Prompts, privacy, and personalized learning: integrating AI into nursing education—a qualitative study

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Abstract

Background Generative artificial intelligence (GenAI) has emerged as a powerful tool in nursing education, offering novel ways to enhance clinical reasoning, critical thinking, and personalized learning. However, questions remain regarding the ethical use of AI-generated outputs, data privacy concerns, and limitations in recognizing emotional nuances.

Objective This study aims to explore how nursing students utilize GenAI tools to develop care plans, with a particular focus on the innovative role of prompt engineering. By identifying both challenges and opportunities, it seeks to provide actionable insights into seamlessly integrating GenAI into nursing education while safeguarding humanistic nursing skills.

Methods A qualitative design was adopted, involving semi-structured interviews with third-year undergraduate nursing students at a single institution. Participants worked with anonymized clinical cases and multiple GenAI tools, emphasizing the iterative design of prompts to optimize care-plan outputs. Data were analyzed thematically to capture detailed perspectives on AI-facilitated learning and ethical considerations.

Results Findings indicate that GenAI tools enhanced efficiency and conceptual clarity, allowing students to focus more on higher-order clinical thinking. Prompt engineering significantly improved the accuracy and contextual relevance of AI-generated care plans. However, students expressed concerns about incomplete or imprecise responses, GenAI's limited emotional understanding, and privacy risks associated with sensitive healthcare data. When used with careful prompt refinement and critical evaluation, GenAI was viewed as a valuable supplement rather than a replacement for humanistic nursing competencies.

Conclusion This study highlights the transformative potential of GenAI in nursing education, underscoring the importance of structured prompt engineering and ethical safeguards. By balancing technological innovation with empathy, communication, and cultural sensitivity, nursing educators can harness AI to deepen clinical reasoning and prepare students for future AI-enhanced practice. Further research across diverse settings is needed to validate these findings and refine best practices for integrating GenAI into nursing curricula.

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Introduction

Background

The integration of generative artificial intelligence (GenAI) into nursing education is transforming traditional pedagogical approaches, particularly in cultivating clinical reasoning and logical thinking skills [1–2]. GenAI tools, such as ChatGPT, have demonstrated substantial potential in medical education [3–4]. Studies [5–6] indicate that GenAI comprehensive medical information, enabling novices to analyze complex clinical scenarios. Through simulated case generation, GenAI further aids students in refining their diagnostic and care-planning abilities, thereby enhancing both clinical reasoning and readiness for real-world practice [7–8]. As a dynamic learning tool, GenAI can also personalize case studies based on individual student needs and provide real-time feedback, thus improving health literacy and clinical competence [9–10].

However, the effective adoption of GenAI in nursing education requires more than just technical proficiency [11], it also depends on how students interact with GenAI tools, structure their inputs, and refine responses for accuracy and relevance [12]. One approach to improving AI-assisted learning is prompt engineering, which refers to the process of designing and refining questions or instructions given to an GenAI to generate accurate and relevant output [13]. In the medical education field, research on prompt engineering has primarily focused on medical question-answering, communicate with patients, and performance in medical examination questions [14–16]. To the best of our knowledge, no studies have explored how prompt engineering can be applied to nursing care planning education using real clinical cases.

A recent review on GenAI in medicine indicates that most studies focus on English-based models, particularly GPT-3.5 (61%) and GPT-4 (54%), with limited research on non-English GenAI [17]. Since 2023, several high-performing Mandarin-language GenAI models, such as ERNIE, QWen, and ChatGLM, have emerged, specifically trained on Chinese-language medical datasets [18]. These models address regional gaps in GenAI development, offering more accurate medical terminology processing and improved contextual adaptation in healthcare settings [19–21]. Despite their growing adoption, research on their application in nursing education remains limited.

This study addresses the gaps by investigating prompt engineering in nursing education within Mandarin-speaking regions, leveraging local GenAI to enhance nursing care planning and AI-assisted learning strategies. Unlike prior studies that focus on GenAI accuracy or quantitative outcomes, this research qualitatively explores how nursing students interact with and refine GenAI responses, providing insights into structured prompt engineering techniques for optimizing AI-generated nursing care plans.

Objectives

This study investigates nursing students' experiences and perceptions regarding the use of GenAI tools in formulating nursing care plans. Specifically, it seeks to address the following research questions:

1. How do nursing students perceive the use of GenAI in developing nursing care plans?
2. What challenges and barriers do students face when integrating GenAI into the formulating nursing care plans?
3. How does prompt engineering impact the quality and accuracy of AI-generated nursing care plans?

By addressing these questions, this study aims to provide insights into optimizing GenAI integration in nursing curricula, improving AI-generated nursing care plans, and enhancing student engagement with GenAI tools in clinical education.

Methods

Study design

This study employed a qualitative exploratory design. It uses focus group interviews to capture the breadth and depth of nursing students' experiences. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist was followed [22].

Context

This study incorporated GenAI tools to assist nursing students in formulating care plans, fostering engagement, and improving learning outcomes. It was integrated into three courses—"Medical Nursing," "Surgical Nursing," and "Nursing Informatics."

The first two provided anonymized clinical cases for practice, while "Nursing Informatics," introduced students to the principles of GenAI utilization, prompt engineering, and the ethical considerations of using GenAI, such as data privacy and confidentiality.

A faculty team created a multi-step prompt template, grounded in the literature and verified by clinical nursing specialists.The prompt template included four key components: (1) Role Declaration, where students specified the GenAI's role (e.g., an experienced clinical nurse);

Table 1 Participants' demographic data

ID	Group	Class leader	Case name	Case analysis score
N1	1	Yes	Brain Tumor	70
N2	1	No	Colon Tumor	85
N3	1	No	Nephrotic Syndrome	85
N4	1	No	Intracranial Hypertension	80
N5	1	Yes	Cranial Tumor	80
N6	2	No	Hypertensive Heart Disease	80
N7	2	No	Thyroid Tumor	85
N8	2	No	Hyperthyroidism	85
N9	2	No	Upper Gastrointestinal Bleeding	85
N10	2	No	Heart Failure	85
N11	2	No	Thyroid Nodule	90
N12	3	Yes	Liver Cancer	90
N13	3	No	Acute Liver Failure	85
N14	3	Yes	Thyroid Tumor	85
N15	3	No	Nephritis	85
N16	3	Yes	Renal Failure	85
N17	3	No	Hypertension	85

(2) Step-by-Step Breakdown, structuring the GenAI's reasoning through predefined steps; (3) Explicit Output Requirements, which directed the GenAI to generate comprehensive, evidence-based responses (e.g., develop a structured nursing care plan using NANDA-I principles); and (4) Chain of Thought, prompting the GenAI to articulate its reasoning process clearly.

Seven popular Chinese-language GenAI tools were selected for this study. Groups of 2–3 students were assigned one anonymized clinical case and two GenAI tools. GenAI tools were randomly assigned to student groups. Students were asked to organize clinical data, apply structured prompts, and iteratively refine their queries to achieve satisfactory GenAI responses. These responses were evaluated against textbook and literature standards. A panel of specialized nursing educators assessed the quality of the completed cases, while informatics instructors evaluated the prompt structures.

Participants and sampling

From September to November 2024, all 160 third-year undergraduate nursing students from four classes at a university in Zhejiang Province participated in a study utilizing GenAI to analyze real hospital cases. These cases were anonymized before being used to complete nursing care plan development.

After completing the assignments, We selected 17 participants for interviews based on the principle of maximum variation to ensure diverse perspectives. Their demographic profiles are shown in Table 1. The selection criteria included differences in academic performance

(course grades ranging from 70 to 90), class leadership roles (5 class leaders vs. 12 non-leaders), technical proficiency, and attitudes toward using GenAI (evaluated based on classroom performance in using digital tools and GenAI applications). The participants were divided into three groups: Group 1 (5 participants), Group 2 (6 participants), and Group 3 (6 participants) [23]. The age of participants ranged from 19 to 21 years, including 4 male and 13 female participants.

Inclusion criteria included:

- Full participation in the course, including the completion of case analysis and nursing care plan assignments;
- Adequate communication skills to articulate their experiences and perspectives clearly;
- Provision of informed consent and willingness to participate in the study.

Data collection

Data were gathered through semi-structured interviews. The initial interview guide was developed based on a review of relevant literature and the study objectives, followed by group discussions within the research team. To minimize bias, the research team designed the guide with open-ended questions, allowing participants to freely express their experiences without influence from leading questions. Two nursing undergraduates participated in a pilot interview to refine the interview guide based on their feedback, resulting in the final version of the guide. The full list of interview questions covered topics related to students' experiences with using GenAI, strategies for prompt design, challenges encountered during GenAI utilization, concerns regarding data privacy, and their perceptions of GenAI role in nursing education ().

Data analysis

After the interviews, two researchers (FCL and JWJ) transcribed the audio recordings into text within 24 h using the iFLYTEK Smart Recorder SR302, which supports offline automatic transcription. They cross-checked the transcripts carefully against field notes to ensure accuracy and completeness.

Qualitative content analysis [24] guided the data analysis, and coding was performed using Python QualCoder software. Initially, the research team familiarised themselves with the data by repeatedly reading through the transcripts. In the inductive phase, two researchers collaboratively performed open coding, carefully reviewing transcripts line by line and assigning initial codes to capture the meaning of each phrase or line.

Following inductive open coding, the researchers applied a deductive approach guided explicitly by predefined categories derived from the interview guide.

Similar inductively-generated codes were systematically merged into overarching categories, forming a structured analytical framework closely aligned with the topics from the interview guide. This analytical framework was then consistently applied across the three transcripts, with similar or related categories further consolidated into final themes.

Data saturation was determined through iterative review and refinement. The research team conducted repeated discussions and careful re-examinations of the transcripts until no new meaningful codes, themes emerged. Preliminary and final themes were regularly reviewed by the research team and validated through feedback from selected nursing student participants, enhancing the credibility and accuracy of the findings.

Rigor

Interviewers were trained in qualitative research techniques, and each focus group had a moderator and an observer to facilitate discussion and monitor group dynamics [23]. The interviews were conducted in private rooms without interruption. Each interview lasted around 60–90 min, with flexibility to extend them as needed. The researchers maintained neutrality, clarifying any unclear responses by asking follow-up questions.

To minimize researcher bias in data analysis, two researchers independently coded and analyzed the data, followed by a comparison of their coding results to identify and resolve discrepancies. Regular team discussions were conducted to enhance inter-coder reliability and ensure consistency in theme identification. To further validate the findings, the finalized transcripts were shared with participants for member checking, ensuring accuracy and completeness while reducing the risk of researcher interpretation bias.

Results

Through qualitative content analysis, five key themes emerged from nursing students' experiences with GenAI in formulating nursing care plans:

1. Experience with GenAI usage.
2. Effectiveness in nursing case analysis.
3. Prompt design and its role.
4. Privacy and data security.
5. Emotional understanding of GenAI.
6. Changes in Learning Methods and Professional Perceptions.

To illustrate the content analysis process, an example of how initial codes were condensed into subthemes and final themes can be found in supplementary file 2.

Experience with GenAI usage

Undergraduate nursing students described a wide array of experiences when integrating GenAI tools into their learning routine. Most notably, they highlighted GenAI's efficiency in organizing scattered information and constructing initial frameworks. However, they also encountered persistent challenges regarding accuracy and completeness, particularly when more nuanced or complex details were required.

Efficiency in information organization and framework construction

Many students praised GenAI for its capability to simplify large volumes of content and provide structured outlines, which helped them quickly map out their nursing interventions and diagnoses.

> *GenAI did a fantastic job organizing the overwhelming clinical data. It gave me a clear starting point for my nursing interventions and diagnoses, making my assignments more streamlined and systematic. (N 9)*

> *It was really helpful how GenAI could instantly generate an analytical framework. I felt like I had a basic blueprint to work from, which saved me so much time refining my ideas. (N 3)*

Enhanced convenience and analytical efficiency

The majority of students were especially appreciative of GenAI's rapid response to queries, describing it as a game-changer in terms of time-saving and immediate feedback.

- *"I just type in what I need to know, and boom– there's my answer, all nicely organized. Never had anything this quick before!" (N 5)*
- *"I used to be buried in textbooks for hours trying to find specific information. Now? I just ask the AI and get pointed in the right direction almost instantly. It's like having a super-fast study buddy!" (N 1)*
- *"GenAI brings multiple resources into one place, which is especially valuable when I'm working on complex nursing topics that require cross-referencing." (N 14)*

Challenges in accuracy and completeness

students consistently pointed out instances where GenAI's responses were either factually incorrect or lacked the granularity needed for real-world nursing applications.

- *"Sometimes GenAI presents an answer confidently, but it can be partially wrong or miss crucial points.*

I often need to correct or fill in those gaps through textbooks or my own clinical knowledge." (N 11)

- "*ERNIE Bot was like getting a blueprint, Great for giving you the big picture, but when it came to the details? That's where things got a bit fuzzy. I spent quite a bit of time filling in the gaps to make it actually work for real patients.*" (N 6)
- "*I tried Doubao too, It's funny– it'll give you these really detailed responses, which is great, but you've got to be careful. Sometimes it is spot-on, other times... not so much. I learned pretty quickly that I needed to double-check everything and adjust it based on what my patient actually needed.*" (N 16)

Effectiveness in nursing case analysis

When it came to applying GenAI directly to nursing case analysis, students generally acknowledged its utility in building a solid initial framework. However, they found that to achieve a deeper level of professional rigor and precision, they needed to revise and expand upon the generated content. Nonetheless, they appreciated how GenAI broadened their analytical horizons, often introducing them to perspectives beyond traditional textbook materials.

Comprehensive framework vs. Depth

According to the participants, GenAI outlines were structurally clear but lacked the professional nuances required for high-quality nursing care plans. Most reports required further refinement to add terminological rigor and clinical accuracy.

- "*The structure AI provided felt like a well-drawn skeleton—great shape, but no real substance or professional terminology. It needed a 'soul' to be truly complete.*" (N 2)
- "*While AI includes nursing goals and interventions, it remains somewhat generic. We need to delve deeper into the 'whys' and 'hows' to meet professional standards.*" (N 7)

Need for content refinement and supplementation

Students emphasized that merging AI-generated frameworks with textbook knowledge, clinical guidelines, and personal experience was key to crafting comprehensive nursing plans.

- "*AI's output is like a rough gemstone—promising, but you have to polish it with textbooks, evidence-based guidelines, and your clinical know-how to make it shine.*" (N 5)
- "*In my process, it was crucial to refine the prompts multiple times, so AI's answers aligned more closely with the patient's unique needs and context.*" (N 12)

Quality issues in case reports

While GenAI often produced a thoroughly organized report, participants noted a gap between theoretical completeness and practical application. Adjustments were needed to fill in specific details and ensure the plan was patient-centered.

- "*Generated plans look complete at a glance, but when you dig deeper, there's a shortage of individualized information. We had to revise and tailor the content significantly to match our patient's exact condition.*" (N 15)
- "*Its coverage of patient demographics, diagnoses, and overall goals was decent. But for specifics—like positioning strategies for a bedridden patient— GenAI's recommendations were too vague to be clinically useful.*" (N 11)

AI's capability in supplementary analysis

Nonetheless, students recognized that AI could highlight critical but easily overlooked details, thereby expanding their analytical depth and prompting them to consider broader aspects of patient care.

- "*It was like having an extra set of eyes. It caught a potential issue of hidden edema in our case, reminding us to monitor fluid balance and electrolytes more carefully. Without AI, I might have missed that.*" (N 6)
- "*What impressed me was how it went beyond just the basics we learn in class, Like when we were checking kidney function - it brought up these small but important details about changes in urine output and specific gravity. These little hints helped us understand so much more about what was really going on with our patient.*" (N 13)

Prompt design and its role

With customized medical prompts, GenAI tools can address complex healthcare challenges that were previously difficult to tackle without access to extensive medical datasets and resources [25]. Well-designed prompts enhance learning by fostering engagement with the subject matter, encouraging critical thinking, and improving knowledge retention. By using effective prompts, students demonstrate improved decision-making and problem-solving abilities, enabling them to apply theoretical knowledge more effectively in practical scenarios [26].

Challenges in prompt design

Participants frequently emphasized that designing prompts often involves iterative adjustments, particularly when dealing with specialized medical conditions.

- *"When designing a care plan for a patient with cranial tumors, we realized the importance of continuously refining prompts to find the most appropriate nursing care plan. Initially, we used generic prompts focusing on vital signs and pain management. However, as we delved deeper into the patient's condition, we found these prompts inadequate for addressing specific needs, such as managing intracranial pressure caused by brain edema. For instance, we refined our prompts to include: 'List potential complications and prioritize them by severity', which enabled us to formulate more targeted care measures." (N 1)*

- *"We noticed that while general prompts could produce useful nursing diagnoses and interventions, they often failed to capture the complexity of specific cases. For instance, in caring for a post-thyroidectomy patient, the AI suggested monitoring thyroid function and initiating hormone replacement therapy, which was helpful. However, the patient also faced psychological issues like depression and nutritional challenges due to dietary adjustments post-surgery. The generic prompts often lacked the nuance required for these specific situations." (N 8)*

Strategies for learning and refinement

Students adopted systematic approaches to improve the effectiveness of prompts, starting with examples provided in the curriculum and refining them based on GenAI's results.

- *"We began with examples from the course materials, progressively refining the prompts and making adjustments based on the generated responses." (N 17)*

- *"In the beginning, we were too vague—like just saying 'nursing interventions', so we got irrelevant or redundant result. To address this, we refined our approach by narrowing the scope. For example, instead of simply stating 'nursing interventions,' we specified 'nursing interventions for XX condition,' including key details such as required components like medication management, dietary guidance, and rehabilitation exercises. Additionally, we added constraints, such as the patient's age, gender, condition, and specific nursing goals like pain relief or quality-of-life improvement." (N 10)*

Key takeaways for improving prompt design

Students shared strategies for improving prompt design to achieve better AI-generated outputs:

- *"The clearer you are with what you ask, the better answers you get - stuff you can actually use in real situations." (N 12)*

- *"When you narrow down what you're asking about, the answers get way more accurate. Like, when I tell it to 'think like a charge nurse', the responses suddenly sound way more professional and practical!" (N 3)*

- *"I always make sure to tell it which nursing problems are most important to tackle first. Really helps get responses that actually matter for the patient." (N 7)*

- *"When I give it a specific format to follow, like a template, everything comes back super organized and makes way more sense. It's like giving it a roadmap to follow!" (N 14)*

Privacy and data security

Privacy and data security emerged as prominent concerns among participants. Worries about AI's potential to compromise patient confidentiality influenced the frequency and depth of AI use.

Concerns about privacy breaches

Participants expressed apprehension about whether AI could incorporate inputted case data into its database, potentially leading to unintended privacy breaches.

- *"I always wonder if all these cases we're typing in are somehow being stored by the AI. Like, where does all that information actually go?" (N 13)*

- *"Sure, we're careful about removing patient details and double-checking everything before we put it in. But here's the thing - what if the AI is smarter than we think? What if it's connecting dots we don't even see? Sometimes I wonder if it might figure out more about our patients than we're actually telling it. That's kind of scary when you think about it." (N 9)*

Impact of data security concerns

- *"These concerns affected participants' willingness to fully utilize AI tools. This worry has impacted the frequency and depth of my AI usage. Sometimes, I just skip certain features altogether, or I only input information that's not sensitive at all." (N 6)*

Strengthening privacy protection

Participants emphasized the importance of minimizing risks by removing sensitive information from inputs and ensuring robust legal protections.

- *"When using AI, we should remove as much patient-sensitive information as possible. This can reduce the risk of privacy breaches. After all, nobody wants their privacy to be casually leaked, right?" (N 3)*

- *"Legal safeguards are equally important. I believe that as technology advances and legal regulations improve, we can strike a balance where AI's*

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advantages are fully utilized while ensuring patient privacy and data security." (N 2)

Emotional Understanding of GenAI
Participants commonly noted limitations in GenAI's ability to understand emotions, describing its responses as often superficial and lacking in personalized analysis. Although some GenAI tools demonstrated improvements in emotional expression, they still fell short of expectations for delivering truly individualized care [27].

Limitations in emotional Understanding
Undergraduate nursing students highlighted that GenAI's emotional understanding remained basic, often offering general and surface-level suggestions.

- *"GenAI often includes emotional care recommendations, but they are too general. For example, when recognizing that a patient with upper gastrointestinal bleeding might feel anxious, it suggests relaxation techniques like deep breathing or meditation. While it's nice that GenAI recognized the anxiety, what these patients really need is human touch and family support." (N 9)*
- *"The GenAI's recommendations felt like they came from a textbook rather than understanding a real person. Take our diabetic nephropathy patient - there was no consideration of their unique lifestyle, diet preferences, or emotional state." (N 16)*

Gradual improvement and integration
Despite its limitations, participants highlighted ways to leverage AI's strengths in emotional understanding while addressing its shortcomings.

- *"AI's limitations in emotional understanding do exist, but that doesn't mean we can't use it. Instead, We can leverage its data-processing capabilities while adding our human expertise to the mix." (N 14)*
- *"To improve AI's emotional understanding, we need to provide more comprehensive patient data, including physical, psychological, and social aspects. Additionally, AI algorithms must advance in processing complex data and conducting in-depth analyses." (N 4)*

Superficial emotional insights
Participants emphasized that AI's suggestions for emotional support often lacked actionable details and specificity, making them less practical for direct application.

- *"While AI can suggest psychological support based on a patient's emotional state, the recommendations are often too general and lack specific, actionable*

methods, making it difficult to directly guide patient self-regulation or improvement." (N 1)

Changes in learning methods and professional perceptions
The introduction of GenAI had a significant impact on participants' learning methods. It expanded knowledge sources and improved learning efficiency, but also introduced some negative changes. Participants highlighted the double-edged sword effect of AI usage, noting its potential to both enhance and hinder their learning and professional growth [28].

Positive changes
Participants appreciated how AI enriched their learning experience by providing quick access to diverse knowledge and improving efficiency.

- *"GenAI helped me personalize care plans and access the latest research and practices in diabetes care, enriching my knowledge and making it easier to create nursing plans." (N 16)*
- *"When preparing a case on 'chronic thyroid disease,' I used AI to gather more comprehensive information, significantly improving my report preparation efficiency and quality." (N 11)*

Negative changes
Over-reliance on AI led to reduced critical thinking and a mechanical approach to learning.

- *"My reliance on GenAI reduced my ability to think independently. For instance, while analyzing a colorectal cancer patient with a history of multiple diseases, I should have carefully reviewed their medical history and nursing needs. However, I relied too much on GenAI's standard answers, which hampered my analytical and judgment skills." (N 2)*
- *"While organizing 'emergency care measures for liver failure', GenAI provided detailed answers, but I found myself mechanically copying them without understanding the underlying principles. This quick-answer approach deprived me of the opportunity for in-depth exploration and understanding." (N 13)*

Double-edged sword effect
GenAI improved Participants acknowledged that while AI improved learning efficiency, over-dependence on it could hinder deeper learning and critical thinking development.

- *"It improved my case analysis efficiency, but I realized that my reliance on GenAI's recommendations limited my ability to independently analyze and synthesize information." (N 15)*

- *"While GenAI can enhance learning efficiency, over-reliance might foster bad habits like a lack of initiative and an overdependence on technology." (N 7)*

Changes in professional perceptions

GenAI is reshaping nurse students views of their profession. GenAI broadened participants' understanding of nursing, highlighting its integration with technology and innovation, while reaffirming the irreplaceable human aspects of care.

- *"I used to think nursing was just about bedside care, but working with AI opened my eyes! Now I see it's this amazing blend of patient care, tech, and data analysis. It's like the whole field just got bigger and more exciting!" (N 9)*
- *"It actually motivated me to sign up for IT courses! Who would've thought I'd be studying tech as part of my nursing journey? But it makes so much sense now - it's all connected." (N 1)*
- *"GenAI showed me that nursing isn't just about following routines– it's this dynamic field where we're constantly innovating and learning. It actually sparked my interest in nursing research. There's so much to explore!" (N 3)*
- *"Working with GenAI really highlighted the intellectual side of nursing. It's not just physical care– we're part of this incredible professional field with endless opportunities for growth." (N 8)*
- *"GenAI is powerful, but it actually made me appreciate the human side of nursing even more. Those emotional connections we make? That empathy we share? That's something no technology can replace. It's motivated me to really focus on developing those human skills." (N 12)*

Discussion

The transformative role of GenAI in developing nursing plan

As medical education moves beyond rote memorization to emphasize critical reasoning, nursing programs must also evolve [29]. Early training in advanced cognitive skills can better prepare students for handling complex patient scenarios [30]. Integrating GenAI tools into nursing education offers a unique opportunity to achieve these objectives [31]. This aligns with Constructivist Learning Theory, which emphasizes learning as an interactive process [32]. GenAI facilitates this by enabling iterative refinement, collaborative discussions, and real-time feedback, encouraging active problem-solving rather than passive learning.

Our analysis of participants' experiences revealed patterns based on academic performance and leadership roles. Two students who scored above 90 explicitly

demonstrated critical engagement with GenAI responses. Both participants expressed skepticism regarding GenAI accuracy and completeness, frequently revising and refining their prompts to improve response quality [33]. Additionally, leadership experience appeared to influence students' perceptions of GenAI's capabilities. Three out of five class leaders explicitly mentioned GenAI's emotional limitations.

Previous studies [34–35] indicate that GenAI can enhance learning efficiency, broaden analytical perspectives, and facilitate personalized learning for nursing students. In line with these findings, the present study shows that GenAI is particularly adept at organizing large volumes of clinical information, providing structured frameworks, and extending insights beyond traditional materials. By leveraging these AI-driven capabilities, students can devote more time to higher-level tasks, such as evaluating patient-specific data and customizing care interventions. Emerging research by Samala et al. further highlights the expanding role of GenAI in healthcare education [36–37].

However, challenges remain. Consistent with previous studies [38–39], Participants noted issues including GenAI's limited real-time clinical context, insufficient understanding of complex cases, a lack of emotional perception, and occasional inaccuracies in content. Given the high stakes in nursing and healthcare, where precision is paramount, these shortcomings must be addressed. Educators have a crucial responsibility to teach students how to detect potential biases, critically analyze AI outputs, and design precise, contextually aware prompts. Such strategies can help optimize AI's benefits in clinical and educational settings [40].

Balancing GenAI technology with humanistic nursing skills

While GenAI are proficient at data processing, they struggle to interpret nuanced emotional or nonverbal cues [41]. Participants underscored this limitation, noting that GenAI often fails to capture subtle emotional concerns vital to individualized patient care. This challenge may be more pronounced in Chinese cultural contexts, where emotions are often conveyed implicitly, compared to Western settings where direct verbalization is more common [42]. These observations echo broader concerns about the "lost art" of nursing [43], including skills like empathetic communication, thorough history-taking [44], and direct observation at the bedside [45].

This gap in GenAI's emotional understanding also highlights the importance of social context in learning and clinical practice. Constructivist Learning Theory suggests that knowledge is built through social interactions, essential for developing clinical judgment and empathy [46]. Benner also believes that: "*expert nurses focus on*

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the needs, resourcefulness, a concern of the other, not their own virtuosity and virtuousness in providing care" [47].

The findings reaffirm that GenAI can streamline data management and assist in care planning, but it cannot replace the profound impact of genuine human interactions. Attributes like compassion, empathy, and cultural competence remain indispensable in nursing practice. Going forward, the most capable nurses will be those who combine technical proficiency in AI with deep-rooted humanistic values, ensuring patients receive both technological excellence and personalized, empathetic care [48].

Ethical considerations and privacy concerns
Participants also highlighted ethical and privacy challenges, reflecting wider debates on data protection in healthcare. They expressed apprehensions about safeguarding patient confidentiality and preventing the misuse of sensitive information, a concern that resonates with recent calls for stricter regulations around healthcare data [49].

To address these issues, nursing education should incorporate formal instruction on data ethics, legal obligations, and the responsible use of GenAI. Concurrently, healthcare institutions must establish robust data security measures to protect patient confidentiality and bolster trust in AI-assisted care [50]. By embedding such frameworks into standard practice, educators and clinicians can foster a culture of responsible innovation that respects patient rights and ethical norms.

Implications for nursing education and practice
The findings of this study highlight several implications for nursing education:

1. **GenAI Training for Educators and Students**:

   - Educators must be trained to effectively integrate GenAI tools into the curriculum, while students should develop skills in prompt engineering, critical evaluation, and ethical GenAI usage.
   - A two-hour prompt engineering training module could be introduced, incorporating iterative exercises with simple clinical cases to help students refine AI-generated responses.

2. **Reimagining Curricula**:

   - Nursing programs should emphasize a balance between high-tech AI competencies and low-tech humanistic skills, such as empathy, communication, and physical assessment.
   - Weekly case studies combining AI analysis with emotional reflection can be incorporated

to reinforce both clinical reasoning and compassionate nursing practice.

3. **Research and Development**:

   - Future studies should explore ways to enhance GenAI's emotional understanding, refine algorithms for greater contextual accuracy, and address privacy concerns.

4. **Professional Identity and Career Development**:

   - Engaging with AI broadens students' understanding of nursing, blending technology with empathy. While AI highlights innovative career pathways, it also reinforces the importance of compassion and human connection in nursing practice.
   - Career development programs should introduce AI-enhanced roles in healthcare, allowing students to explore interdisciplinary opportunities.

Limitations
This study is limited by its focus on a single institution and a subset of Large Language Models. Additionally, the research only included third-year nursing students, excluding other student groups that may offer unique perspectives. Future research could expand to include students from different academic years and disciplines, such as medical students, to capture a broader range of experiences and insights. Exploring multiple educational settings and examining the long-term effects of AI integration on nursing competencies with larger, more diverse populations would further validate and refine the findings. Such broader investigations could enhance the generalizability of the results and provide deeper insights into optimizing AI's role in healthcare education.

Future research
Future research should incorporate external educators or clinical practitioners to assess AI-generated care plans, providing an additional layer of validation. Additionally, Further studies could also explore educators' perspectives on integrating GenAI into nursing education, including its impact on teaching methodologies, student assessment, and clinical decision-making training.

Conclusion
As GenAI continues to evolve, nursing education must adapt to prepare students for the challenges and opportunities of an AI-assisted healthcare environment. By integrating advanced technological tools with humanistic nursing skills, educators can cultivate a new generation of nurses who are both intellectually incisive and deeply

compassionate. Balancing technological advancements with ethical considerations and human-centered care will be key to ensuring that GenAI enriches, rather than replaces, the core values of nursing practice.

Abbreviation
GenAI   Generative Artificial Intelligence

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-03115-8.

Supplementary Material 1

Supplementary Material 2

Data availability
The data used in this research are available upon individual request from the corresponding author.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and all relevant guidelines and regulations. Approval for the study was granted by the Research Ethics Committee of ZheJiang Shuren University (Approval Number: ZJSU20250103). All participants were fully informed about the purpose and procedures of the study. Participation was voluntary, and participants had the right to withdraw from the study at any time without any consequences. The study ensured that informed consent was obtained from all participants. All collected data were anonymized and kept confidential.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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