility prompts. These outputs functioned only as supplementary indicators and did not determine inclusion decisions. These AI-assisted outputs were used exclusively as supplementary indicators and not as definitive screening decisions, in accordance

with established best practice for AI-augmented systematic reviews (de la Torre-López et al., 2023). Two researchers (VR and JG) independently screened all records by title and abstract according to predefined inclusion and exclusion criteria. Disagreements were resolved through discussion with co-authors (LN, BM and KW), consistent with Joanna Briggs Institute guidance (JBI, 2020). Following this process, 345 studies were excluded and 92 progressed to full-text review.

During full-text screening, AI tools were used to assist with extraction of structured metadata and thematic summaries. All outputs were manually verified against the original studies prior to decision-making. Full texts were independently reviewed by both researchers and discrepancies resolved through consensus. 83 studies were excluded, resulting in 9 studies being retained for final analysis. The use of blinded reviewer assessment, consensus procedures and documented audit trails enhanced transparency and reproducibility throughout the screening process (See Fig. 1 with PRISMA-ScR guidelines/flow diagram for a detailed audit trail of study screening process) (Tricco et al., 2018). This dual-layered AI-human screening framework enhanced both credibility and reliability, two cornerstones of systematic evidence synthesis (Gough et al., 2017, McGuinness and Higgins, 2021). The combined use of AI-driven automation and human critical appraisal exemplifies the emerging paradigm of human-in-the-loop review methodologies, which leverage computational efficiency while preserving the epistemological rigour and interpretive depth inherent to human judgment (Chan et al., 2024, Kallmes et al., 2025, Syriani et al., 2024, Xu et al., 2025, Guo et al., 2024). This approach is increasingly recognised as an advanced model for conducting transparent and methodologically sound scoping and systematic reviews in complex and data-intensive research domains (de la Torre-López et al., 2023; Chan, et al., 2024; Xu et al., 2025; Syriani et al., 2024).

Step 4: Charting of the data and Step 5: Collating, summarising and reporting results

Steps 4 and 5 of Arksey and O'Malley's (2005) framework were combined to facilitate progression from data extraction to synthesis and interpretation.

3.2. Data Extraction

Data extraction followed an AI-assisted, researcher-validated approach within Covidence. AI tools generated preliminary structured extraction matrices using predefined domains including bibliographic information, study design, population characteristics, intervention or phenomenon of interest, outcomes and principal findings. Manual verification was subsequently undertaken by four reviewers (BM, LN, VR & JG), who compared AI-generated outputs with the original studies to ensure accuracy and conceptual consistency (Chan et al., 2024; Kallmes et al., 2025; Syriani et al., 2024; Xu et al., 2025; Guo et al., 2024). Discrepancies or interpretive ambiguities identified during this process were meticulously corrected through consensus discussions, ensuring consistency and alignment with the review's analytical framework (Gough et al., 2017). Validated extractions were consolidated into a master dataset ("MASTER_AI_Nursing_Ed_Extraction_Formatted.xlsx"). This dataset integrated both the AI-derived structured summaries and the manually refined datasets produced by the four reviewers. It served as the basis for subsequent synthesis. Covidence maintained version control and an auditable record of researcher decisions and modifications (Harrison et al., 2020). This AI-researcher collaborative model enhanced the credibility, dependability and confirmability of the extracted data, consistent with Lincoln and Guba's (1985) trustworthiness criteria and the quality standards recommended by the Joanna Briggs Institute (JBI, 2020).

3.3. Data Analysis

Data analysis employed a convergent mixed-analytic design combining descriptive mapping with qualitative thematic synthesis,

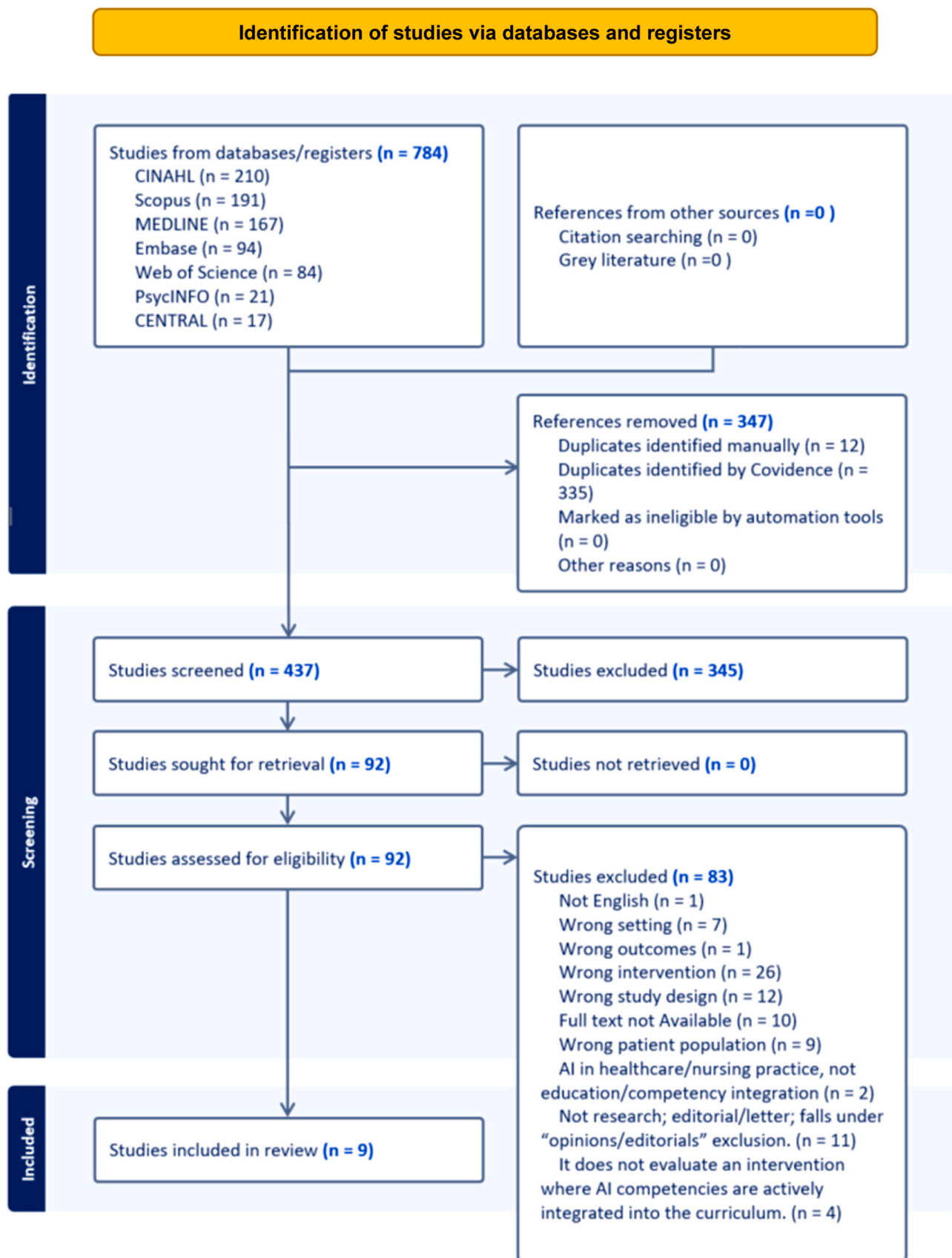


Fig. 1. PRISMA 2020 flow diagram.

guided by JBI evidence synthesis principles (JBI, 2020) and PRISMA-ScR recommendations (Tricco et al., 2018). Descriptive mapping summarised study characteristics including country of origin, study design, population and intervention context. Frequencies were calculated to illustrate the geographical and methodological distribution of evidence. AI tools supported preliminary pattern identification through tokenisation and lexical frequency mapping of extracted text. These computational outputs served solely as analytic scaffolds, while interpretive coding and synthesis remained under direct human control, ensuring epistemic and contextual validity.

Manual thematic analysis was conducted independently by four reviewers (JG, VR, BM and LN) using Braun and Clarke's (2019) reflexive thematic analysis framework. Reviewers undertook open and axial coding before collaboratively refining findings into higher-order themes through consensus discussions. Inter-reviewer triangulation and audit documentation within Covidence supported methodological transparency and consistency throughout the analytical process. This multi-reviewer, AI-supported analytical framework achieved a high level of rigour, reliability and reproducibility balancing computational efficiency with interpretive depth and maintaining fidelity to qualitative epistemology (Elo and Kyngäs, 2008; JBI, 2020).

4. Results

4.1. Study Selection

The selection process followed a systematic approach beginning with database identification, removal of duplicates, screening of titles and abstracts and full-text review based on the predefined eligibility criteria. Reasons for exclusion at the full-text stage included wrong population, absence of AI intervention and lack of empirical outcome data. A total of nine studies met the inclusion criteria for this review and were retained for final synthesis (Abuadas et al., 2025; Anthamatten and Holt, 2024; Arkan et al., 2025), Benfatah et al., (2024), Chang and Su, (2025), Hwang et al., (2024), Maguire and White, (2025); Sepanloo et al., (2025), Shen et al., (2025)) (Fig. 1).

4.2. Overview of Study Characteristics

The included studies were published between 2023 and 2025, reflecting an emerging and rapidly expanding evidence base on AI in nursing education. The studies were conducted across six countries, with the largest number originating from the United States (n = 3) (Anthamatten and Holt, 2024; Maguire and White, 2025; Sepanloo et al., 2025) followed by Taiwan (n = 2) (Chang and Su, 2025; Hwang et al., 2024) and individual studies from Jordan (Abuadas et al., 2025), Morocco (Benfatah et al., 2024), Turkey (Arkan et al., 2025) and China (Shen et al., 2025). This geographical spread demonstrates a global interest in exploring AI-enhanced pedagogy across culturally and educationally diverse contexts.

The educational settings examined in the studies were wide-ranging and encompassed undergraduate nursing programmes including community health, obstetric nursing and neonatal skills training as well as simulation-based education, advanced practice settings and ethics-focused instruction. The methodological approaches were similarly diverse and included mixed-methods (n = 1, Maguire and White, 2025), quasi-experimental designs (n = 4, (Abuadas et al., 2025; Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024)), a randomised controlled trial (n = 1, (Arkan et al., 2025)), a pilot mixed-methods evaluation (n = 1, (Sepanloo et al.2025)), a pilot implementation study (n = 1, (Anthamatten and Holt, 2024)) and a qualitative descriptive design (n = 1, (Shen et al., 2025)). Sample sizes ranged from 10 (Sepanloo et al., 2025) to 160 participants (Maguire and White, 2025), involving predominantly undergraduate and postgraduate nursing students, with one study also incorporating faculty perspectives (Sepanloo et al., 2025). Maguire and White (2025) study demonstrated

the largest sample with Knowledge changes from pre intervention (Mean 33.29, SD 5.33) to post intervention (Mean 36, SD 46.76). Sepanloo et al. (2025) the study with the smallest sample demonstrated mean changes in cognitive workload assessment (Mean 5.24, SD 3.67). Other measures reported means only (Table 1).

Across the included studies, AI was consistently used as a pedagogical enhancement strategy that complemented, rather than replaced, traditional instructional methods. The AI technologies varied in function and complexity, including ChatGPT-based generative AI tools, AI-supported debriefing systems, mixed-reality conversational agents, AI-enabled virtual simulation tutors and mobile expert decision-support systems (See Table 2 column AI Tools for more information on this). These tools were integrated to support virtual simulation, communication development, reflective learning, automated feedback and structured clinical reasoning. Table 2 provides a detailed summary of the characteristics of the included studies.

4.3. Thematic findings

Analysis data from the studies generated five interrelated themes that demonstrate how AI use is influencing teaching and learning competencies in nursing education. Table 3 provides an overview of thematic findings and relative competency domains, while Table 4 provides more detail on the thematic findings and finally Table 5 demonstrates a cross verification matrix of themes.

The themes illustrate AI's contribution to knowledge development, learner confidence, clinical reasoning, interpersonal capability and educational engagement in relation to competence domains across a range of academic and clinical training contexts. Each theme is framed as something observable, measurable and teachable in nursing education. The themes map directly on to core nursing competencies. In nursing knowledge and skills are a foundational clinical competency (Purabdollah et al., 2023), self-efficacy and confidence relate to competence in professional identity and practice readiness such as performing within one's scope of practice (Han et al., 2025 and Johnson et al., 2012). Clinical reasoning and decision making relates to competence in higher order critical judgement (Levett et al., 2010). Communication and empathy in learning relates to therapeutic and interprofessional competence attainment in nursing (WHO, 2016) The final theme engagement, satisfaction and pedagogical acceptability relates to competence in learner commitment and professional development (Benner et al., 2010). These themes represent multidimensional

Table 1
Inclusion and exclusion criteria.

Category	Inclusion Criteria	Exclusion Criteria
Population	Studies focusing on nursing students (undergraduate, postgraduate) or nurse educators	Studies not focused on nursing education
Exposure / Intervention	Integration of AI into nursing curricula or education; pedagogical approaches; educational methodologies; interprofessional educational interventions (including nursing students)	Studies on AI use in general healthcare or clinical practice not related to education
Outcome	Competence level (knowledge, skills, attitudes, or readiness related to AI).	–
Setting	Academic or clinical education settings	Studies on the clinical use of AI by nurses
Types of Sources	Peer-reviewed journal articles, conference abstracts	Conference proceedings, opinion pieces, letters to the editor, or editorials
Study Designs	Quantitative, qualitative, mixed-methods studies, systematic reviews, scoping reviews	Literature or narrative reviews
Language	Studies published in English	Non-English publications

Table 2
Included studies characteristics.

Author(s)	Year	Country	Design / Approach	Educational Context	AI Tool(s)	Purpose of Integration	Sample	Reported Outcomes
Abuadas et al.	2025	Jordan	Quasi-experimental (pre–post)	AI ethics education	AI ethics learning modules	Improve ethical awareness and AI-related moral sensitivity	115	↑ Ethical awareness, ↑ moral sensitivity, ↑ attitudes
Anthamatten & Holt	2024	USA	Pilot implementation study	Family Nurse Practitioner programme	AI-enabled virtual simulation tutor	Strengthen diagnostic reasoning in advanced practice	77	↑ Clinical competence
Arkan et al.	2025	Turkey	Randomised Controlled Trial (RCT)	Nursing process training	ChatGPT 3.5	Improve nursing-process competence & problem-solving	96	↑ Problem-solving, ↑ competency, ↑ satisfaction
Benfatah et al.	2024	Morocco	Comparative quasi-experimental study	Simulation-based education	AI-supported debriefing system	Enhance debriefing quality and clinical skills	40	↑ Confidence, ↑ skills, ↑ satisfaction
Chang & Su	2025	Taiwan	Quasi-experimental	Obstetric nursing education	GAI-PCC (ChatGPT-based persona creator)	Improve reasoning through AI-generated patient personas	66	↑ Knowledge, ↑ self-efficacy, ↑ decision-making
Hwang et al.	2023	Taiwan	Quasi-experimental	Neonatal/ professional skills training	DRI mobile expert system	Support decision–reflection–interaction (DRI) learning	38	↑ Achievement, ↑ self-efficacy
Maguire & White	2025	USA	Mixed-methods	Community health nursing (BSN)	PCS Spark + generative AI chatbot	Improve communication, empathy & ageing-related knowledge	160	↑ Knowledge, ↑ empathy, ↑ communication
Sepanloo et al.	2025	USA	Pilot mixed-methods evaluation	Mixed-reality simulation	Conversational AI in mixed reality	Increase realism and enhance clinical reasoning	10	↑ Realism, ↑ clinical reasoning
Shen et al.	2025	China	Qualitative descriptive	Undergraduate nursing (GenAI use)	Generative AI tools (ChatGPT-type LLMs)	Explore prompt use, privacy issues & personalised learning	17	↑ Personalisation, ↑ reflective thinking; privacy concerns

Note: AI = Artificial Intelligence; BSN = Bachelor of Science in Nursing; MR = Mixed Reality; RCT = Randomised Controlled Trial; DRI = Decision–Reflection–Interaction. Arrows (↑) indicate reported improvement in outcomes.

Table 3
Overview of thematic findings and competence domains.

Theme	Description	Relative competency domain
Knowledge and skills development	AI tools helped students acquire new knowledge, strengthen clinical skills, and improve academic performance.	Cognitive domain and behavioural/ performance domain
Self-efficacy and confidence building	AI-supported learning fostered increased self-belief, capability, and confidence in completing clinical tasks.	Affective domain
Clinical reasoning and decision-making	AI enhanced analytical thinking, situational interpretation, and clinical judgement.	Cognitive and affective domain
Communication and empathy in learning	AI-facilitated simulations and feedback improved communication skills, empathy, and reflective interaction.	Affective domain
Engagement, satisfaction and pedagogical acceptability	AI-enhanced learning increased motivation, satisfaction, and learner engagement, although concerns about privacy and accuracy were noted.	Affective domain

competency development encompassing cognitive, affective and behavioural domains essential for safe, effective nursing practice (Table 3).

4.4. Interpretation of Findings

The synthesis of the data from the nine included studies demonstrates that AI integration in nursing education contributes to

improvements across cognitive, affective and behavioural learning domains. AI technologies primarily functioned as pedagogical amplifiers, enhancing rather than replacing human instruction. Through adaptive feedback, simulation realism and reflective engagement, AI-supported environments elevated learning experiences and supported the development of core nursing competencies. These findings align with the notion that technology-enhanced learning strengthens higher-order thinking and self-regulated learning (de la Torre-López et al., 2023).

The interpretive process adhered to recognised standards of qualitative trustworthiness and methodological rigour, supported by iterative coding and thematic triangulation consistent with established frameworks (Lincoln and Guba, 1985; Braun and Clarke, 2019; JBI, 2020). Together, the five themes reflect AI’s multidimensional contributions to contemporary nursing education.

1. Knowledge and Skills Development

All nine studies demonstrated that AI-supported interventions enhance students’ acquisition of clinical knowledge, procedural accuracy and domain-specific skills. Mixed-reality and virtual simulations deepened learners’ comprehension of complex patient scenarios and clinical pathways (Anthamatten and Holt, 2024; Sepanloo et al., 2025), while AI-enhanced debriefing improved clinical-skill performance and reflective understanding in simulation settings (Benfatah et al., 2024). Generative AI supported more structured and analytically sound care-plan development (Shen et al., 2025). ChatGPT-assisted training improved competency across nursing-process domains (Arkan et al., 2025) and AI-focused ethics instruction improved ethical knowledge and moral sensitivity (Abuadas et al., 2025). By utilising AI-enhanced training environments, such as immersive mixed reality simulations (Sepanloo et al., 2025) and structured competency-based frameworks like AID-TANE (Maguire and White, 2025), nursing education can effectively bridge the gap between theoretical knowledge and practical clinical application, leading to measurable gains in student performance (Hwang et al., 2024).

The collective findings confirm that AI strengthens conceptual

Table 4
Thematic findings.

Theme	Description of theme	Number of studies	Supporting Studies
Knowledge and Skills Development	AI enhanced conceptual knowledge, clinical skills, diagnostic accuracy, ethical competence, and care-planning ability.	N = 9	Maguire and White (2025); Hwang et al. (2024); Benfatah et al. (2024); Sepanloo et al. (2025); Anthamatten and Holt (2024); Shen et al. (2025); Chang and Su (2025); Arkan et al. (2025); Abuadas et al. (2025)
Self-efficacy and Confidence Building	AI-supported activities improved confidence, self-belief, and perceived capability in clinical and ethical tasks.	N = 7	Hwang et al. (2023); Benfatah et al. (2024); Chang and Su (2025); Arkan et al. (2025); Maguire and White (2025); Abuadas et al. (2025); Sepanloo et al. (2025)
Clinical Reasoning and Decision-making	AI strengthened analytical thinking, judgement, situational awareness, diagnostic reasoning, and decision-making.	N = 7	Sepanloo et al. (2025); Anthamatten and Holt (2024); Chang and Su (2025); Hwang et al. (2023); Arkan et al. (2025); Shen et al. (2025); Benfatah et al. (2024)
Communication, Empathy, and Reflective Interaction	AI enhanced communication, empathy, interpersonal understanding, and reflective dialogue.	N = 3	Maguire and White (2025); Benfatah et al. (2024); Shen et al. (2025)
Engagement, Satisfaction, and Pedagogical Acceptability	Students reported increased engagement, satisfaction, motivation, and acceptability of AI-assisted learning.	N = 6	Arkan et al. (2025); Benfatah et al. (2024); Anthamatten and Holt (2024); Sepanloo et al. (2025); Maguire and White (2025); Shen et al. (2025)

Table 5
Theme–Study Cross-Verification Matrix.

Study	Knowledge & Skills	Self-efficacy & Confidence	Clinical Reasoning & Decision-making	Communication & Empathy	Engagement, Satisfaction & Acceptability
Abuadas et al. (2025)	✓	✓ (ethical confidence)	–	–	–
Anthamatten and Holt (2024)	✓	–	✓ (diagnostic reasoning)	–	✓
Arkan et al. (2025)	✓	✓	✓ (problem-solving → reasoning)	–	✓
Benfatah et al. (2024)	✓	✓	✓ (reflective reasoning)	✓ (debriefing communication)	✓
Chang and Su (2025)	✓	✓	✓	–	–
Hwang et al. (2024)	✓	✓	✓	–	–
Maguire and White (2025)	✓	✓	–	✓ (communication + empathy)	✓
Sepanloo et al. (2025)	✓	✓	✓	–	✓
Shen et al. (2025)	✓	–	✓ (higher-order reasoning)	✓ (reflective communication)	✓ (mixed acceptability)

learning, supports procedural fluency and enhances students' ability to transfer knowledge into practice consistent with literature that positions AI as a mechanism for amplifying cognitive and metacognitive learning (de la Torre-López et al., 2023).

2. Self-efficacy and Confidence Building

Seven studies identified clear improvements in learner self-efficacy and confidence following engagement with AI-enhanced educational strategies. AI-enabled decision-making frameworks and reflective learning systems supported students in feeling more capable of navigating clinical tasks, particularly within decision–reflection–interaction models (Hwang et al., 2024). AI-enhanced debriefing likewise contributed to increased confidence after simulation-based practice, with students reporting greater assurance in their clinical performance and reflective insights (Benfatah et al., 2024). Generative AI strategies strengthened students' confidence in interpreting and responding to obstetric scenarios (Chang and Su, 2025), while ChatGPT-supported nursing-process training enhanced confidence in reasoning, documentation and overall problem-solving ability (Arkan et al., 2025).

AI-assisted communication simulations further promoted confidence in interacting with older adults and engaging in emotionally sensitive conversations (Maguire and White, 2025). Mixed-reality simulations increased learners' comfort and confidence when approaching deteriorating patient scenarios, offering a safe and immersive space to practise high-stakes decision-making (Sepanloo et al., 2025). In addition, AI-supported ethics education contributed to increased moral confidence and ethical self-efficacy, reinforcing students' readiness to address ethically complex clinical situations (Abuadas et al., 2025).

Collectively, these findings demonstrate AI's role in strengthening affective learning by providing structured guidance, adaptive feedback and psychologically safe environments where learners can practise, make mistakes and refine their clinical judgement. This reflects broader educational theory, which emphasises the value of scaffolded, feedback-rich learning contexts in cultivating confidence, competence and self-regulated learning behaviours (Braun and Clarke, 2019).

3. Clinical Reasoning and Decision-making

AI-supported learning modalities played a significant role in strengthening analytical reasoning, diagnostic accuracy and decision-making across the included studies. Conversational AI agents embedded within mixed-reality environments enhanced situational interpretation and clinical reasoning, particularly in rapidly evolving patient scenarios requiring real-time judgement (Sepanloo et al., 2025). AI-integrated virtual simulations similarly strengthened diagnostic reasoning and clinical decision-making among advanced practice nursing students, offering authentic, high-fidelity opportunities to interpret clinical cues and refine diagnostic conclusions (Anthamatten and Holt, 2024). Generative AI tools encouraged higher-order analytical thinking and reflective care-planning, enabling learners to approach clinical problems more systematically and critically (Shen et al., 2025).

Structured persona-creation approaches supported the application of clinical reasoning in obstetric contexts, helping students evaluate complex maternal–fetal scenarios (Chang and Su, 2025).

AI-enabled nursing-process training improved systematic clinical reasoning, problem-solving and the ability to evaluate and justify clinical decisions (Arkan et al., 2025). In addition, AI-driven Decision–Reflection–Interaction (DRI) systems further strengthened judgement and structured clinical thinking by guiding learners through iterative cycles of assessment, reflection and decision-making (Hwang et al., 2024). Finally, in Benfatah's et al. (2024) research the AI-assisted debriefing group showed a significant improvement in confidence, knowledge and skills and satisfaction compared with the control group. Additionally, increased active participation and critical reflection were observed in the experimental group.

Taken together, these findings highlight AI's function as a cognitive scaffold that supports analytical depth, reflective judgement and informed decision-making key components of safe, competent nursing practice. This aligns with established educational frameworks emphasising structured learning, iterative reflection and evidence-informed decision processes as core elements of high-quality nursing education (JBI, 2020).

4. Communication and Empathy in Learning

AI-supported learning environments contributed to interpersonal and affective learning by improving communication strategies, reflective dialogue and empathy. AI-driven simulations involving older adults enhanced students' empathic understanding and communication performance (Maguire and White, 2025). AI-assisted debriefing facilitated structured reflective conversation and improved articulation of clinical communication (Benfatah et al., 2024). Generative AI tools prompted students to verbalise their reasoning, reflect on communication choices and refine patient-centred interactions (Shen et al., 2025).

These findings highlight AI's capacity to support not only cognitive but also relational aspects of nursing by strengthening empathetic communication, reflective practice and emotional awareness central components of person-centred care (Lincoln and Guba, 1985).

5. Engagement, Satisfaction and Pedagogical Acceptability

Six studies reported high acceptability, satisfaction and engagement with AI-enhanced learning approaches. Students valued the authenticity, interactivity and responsiveness of AI-supported environments, including mixed-reality simulations (Sepanloo et al., 2025), virtual simulations (Anthamatten and Holt, 2024) and ChatGPT-enabled learning (Arkan et al., 2025). AI-enhanced debriefing and AI-supported community-health simulations were also perceived as engaging and valuable (Benfatah et al., 2024; Maguire and White, 2025). Although generative AI tools increased engagement, concerns remained regarding data privacy, output accuracy and academic integrity (Shen et al., 2025).

These findings support broader pedagogical evidence that learner-centred, technologically mediated environments can increase engagement and satisfaction when grounded in clear educational rationale.

4.5. Synthesis Summary

The findings of this scoping review illustrate that the integration of artificial intelligence into nursing education generally supports improvements in cognitive, affective and behavioural learning outcomes (Arkan et al., 2025; Chang and Su, 2025; Hwang et al., 2024; Maguire and White, 2025; Sepanloo et al., 2025). Across the included studies, AI functioned as a pedagogical enhancer that was associated with improved understanding of clinical concepts, enhanced skill performance and supported the application of knowledge in simulated and practice-based environments (Anthamatten and Holt, 2024; Arkan et al., 2025; Benfatah et al., 2024; Sepanloo et al., 2025). Rather than replacing human instruction, AI tools provided structured support and adaptive guidance that reinforced learning, making instructional processes more robust and responsive to learner needs (Hwang et al., 2024;

Shen et al., 2025; Sepanloo et al., 2025)

AI technologies also played a notable role in improving students' confidence and self-efficacy, particularly in situations that require complex decision-making and reflective practice (Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024). Learners benefited from opportunities to rehearse clinical decisions, receive personalised feedback and revisit challenging scenarios in safe, controlled environments (Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024). These conditions supported the development of professional confidence, enabling students to approach unfamiliar or demanding clinical situations with greater perceived assurance and readiness (Anthamatten and Holt, 2024; Sepanloo et al., 2025).

A further benefit of AI integration was the reported enhancement of clinical reasoning and decision-making, supported through conversational systems, virtual simulations and generative AI-based prompting tools (Chang and Su, 2025; Sepanloo et al., 2025). These approaches helped students to analyse scenarios more systematically, improve interpretation of patient cues interpret patient cues and justify their decisions using sound clinical judgement (Anthamatten and Holt, 2024; Arkan et al., 2025; Hwang et al., 2024). AI thus served as a cognitive scaffold, facilitating deeper engagement with clinical information and promoting habits of analytical thinking essential for safe nursing practice (Shen et al., 2025; Sepanloo et al., 2025).

Although less frequently reported, AI-supported learning environments also demonstrated potential to support communication, empathy and reflective interaction (Maguire and White, 2025; Shen et al., 2025). Simulated patient encounters and reflective dialogue tools encouraged students to articulate their reasoning processes, consider the emotional dimensions of care and develop their communication strategies (Maguire and White, 2025; Shen et al., 2025). These findings suggest that AI, when used intentionally, can complement the humanistic and relational aspects of nursing education rather than detract from them.

Finally, most studies reported high levels of engagement, satisfaction and pedagogical acceptability, with learners describing AI-enabled environments as interactive, motivating and relevant to clinical practice (Arkan et al., 2025; Benfatah et al., 2024; Hwang et al., 2024). While concerns regarding data privacy, accuracy and academic integrity were noted particularly with generative AI, students generally valued the authenticity and responsiveness of AI-supported activities (Abuadas et al., 2025; Shen et al., 2025). These results highlight the importance of ethically grounded implementation frameworks that allow AI to enhance learning while safeguarding academic and professional standards (Abuadas et al., 2025; Shen et al., 2025).

Taken together, the thematic synthesis suggests that AI when integrated thoughtfully and supported by ethical governance, can enhance the overall quality, depth and engagement of nursing education (Abuadas et al., 2025; Maguire and White, 2025; Sepanloo et al., 2025). By extending learners' cognitive, reflective and interpersonal capacities, AI supports the preparation of competent, confident and person-centred nursing graduates (Arkan et al., 2025; Chang and Su, 2025; Sepanloo et al., 2025). Rather than automating or replacing human teaching, AI serves as a complementary pedagogical partner that enriches both the technical and humanistic dimensions of contemporary nursing education (Shen et al., 2025; Maguire and White, 2025).

5. Discussion

5.1. Interpretive analysis: implications for policy, practice and future research

The findings of this scoping review underscore the transformative potential of artificial intelligence (AI) as a pedagogical catalyst in nursing and health professional education (Abuadas et al., 2025; Anthamatten and Holt, 2024; Arkan et al., 2025; Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024; Maguire and White, 2025; Sepanloo et al., 2025).

Shen et al. (2025). While the integration of AI has demonstrated clear pedagogical advantages across cognitive, affective and behavioural learning domains, its long-term adoption depends on thoughtful policy alignment, institutional readiness and sustained research investment (Bates et al., 2021).

5.2. Implications for educational practice

The synthesis affirms that AI can effectively function as an instructional adjunct enhancing reflection, self-regulation and competency-based learning when guided by educators. Therefore, it seems that academic institutions can integrate AI-enhanced learning tools within existing pedagogical frameworks, ensuring that such technologies are contextually relevant, ethically implemented and aligned with professional standards of nursing education. It is also important that when educators consider integrating AI-enhanced learning tools into existing pedagogical frameworks that is within the institutional policy on use of AI-enhanced learning tools as this may vary from institution to institution (Abuadas et al., 2025; Anthamatten and Holt, 2024; Arkan et al., 2025; Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024; Maguire and White, 2025; Sepanloo et al., 2025) Shen et al. (2025). The Higher Education Authority (HEA) in Ireland supports this approach through its Generative AI in Higher Education Teaching & Learning Policy Framework which emphasises that institutions should adopt a values-led, evidence-informed strategy, with clear governance and institutional policies guiding the ethical and pedagogically sound use of AI tools (HEA, 2025). Globally, UNESCO underscores this necessity in its policy guidance for AI in education. In its report *AI and Education: Guidance for Policy-Makers* (UNESCO, 2021), UNESCO asserts that institutional policies and regulatory frameworks are essential to ensure responsible AI adoption calling for clear governance structures, alignment with educational goals, equity and accountability in the deployment of AI in learning environments.

AI-enabled simulations, conversational tutors and automated feedback systems can be strategically embedded within competency-based education models, supporting iterative skill development, formative assessment and personalised learning. Importantly, these tools should not replace educators but rather amplify their capacity to deliver adaptive and student-centred instruction (Abuadas et al., 2025; Anthamatten and Holt, 2024; Arkan et al., 2025; Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024; Maguire and White, 2025; Sepanloo et al., 2025).

Shen et al., (2025)). Educators must also receive targeted professional development to ensure confidence in interpreting and managing AI outputs. Building AI literacy among faculty will be crucial to safeguard the balance between technological efficiency and human judgement particularly in clinical education contexts where ethical discernment and empathy remain core professional competencies. Emerging literature underscores the necessity of such initiatives, highlighting that structured AI education both enhances knowledge and confidence awareness among healthcare practitioners (Schubert et al., 2025). This is already underway in the authors institution where a targeted CPD course on 'AI in Healthcare' has been released to staff. Across four concise modules, the course is guiding learners through the evolving role of artificial intelligence in healthcare (RCSI, 2026). It is demonstrating how AI can empower professionals to focus on what only humans can do: care with compassion, communicate clearly, collaborate effectively and create innovative solutions. Perhaps the next step will be to develop a course for educators on interpreting and managing AI outputs for healthcare students as they use the differing technologies available in their programmes.

5.3. Future directions

At the policy level, the integration of AI into nursing curricula demands regulatory foresight and ethical governance frameworks that

prioritise accountability, transparency and equity. Regulatory bodies and educational institutions should establish standardised guidelines for AI adoption in pedagogy, addressing issues of data privacy, algorithmic bias and validation of AI-driven educational content.

The implementation of AI ethics frameworks in health education policy should ensure that AI systems are designed and deployed in ways that protect student autonomy, respect data confidentiality and maintain parity of access across socio-economic and geographic boundaries. Institutions should also consider developing AI ethics committees or cross-disciplinary governance structures to oversee the integration of intelligent systems in academic programmes.

Strategic investment in infrastructure and interdisciplinary collaboration is equally critical. Partnerships between nursing faculties, computer science departments and healthcare technology organisations can foster innovation while maintaining clinical and ethical integrity. Policymakers should therefore facilitate funding mechanisms that support pilot studies, capacity building and implementation research focused on AI in nursing education.

Although the nine studies included in this review consistently reported positive educational outcomes (Abuadas et al., 2025; Anthamatten and Holt, 2024; Arkan et al., 2025; Benfatah et al., 2024; Chang and Su, 2025; Hwang et al., 2024; Maguire and White, 2025; Sepanloo et al., 2025; Shen et al., 2025) the evidence base remains emergent and methodologically heterogeneous. Future research should aim to improve comparability across studies and facilitate meta-analysis, the field needs to standardise outcome measures for evaluating AI-assisted learning. Furthermore, assessing the full impact of these technologies requires a shift toward longitudinal and multi-site studies to gauge the sustained effects of AI on learner competence, empathy development and professional identity formation. As AI integration advances, research must also explore the ethical and sociotechnical dimensions, including essential issues like data governance, the transparency of algorithms and ensuring fairness in automated feedback systems. The adoption of explainable AI (XAI) frameworks will be vital for enhancing both trust and interpretability in educational decision-making. By addressing these methodological, ethical and practical considerations, the next generation of educators and researchers can build a robust and responsible foundation for integrating AI into nursing education.

5.4. Limitations

Several limitations should be considered when interpreting the findings of this scoping review. First, the evidence base remains relatively small and recent, with only nine studies published between 2023 and 2025 meeting the inclusion criteria. This reflects the emerging nature of artificial intelligence integration in nursing education and limits the ability to draw definitive conclusions regarding long-term educational outcomes or generalisability across diverse educational contexts. Second, consistent with the purpose of scoping reviews, this study aimed to map the breadth of available evidence rather than critically appraise the methodological quality of included studies. As such, the findings represent an overview of current research trends and pedagogical applications rather than an evaluation of the strength of evidence supporting specific AI interventions. Third, the included studies demonstrated considerable heterogeneity in study design, educational settings, AI tools used and outcome measures. This variability limited the ability to directly compare findings across studies and prevented quantitative synthesis of results. Fourth, the review focused on literature published in English and in selected databases, which may have resulted in the exclusion of relevant studies published in other languages or indexed in additional sources. Consequently, some emerging international perspectives on AI in nursing education may not have been captured. Finally, although generative AI was used to support structured data extraction as part of a hybrid AI-human methodology, all outputs were manually verified by multiple reviewers to maintain transparency and accuracy. Nevertheless, the integration of AI-assisted processes may

introduce potential bias or variability in interpretation, highlighting the importance of continued methodological refinement when incorporating AI tools into evidence synthesis.

6. Conclusion

In summary, this interpretive analysis highlights that sustainable and ethically responsible integration of AI into nursing education requires cohesive action at three levels: Practice, Policy and Research. On the practical front, this involves embedding AI pedagogies into curricula and developing competence, thus maintaining reflective oversight. Concurrently, robust policy is essential for establishing ethical and institutional governance concerning AI use. Finally, sustained research is needed to generate evidence on the efficacy, safety and long-term educational impact of AI tools and methods. AI's enduring value will depend not merely on technological sophistication, but on its alignment with the humanistic ethos of nursing education where critical reasoning, empathy and professional judgement remain central to learning. The deliberate synthesis of human expertise and machine intelligence offers a paradigm through which nursing education can evolve into a digitally fluent, ethically grounded and globally adaptive discipline.

CRediT authorship contribution statement

Nugent Linda Elizabeth: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Bridget Murray:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Killian Walsh:** Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Vishnu Renjith:** Writing – original draft, Visualization, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jomin George:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Zena Moore:** Writing – review & editing, Validation, Methodology, Data curation. **Declan Patton:** Writing – review & editing, Visualization, Validation, Supervision, Methodology. **O'Connor Tom:** Writing – review & editing, Validation, Methodology. **Chanel Watson:** Writing – review & editing.

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests. Linda Nugent reports was provided by Royal College of Surgeons in Ireland. Linda Nugent reports a relationship with Royal College of Surgeons in Ireland that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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