

REVIEWS

The application of conversational artificial intelligence in nursing clinical reasoning education: A scoping review of roles, opportunities, and challenges

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ABSTRACT

Clinical reasoning is a core competency in nursing practice, yet its effective teaching faces challenges such as time constraints, limited resources, and insufficient individualized instruction. The rapid advancement of conversational artificial intelligence (CAI) in recent years offers new possibilities for innovating nursing education models. This scoping review aims to systematically map the current application of CAI in nursing clinical reasoning education, delineate its specific roles, analyze the educational opportunities it presents, and identify the main challenges and future directions. By synthesizing existing evidence, this review seeks to provide an evidence-based reference for educators, technology developers, and policymakers to promote the effective and responsible integration of this technology into nursing education. It also offers practical guidance for the application of conversational AI in clinical nursing teaching such as outpatient nursing training.

Key Words: Clinical reasoning, Conversational artificial intelligence, Educational technology, Nursing education, Simulated patient

1. INTRODUCTION

Clinical reasoning is the core cognitive process through which nurses collect and process information, identify patient problems, make decisions, and take action, directly impacting patient safety and care quality.^[1] Traditional methods for teaching this critical skill, such as case discussions, high-fidelity simulation, and clinical placements, are effective but constrained by faculty-to-student ratios, high costs, limited scenario repeatability, and a lack of immediate, personalized feedback.^[2] The breakthrough of generative artificial intelligence (AI), particularly large language models (LLMs), has ushered in a new era where conversational artificial intelligence (CAI) agents are rapidly permeating healthcare

and education.^[3] These technologies, capable of natural language interaction, offer learners an on-demand, infinitely repeatable, and customizable interactive environment, presenting unprecedented opportunities to address the shortcomings of traditional pedagogy.^[4] However, integrating CAI into the rigorous framework of nursing education introduces multifaceted challenges related to instructional design, technological reliability, ethical considerations, and outcome evaluation.^[5] Therefore, a systematic synthesis of existing literature is essential to map the current knowledge landscape, clarify the specific roles and potential value of CAI in developing nursing students' clinical reasoning, and identify pressing issues to inform future research and practice.^[6]

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2. THE EVOLUTION AND THEORETICAL FOUNDATIONS OF CAI IN NURSING EDUCATION

2.1 From traditional computer-assisted instruction to generative CAI: The trajectory of technological development

The application of CAI in nursing education has evolved from traditional computer-assisted instruction to generative CAI systems. Early computer-assisted instruction tools featured structured, linear learning paths with limited interactivity for nursing students. The emergence of generative AI represented by ChatGPT has brought a paradigm shift.^[3] It enables open-ended, context-aware conversations that can simulate patient interactions and provide personalized feedback for nursing education. This evolution is driven by natural language processing and LLMs, making AI a more effective tool for nursing clinical reasoning training that traditional digital tools cannot match. The development of CAI in nursing education has shifted from simple information delivery to interactive learning experiences tailored to nursing teaching needs.

2.2 Learning support from constructivist and sociocultural theoretical perspectives

Generative CAI aligns powerfully with constructivist and sociocultural learning theories, which posit that knowledge is actively built by learners through social interaction and contextual experience. From a constructivist view, these AI tools act as cognitive partners, engaging students in problem-solving dialogues that scaffold their understanding of complex nursing concepts, such as managing clinical deterioration of outpatient surgery patients or conducting sensitive end-of-life conversations.^[7] Sociocultural theory emphasizes learning through mediated social interaction; AI simulations provide a safe, simulated social environment where students can practice communication, receive immediate feedback, and internalize professional discourse without the high stakes of real patient care.^[8] This theoretical alignment positions AI not as a mere information repository but as a dynamic participant in the social construction of clinical knowledge and professional identity in nursing education.

2.3 Analyzing the convergence of clinical reasoning teaching models and AI technology

The integration of generative AI into nursing education finds a natural fit in models designed to teach clinical reasoning—a core, complex competency for nurses. Clinical reasoning involves a non-linear process of data collection, hypothesis generation, and decision-making. Conversational AI can effectively simulate this process by engaging students in it-

erative, case-based dialogues. For instance, AI systems can role-play as outpatient surgery patients with specific postoperative symptoms, prompting students to ask relevant history questions, interpret findings, and formulate care plans, thereby practicing the cognitive steps of clinical judgment.^[9] Furthermore, AI can provide structured feedback on a student's diagnostic reasoning process, highlighting gaps in questioning or logic, which directly supports the deliberate practice required to develop expertise.^[10] This convergence allows for scalable, repetitive practice of clinical reasoning in a controlled, feedback-rich environment, complementing traditional clinical placements in nursing education.

3. CORE ROLES OF CAI IN NURSING CLINICAL REASONING EDUCATION

3.1 As a simulated patient: Constructing immersive, low-risk scenarios for history-taking and assessment training

3.1.1 *Simulating diverse cases and personalized disease progression*

Conversational AI enables the creation of a vast library of virtual patients with diverse demographic backgrounds, medical histories, and presenting symptoms, which is crucial for comprehensive clinical reasoning training in nursing. These systems can simulate personalized, dynamic disease progression based on the student's line of questioning and decisions, moving beyond static case studies. For instance, a Generative Pre-trained Transformer (GPT)-based system can generate unique outpatient surgery patient profiles and adjust the clinical presentation in real-time, such as simulating postoperative wound infection or mild bleeding symptoms. It provides students with varied and unpredictable scenarios that mimic real-world clinical uncertainty.^[11] This capability allows for repetitive, low-stakes practice across a spectrum of nursing conditions, from common presentations like acute uncomplicated cystitis to postoperative complications of outpatient minor surgeries, building a more robust illness script library for nursing students.^[12,13]

3.1.2 *Exercising communication skills through real-time language interaction and simulated emotional responses*

AI-driven conversational agents provide a platform for practicing not just clinical questioning but also core communication skills through natural language interfaces in nursing education. Students can engage in free-text or voice-based conversations with virtual patients, such as communicating with anxious outpatient surgery patients about preoperative preparation and postoperative precautions. They practice how to phrase questions, respond to patient cues, and build rapport.

While current systems may have limitations in emotional depth and natural conversational flow, they offer a foundational tool for structuring history-taking in nursing.^[14] Training with such systems has been shown to improve students' communication skills and their ability to gather a complete history, as evidenced by studies comparing AI-simulated patient interactions to traditional role-playing methods.^[11] This practice is essential for developing the patient-centered communication skills required for accurate clinical assessment in nursing practice.

3.2 As an intelligent tutor and coach: Providing immediate, formative feedback and guided questioning

3.2.1 Socratic questioning and prompts targeting the reasoning process

Acting as an intelligent coach, CAI can guide students' clinical reasoning by employing Socratic questioning techniques in nursing education. Instead of simply providing answers, the system can prompt learners to justify their diagnostic hypotheses for nursing cases, consider alternative explanations, or identify which pieces of clinical data are most pertinent. For example, when a student judges the cause of postoperative pain in an outpatient surgery patient, AI can prompt the student to analyze whether the pain is related to surgical wounds, inflammation, or other factors. This approach fosters deeper cognitive processing and helps students externalize their internal reasoning, a key step in developing metacognitive skills for nursing practice. By challenging assumptions and prompting reflection on the diagnostic process, AI tools move beyond knowledge delivery to actively shape clinical thinking habits of nursing students.^[15] This guided inquiry helps bridge the gap between theoretical knowledge and its application in complex, ambiguous patient situations in nursing.

3.2.2 Specific feedback and correction on nursing diagnoses and intervention plans

A systematic review confirms that AI-based conversational agents effectively enhance cognitive outcomes in nursing education, including clinical reasoning and critical thinking.^[4] These systems can provide immediate, specific feedback on a student's proposed nursing diagnoses and care plans. For example, after a simulated interaction with an outpatient surgery patient with postoperative nausea and vomiting, the AI can analyze the student's documented assessment and highlight discrepancies, missing information, or illogical connections between data and conclusions. It can reference evidence-based nursing guidelines or protocols to correct misconceptions and suggest more appropriate nursing interventions such as position adjustment and antiemetic medication administration. This formative feedback is instantaneous

and scalable, allowing students to learn from mistakes in a safe environment and refine their clinical judgment before encountering real patients.^[4]

3.3 As a collaborative learning partner: Promoting reflective practice and metacognitive development

3.3.1 Guiding students to explain their thought process and self-assess

Conversational AI can function as a collaborative partner that prompts reflective practice, a cornerstone of developing clinical expertise in nursing. The system can engage students in a post-encounter dialogue, asking them to articulate their reasoning behind specific questions asked or decisions made during the simulation of nursing cases. For example, after a simulated nursing intervention for an outpatient surgery patient with postoperative hypotension, AI can guide the student to explain the reasoning for choosing specific nursing measures and self-assess the rationality and comprehensiveness of the intervention. By requiring learners to explain their thought process, the AI encourages metacognition—the awareness and regulation of one's own thinking. This practice of self-explanation helps solidify learning and identify gaps in understanding for nursing students. Qualitative studies on systems like NurCaseAI show that students value such interactive tools for analytical learning, even while recognizing their limitations in complex affective engagement.^[16]

3.3.2 Supporting dialogue-based review and knowledge integration

The interactive nature of CAI makes it an ideal tool for facilitating structured debriefing and knowledge integration after a learning activity in nursing education. The AI can lead a review dialogue, helping students connect the dots between patient history, physical exam findings (simulated or described), and potential diagnoses in nursing cases. For instance, after a simulated training on the nursing care of outpatient cataract surgery patients, AI can guide students to integrate the knowledge of preoperative assessment, intraoperative cooperation, and postoperative care. It can prompt learners to consider how the case aligns with or challenges their existing knowledge, and to synthesize new information into a coherent clinical narrative. This dialogue-based review supports the consolidation of learning and the integration of isolated facts into actionable clinical knowledge, preparing students for the synthesis required in real-world nursing practice.^[17] This process mirrors effective reflective practices used in other health professions education to enhance experiential learning.^[18]

4. MAIN EDUCATIONAL OPPORTUNITIES PRESENTED BY CAI

4.1 Enhancing learning accessibility and flexibility: Supporting asynchronous, independent reinforcement practice

Conversational AI significantly enhances the accessibility and flexibility of nursing education by enabling asynchronous, self-directed learning. These tools provide students with on-demand access to learning support, allowing them to engage in practice and review outside of traditional classroom hours or scheduled faculty availability. For instance, AI-based conversational agents can serve as interactive revision platforms, offering nursing students the opportunity to practice clinical reasoning for outpatient nursing cases or review complex nursing concepts at their own pace.^[19] This is particularly valuable in addressing training challenges such as limited actor availability and high costs in traditional simulation-based methods, as demonstrated by a CAI system for GP consultation skills training, which provided a practical and accessible solution for repeated practice.^[20] By supporting learner-initiated interactions, these systems facilitate practice-oriented education, allowing nursing students to reinforce their knowledge independently and flexibly.^[4]

4.2 Enabling highly personalized learning paths: Adaptive difficulty and targeted content delivery

A key opportunity lies in the ability of CAI to create highly personalized learning experiences for nursing students. These systems can adapt to individual student performance and knowledge states, dynamically adjusting task difficulty and content delivery to optimize the learning path. Research on personalized learning systems integrating reinforcement learning with dynamic knowledge tracing demonstrates how AI can track a student's evolving knowledge and select tasks in real-time to ensure maximum retention and engagement.^[21] This adaptive approach moves beyond a one-size-fits-all model, allowing for the generation of customized learning paths that vary from person to person, thereby improving learning efficiency and outcomes.^[22] In nursing education, aligning the interaction modes and feedback levels of conversational agents with specific educational purposes and nursing content such as outpatient clinical reasoning training is essential for maximizing learning outcomes, highlighting the role of personalization in catering to diverse learning needs of nursing students.^[4]

4.3 Scaling high-quality instructional feedback: Alleviating educator burden and focusing on higher-order guidance

Conversational AI offers the potential to provide scalable, timely, and consistent feedback in nursing education, thereby

reducing the administrative and instructional burden on nursing educators and allowing them to focus on more complex, higher-order teaching. AI-driven tools can generate immediate feedback on student performance during the learning process, addressing a critical need for formative assessment in nursing education.^[23] This capability was evident in an educational innovation for GP trainees, where a CAI system delivered feedback on consultation skills, demonstrating strong acceptability and educational value while freeing up educator resources.^[20] By handling routine feedback and assessment of basic nursing clinical reasoning skills, these systems enable nursing faculty to dedicate more time to mentoring, facilitating deep discussions, and guiding students in developing advanced clinical judgment and humanistic skills that AI cannot replicate.^[24]

4.4 Generating rich teaching resources: Rapid creation of diverse, contextualized clinical case libraries

Generative AI excels at rapidly creating a wide array of realistic and diverse teaching materials, particularly clinical case scenarios for nursing education. This capability allows nursing educators to build extensive, context-rich case libraries that reflect a variety of patient presentations, social determinants, and clinical challenges in nursing practice, especially a large number of outpatient nursing cases. Studies show that AI models like ChatGPT, Gemini, and Bing can effectively interpret complex clinical and social cases, generating responses that cover diagnosis, intervention, and ethical reasoning.^[25] In nursing education, generative AI has been used to create interactive case study systems and simulate patients for practicing sensitive conversations, such as end-of-life care discussions and preoperative communication with outpatient surgery patients, providing a safe and informative learning environment.^[8, 16] This rapid resource generation supports case-based learning methodologies and helps bridge gaps in access to standardized patient experiences in nursing education.

4.5 Boosting learning motivation and engagement: Gamification elements and anthropomorphic interaction experiences

The interactive and often anthropomorphic nature of CAI can significantly enhance nursing students' motivation and engagement in learning. The conversational interface, which mimics human dialogue, along with the potential integration of game-like elements, makes nursing learning more interactive and engaging. For example, AI can set up clinical reasoning challenge tasks for outpatient nursing cases and reward students who complete the tasks well, increasing their learning enthusiasm. Research indicates that technology ac-

ceptance and learning motivation are significant mediators between perceived support and learning engagement, suggesting that well-designed AI tools can positively influence these psychological factors of nursing students.^[26] Furthermore, the use of generative AI simulations for practicing clinical skills has been shown to positively impact students' confidence and competence, making the learning experience more engaging and realistic.^[8] By providing a responsive and interactive learning partner, CAI can help sustain nursing students' interest and foster a more active learning process.

5. KEY CHALLENGES AND LIMITATIONS IN CURRENT IMPLEMENTATION

5.1 Technical reliability and safety challenges

5.1.1 "Hallucination" Phenomenon and Risks to Clinical Information Accuracy

The phenomenon of AI "hallucination," where models generate plausible but factually incorrect or ungrounded information, poses a significant risk to clinical information accuracy in nursing education. Incorrect nursing knowledge and clinical guidance generated by AI may mislead nursing students and affect their future clinical practice. While retrieval-augmented generation (RAG) technology has been proposed to ground outputs in validated knowledge bases, thereby improving reliability, students still perceive analytical constraints and limitations in the conversational quality of these systems.^[16] This inherent unreliability challenges the safe integration of AI tools in nursing education, as the dissemination of incorrect clinical information could lead to the formation of flawed mental models and unsafe future nursing practice. The risk is amplified in unsupervised learning environments, where nursing students may not possess the expertise to identify subtle inaccuracies, underscoring the need for robust validation and continuous monitoring of AI-generated educational content for nursing.

5.1.2 Data privacy, security, and compliance issues

The implementation of AI-driven conversational agents and digital educational resources in nursing education raises critical concerns regarding data privacy, security, and regulatory compliance. These systems often process sensitive student interaction data and may utilize nursing patient case information, including personal information of outpatient surgery patients, necessitating stringent data protection measures. The challenge is compounded by the need to integrate these technologies within complex healthcare and educational IT infrastructures, which must adhere to regulations such as the Health Insurance Portability and Accountability Act (HIPAA) or the General Data Protection Regulation (GDPR). Ensuring system safety involves not only technical

safeguards against data breaches but also establishing clear protocols for data ownership, usage, and retention. A failure to address these issues comprehensively can erode trust, violate ethical standards, and expose nursing education institutions to legal liabilities, thereby hindering the sustainable adoption of innovative educational tools.^[27]

5.2 Pedagogical design and integration challenges

5.2.1 Effective embedding of AI activities into curriculum systems and learning objectives

A primary pedagogical challenge is the thoughtful integration of AI activities into existing nursing curriculum structures to align with specific learning objectives, rather than treating them as isolated technological add-ons. Successful integration requires redesigning nursing educational workflows around digital capabilities to improve efficiency and learning outcomes.^[27] However, this process is complex; poorly optimized integration can lead to nursing educator frustration, student confusion, and ultimately, tool abandonment. The design must consider how AI-supported tasks, such as interactive outpatient nursing case studies, complement and enhance traditional nursing teaching methods to achieve defined competencies in clinical reasoning or critical thinking, ensuring the technology serves a clear pedagogical purpose rather than becoming a distracting novelty in nursing education.

5.2.2 Lack of validated, high-quality prompt engineering frameworks for nursing clinical reasoning

While AI conversational agents show promise in nursing education, their educational effectiveness is heavily dependent on the quality of user prompts and system design. There is a notable scarcity of rigorously validated, pedagogical frameworks for prompt engineering specifically tailored to developing nursing clinical reasoning skills.^[4] Without such frameworks, interactions between nursing students and AI may remain superficial or misaligned with the nuanced, iterative nature of nursing clinical judgment. For example, the prompts designed for training clinical reasoning of outpatient nursing cases may not effectively guide students to conduct comprehensive analysis and judgment. The development of these frameworks requires interdisciplinary collaboration between nursing educators, instructional designers, and AI specialists to create structured prompting strategies that guide students through hypothesis generation, data interpretation, and decision-making processes in nursing practice, thereby maximizing the educational value of AI interactions in nursing education.

5.3 Assessment and efficacy validation challenges

5.3.1 *Difficulties in measuring learning outcomes: Evidence of transfer from interaction to clinical competence*

Measuring the true impact of AI tools on learning outcomes in nursing education, particularly the transfer of skills from simulated interactions to real-world clinical competence of nurses, remains a significant hurdle. While studies can assess immediate cognitive gains like knowledge acquisition or self-reported confidence of nursing students, providing robust evidence that AI-enhanced learning improves actual nursing clinical performance is far more challenging.^[4] This gap exists because nursing clinical competence is multifaceted, context-dependent, and influenced by numerous variables. Isolating the contribution of an AI educational intervention requires sophisticated, longitudinal study designs that move beyond simple pre-post testing to assess behavioral change in nursing practice settings, a level of evaluation that is currently lacking in the literature of nursing education.

5.3.2 *Scarcity of research on long-term effects and skill retention*

The evidence base for AI in nursing education is predominantly focused on short-term interventions and immediate outcomes. There is a pronounced lack of longitudinal research investigating the long-term effects of AI-based education and the retention of acquired skills over time for nursing students.^[4] Without understanding whether nursing knowledge and reasoning patterns developed through AI interactions are durable and persist into clinical nursing practice, it is difficult to justify substantial curricular investments in AI-based nursing education. This research gap calls for studies that follow cohorts of nursing students beyond a single course or semester to evaluate skill decay, the integration of AI-learned concepts into complex clinical nursing situations such as complex outpatient nursing cases, and the ultimate impact on patient care quality months or years after the educational intervention.

5.4 Ethical, professional, and humanistic care considerations

5.4.1 *Potential impact on the nature of nurse-patient relationships and empathy development*

A critical ethical consideration is the potential for AI-mediated learning to inadvertently distance nursing students from the humanistic core of nursing. Current AI systems are often perceived as task-oriented tools for information retrieval and case analysis, offering limited emotional engagement or opportunities to practice empathetic communication in nursing.^[16] For example, when simulating the communication with outpatient surgery patients, AI cannot

fully simulate the complex emotions of patients, making it difficult for students to practice empathetic communication. Over-reliance on such interactions during formative nursing education could risk shaping a transactional view of patient care, where clinical reasoning is divorced from the relational and compassionate aspects central to the nurse-patient relationship. Nursing educators must therefore intentionally design AI integrations that complement, rather than replace, experiences that foster empathy, active listening, and therapeutic communication skills in nursing students.

5.4.2 *Algorithmic bias and health equity issues*

The integration of AI into nursing education carries the risk of perpetuating and amplifying existing societal biases, posing a direct threat to health equity in nursing care. If the training data for educational AI models reflects historical healthcare disparities or lacks diversity in nursing cases, the systems may generate biased clinical scenarios, recommendations, or patient interactions in nursing education.^[28] For example, the AI may generate more nursing cases of specific age groups or genders, leading to the lack of comprehensive training of nursing students. This could reinforce stereotypes and inequitable care practices among future nurses. Furthermore, algorithmic bias in AI-based assessment tools could unfairly disadvantage certain student groups in nursing education. Addressing this challenge requires proactive efforts to audit AI tools for bias, utilize diverse and representative nursing datasets, and educate nursing students about the existence and implications of algorithmic bias as a fundamental component of digital health literacy.

5.4.3 *Digital divide and disparities in teacher-student technology acceptance*

The successful implementation of AI in nursing education is threatened by the digital divide—disparities in access to reliable technology and high-speed internet—and varying levels of digital literacy among both nursing students and faculty.^[28] These disparities can exacerbate existing educational inequalities in nursing education, leaving some nursing students behind, especially those in grassroots nursing education institutions. Concurrently, differences in technology acceptance and self-efficacy among nursing educators can lead to inconsistent implementation and support of AI in nursing teaching. Faculty who are less comfortable with the technology may be unable to guide students effectively or critically evaluate AI-generated content, limiting the tool's potential in nursing education. Overcoming this challenge necessitates institutional investment in infrastructure of nursing education institutions, comprehensive training programs for nursing educators, and support systems to ensure equitable access and foster a culture of digital inclusion in nursing education.

6. FUTURE RESEARCH DIRECTIONS AND PRACTICAL RECOMMENDATIONS

6.1 Priority research areas: Development and validation of specialized models and assessment tools for nursing

Future research must prioritize the development and validation of AI models and assessment tools specifically designed for the nursing domain. Current general-purpose LLMs demonstrate moderate performance in generating nursing diagnoses but are not yet sufficiently reliable for independent clinical or educational use, necessitating expert verification of their outputs.^[29] This underscores the critical need for specialized models that are grounded in validated nursing knowledge, such as those utilizing RAG technology, to improve accuracy and reliability for educational applications in nursing, especially for the clinical reasoning training of outpatient nursing.^[16] Concurrently, there is a significant gap in standardized, validated tools to assess competencies, attitudes, and stressors specific to nursing specializations and AI integration. The development of psychometrically robust instruments, such as scales for nursing specialization attitudes or AI readiness, is essential to inform curriculum optimization, policy-making, and the evaluation of educational interventions in nursing.^[30] Research should focus on creating and testing these domain-specific tools to ensure they effectively measure the unique cognitive, affective, and technical competencies required in modern nursing practice and education.

6.2 Best practice framework construction: Instructional design principles and implementation guidelines for interdisciplinary collaboration

Constructing best practice frameworks requires establishing clear instructional design principles and implementation guidelines born from robust interdisciplinary collaboration for the integration of AI in nursing education. Evidence suggests that the effectiveness of AI-based educational tools, such as conversational agents, is maximized when their interaction modes and feedback levels are carefully aligned with specific educational purposes and nursing content.^[4] A framework should therefore guide the integration of technology, like AI-driven outpatient nursing case studies or simulation programs, into nursing curricula in a way that supports core competencies such as clinical reasoning, critical thinking, and person-centered care.^[16] This necessitates collaboration between nurse educators, instructional designers, AI specialists, and ethicists to develop evidence-based methodologies. For instance, frameworks can outline how to combine AI tools with reflective strategies like narrative writing and discussion groups to enhance professional

competences of nursing students.^[31] The goal is to create scalable, adaptable models that specify optimal intervention dosages, implementation roles (e.g., bedside nurses vs. dedicated facilitators in outpatient departments), and strategies for tailoring interventions to diverse learning contexts and specializations in nursing, from disaster response to palliative care and outpatient nursing.^[32]

6.3 Policy and governance development: Establishing institutional-level ethical guidelines and competency standards for AI use

The safe and effective integration of AI into nursing education mandates the development of comprehensive institutional policies and governance structures in nursing education institutions. A primary focus must be the establishment of clear ethical guidelines and competency standards for both nursing educators and students. Current research highlights a lack of consensus on AI competencies and ethical frameworks within medical and nursing education, leading to non-uniform implementation and potential risks like over-reliance or deskilling.^[33] Policy development should therefore define foundational AI literacy and proficiency requirements for nursing professionals, encompassing dimensions such as ethical application, technical understanding, and tool integration into nursing teaching and assessment.^[34] Nursing education institutions need robust regulatory policies to safeguard patient safety and data privacy, coupled with systems to monitor AI performance and outputs in nursing education.^[29] Furthermore, policies must address equity by ensuring access to digital tools and training across all nursing education resource settings, thereby mitigating institutional disparities in AI readiness and adoption in nursing education.^[35]

6.4 Optimization of blended learning models: Exploring optimal combination strategies for human-machine collaborative teaching

Optimizing blended learning models involves strategically exploring and validating the most effective combinations of human instruction and AI-driven tools to create synergistic, human-machine collaborative teaching environments in nursing education. The blended learning approach, which integrates online resources with interactive face-to-face sessions, is known to enhance student engagement, motivation, and self-directed learning in nursing education.^[36] Future research should investigate how AI components, such as virtual tutors, interactive outpatient nursing case studies, or automated assessment generators, can be optimally embedded within these models to support precision education and active learning without replacing essential human interaction.^[37] Studies need to determine the best strategies for using AI to handle cognitive offloading tasks (e.g., grading,

information delivery) in nursing education, thereby freeing educator time for higher-order teaching activities like facilitating clinical reasoning, providing empathetic feedback, and fostering complex communication skills in nursing students.^[16] For grassroots nursing education institutions and outpatient nursing teaching, it is possible to start with simple AI tools such as free large models to carry out blended teaching. The exploration should aim to define the specific roles of AI as a supplementary tool within a nursing curriculum that prioritizes the development of critical thinking, ethical judgment, and the irreplaceable human elements of nursing care.

7. CONCLUSION

The integration of CAI into nursing clinical reasoning education represents a significant paradigm shift with profound potential to reshape pedagogical approaches in nursing. From an expert perspective, its evolution from a novel technological tool to a multifaceted educational agent—acting as a simulated patient, an intelligent tutor, and a collaborative partner—demonstrates a move toward addressing the perennial challenges of scalability, personalization, and immediate feedback in traditional nursing training models. The impact lies in its capacity to democratize access to high-quality, repetitive, and adaptive practice, thereby potentially accelerating competency development and enhancing learner engagement for nursing students, especially in the clinical reasoning training of outpatient nursing.

However, a balanced analysis requires careful navigation between its transformative opportunities and inherent challenges in nursing education. Experts must weigh the demonstrable benefits of dynamic resource generation and personalized learning pathways against pressing concerns regarding technological reliability, such as the risk of disseminating inaccurate or non-contextual clinical information in nursing. Furthermore, the pedagogical integration of CAI must be critically appraised; its effectiveness is not inherent but contingent upon evidence-based instructional design that thoughtfully embeds AI interactions within sound educational frameworks in nursing. Perhaps the most complex balance lies in the ethical domain: leveraging CAI to augment clinical judgment of nursing students without diluting the essential humanistic components of nursing care, such as empathy and ethical discernment, and vigilantly guarding against embedded algorithmic biases that could undermine equitable education in nursing.

For the domestic nursing education in China, the application of CAI in nursing clinical reasoning training can start with low-cost tools such as free large language models. Nursing educators can use these tools to create a large number of clin-

ical reasoning cases suitable for domestic nursing practice, especially outpatient nursing cases, and carry out blended teaching combined with traditional teaching methods. Grassroots nursing education institutions can gradually promote the application of CAI according to their own actual conditions, and continuously optimize the teaching mode in the practice process.

Therefore, the future trajectory of this field hinges on deliberate, interdisciplinary collaboration in nursing education. Success will be measured not by the sophistication of the technology alone, but by our ability to develop nursing-optimized AI tools, establish robust pedagogical frameworks, conduct rigorous longitudinal outcome research, and formulate proactive ethical and policy guidelines for nursing education. The ultimate goal must be a human-centric, technology-enhanced ecosystem where CAI empowers nursing educators and elevates the learning process. In this balanced model, CAI serves as a powerful adjunct to—not a replacement for—expert human instruction in nursing, collectively fostering a new generation of nurses equipped with robust clinical reasoning skills to navigate complex healthcare environments, including the diverse and complex clinical scenarios in outpatient nursing.

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AUTHORS CONTRIBUTIONS

Hao Chang contributed to the study conception, literature review, manuscript drafting, and revision. All work was completed independently by the sole author. The author has read and approved the final manuscript.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

DATA SHARING STATEMENT

No additional data are available.

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