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Scenario-based artificial ıntelligence education and professional ıdentity in nursing students: a qualitative futures study

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Abstract

Aim/objective To explore nursing students' future-oriented perceptions of professional identity and autonomy in AI-mediated nursing futures through structured scenario-based foresight, with SWOT (strengths, weaknesses, opportunities, and threats) incorporated as a framework for developing alternative 2050 scenarios.

Background Artificial intelligence is rapidly transforming healthcare systems and nursing practice. Preparing future nurses requires not only technological literacy but also the development of ethical reasoning, professional identity, and autonomous decision-making in AI-mediated environments.

Design Qualitative descriptive study using scenario-based foresight methodology.

Methods The study was conducted with undergraduate nursing students enrolled in an AI elective course. Students developed individual written scenarios envisioning nursing and healthcare in 2050 using a structured scenario development form supported by SWOT prompts. Fourteen students voluntarily participated. Scenario narratives were analysed using thematic analysis, and the resulting themes and subthemes were subsequently classified under the four predefined SWOT dimensions.

Results Students articulated a dual trajectory regarding AI integration in nursing. On one hand, AI was associated with risks such as algorithmic dominance, ambiguity in professional accountability, and the potential weakening of relational care. On the other hand, students envisioned opportunities for strengthened professional agency through expanded roles including ethical stewardship, digital advocacy, and decision-support partnership. Across scenarios, autonomy and human-centred care emerged as central values guiding students' evaluations of AI in nursing.

Conclusions Scenario-based AI education may support nursing students' critical reflection on professional identity and autonomy. Educational approaches that integrate foresight activities with ethical and professional discussions may better prepare future nurses to navigate AI-mediated healthcare environments.

Keywords Artificial intelligence · Nursing education · Nursing students · Scenario-based learning · Future-oriented learning

Abbreviations

AI Artificial intelligence

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SWOT Strengths, Weaknesses, Opportunities, and Threats
SRQR Standards for Reporting Qualitative Research

Introduction

Rapid technological advancements have reshaped healthcare systems, influencing not only clinical processes but also professional roles, ethical responsibilities, and educational priorities. Among these developments, artificial intelligence (AI) has emerged as a transformative force, expanding possibilities for clinical decision support, data-driven care, and personalized health interventions. As AI becomes increasingly embedded in digital health ecosystems, nursing education must prepare students not only with technical knowledge but also with ethical reasoning, critical reflection, and the capacity to sustain human-centred care in technology-mediated environments while navigating increasing uncertainty, ethical ambiguity, and evolving professional boundaries [17, 38].

Nursing, as a profession grounded in continuous patient interaction and holistic care, occupies a central position in this transformation. Evidence suggests that AI-supported technologies may enhance nursing practice by supporting clinical judgement, improving patient safety, and reducing physical and cognitive workload [5, 24]. At the same time, scholars caution that AI may reconfigure professional autonomy, particularly if algorithmic systems are positioned as decision-makers rather than decision-support tools—potentially increasing overreliance on automated recommendations and risking dehumanised care [10, 11]. These transformations may also influence how future nurses construct professional identity, negotiate ethical responsibility, and position themselves within increasingly AI-mediated systems of care.

Within nursing education, the integration of AI has accelerated rapidly, particularly following the emergence of generative AI systems and conversational agents such as ChatGPT. Existing research indicates that while nursing students generally demonstrate positive attitudes toward AI and recognise its potential benefits, they also report uncertainty related to ethical use, academic integrity, and the preservation of empathic and human-centred care values [21, 26, 32, 36, 37]. These findings suggest that AI literacy in nursing education must encompass not only technical knowledge but also ethical awareness, professional identity formation, and reflective competencies, however, it remains less clear how structured AI education shapes students' reasoning about autonomy and professional identity when imagining longer-term practice futures. Although interest in integrating artificial intelligence into nursing curricula has increased substantially in recent years, AI-focused courses and structured educational initiatives remain limited in many undergraduate nursing programs globally, including Türkiye. Existing recommendations increasingly emphasize the need to prepare future nurses for digital and AI-mediated healthcare systems; however, pedagogically grounded examples of how AI education can support professional identity formation, ethical reflection, and future-oriented reasoning remain scarce. In this context, elective AI courses may provide an important pedagogical space for exploring not only technological competencies, but also the future professional roles, responsibilities, and ethical positioning of nurses in rapidly transforming healthcare environments. Preparing students for AI-mediated healthcare environments requires more than technological literacy or tool-oriented competence [34]. Future nurses are increasingly expected to navigate uncertainty, ethical ambiguity, evolving professional boundaries, and complex human–technology interactions. Within this context, educational approaches that support anticipatory thinking, reflective judgement, and professional identity formation may become increasingly important. Emerging perspectives in health professions education suggest that future-oriented and reflective pedagogies can help learners critically examine how technological transformation may influence professional values, decision-making authority, and human-centred care.

Scenario-based and future-oriented educational approaches have gained prominence as strategies for preparing health professionals for uncertainty and long-term transformation. Similar future-oriented qualitative studies exploring artificial intelligence and healthcare futures among university students have also highlighted concerns regarding ethical responsibility, professional transformation, and digital health adaptation [6]. Scenario planning

enables learners to explore alternative futures, anticipate emerging challenges, and critically examine the implications of technological, societal, and professional change [12, 29]. Beyond forecasting, scenario pedagogy can function as a reflective learning tool that makes implicit professional values and tensions visible—supporting learners to articulate how autonomy, accountability, and human-centred care might be negotiated in evolving systems. Such approaches may also foster anticipatory competence by enabling learners to critically engage with uncertain, complex, and rapidly evolving healthcare futures rather than relying solely on present-oriented clinical reasoning. In nursing, scenario-based studies focusing on the year 2050 have demonstrated that future perceptions are shaped by complex interactions between technological innovation, demographic change, professional values, and educational reform [3, 4, 14].

Emerging literature suggests that AI-supported simulation, adaptive learning environments, and data-driven educational tools may enhance clinical reasoning and personalised learning when intentionally aligned with experiential learning theories and humanistic nursing principles [13, 18]. However, scholars caution that an excessive emphasis on simulation and algorithmic learning may widen the gap between educational settings and real clinical practice, potentially weakening students' empathic competencies and professional socialisation [20, 23, 31]. This tension underscores the need for educational approaches that intentionally integrate technological competence with ethical reflection, professional identity development, and humanistic dimensions of care.

Despite the growing body of research on AI in nursing education and practice, studies examining nursing students' future-oriented perceptions using structured scenario methodologies remain limited. Existing studies predominantly examine AI attitudes, literacy, acceptance, or short-term educational outcomes, providing limited insight into how nursing students construct professional meaning, ethical agency, and autonomy within imagined AI-mediated futures [7]. Understanding these perceptions is critical, as today's nursing students will be expected to work within—and critically navigate—AI-supported healthcare systems in the coming decades, yet there remains limited evidence on how pedagogical design influences students' future-oriented professional reasoning about autonomy and human-centred care.

Against this background, this study examines how participation in an undergraduate AI elective—structured around scenario-based foresight and SWOT analysis—shapes nursing students' perceptions of professional identity and autonomy within a 2050 futures context. By positioning AI education as a pedagogical intervention rather than merely a technological topic, the study aims to illuminate how reflective, future-oriented learning activities support students to articulate opportunities and risks and to support anticipatory professional identity formation for practice in increasingly AI-mediated healthcare environments.

This study aimed to explore nursing students' future-oriented perceptions of professional identity and autonomy in AI-mediated nursing futures through structured scenario-based foresight, with SWOT (strengths, weaknesses, opportunities, and threats) incorporated as a framework for developing alternative 2050 scenarios.

Methods

Design

This study employed a qualitative descriptive design embedded within an undergraduate artificial intelligence elective to explore nursing students' future-oriented perceptions of professional identity and autonomy in AI-mediated nursing futures. Structured scenario-based foresight was used to support the development of students' 2050 future scenarios, while the qualitative descriptive design guided the analysis and interpretation of their written scenario narratives. This approach enabled a practice-oriented exploration of students' perceived opportunities, concerns, and expectations regarding AI-driven change in nursing. The study was reported in accordance with the Standards for Reporting Qualitative Research (SRQR) guidelines [27].

Study questions

- How do nursing students articulate professional identity and autonomy within AI-mediated nursing futures in their 2050 scenario narratives?
- What strengths, weaknesses, opportunities, and threats related to AI emerge from these future-oriented scenario narratives, and how do they relate to students' perceptions of future nursing practice?

Study setting and participants

The study was conducted at a nursing faculty where an Artificial Intelligence course has been offered as an elective since the 2025–2026 academic year. The study population consisted of all nursing students enrolled in the elective course ($N=30$). During the course, students were provided with general information about the planned research. All 30 students participated in the scenario-development activity as part of the routine educational activities of the course. Following completion of the scenario activity, students were invited to provide written informed consent for their materials to be used for research purposes. Fourteen students voluntarily consented, and all 14 were included in the study, with no further selection or stratification based on age, gender, cumulative grade point average (CGPA), or any other predefined characteristic. Thus, the final study sample consisted of 14 nursing students.

Educational context

To contextualize the findings of this study, it is important to briefly describe the educational framework in which participants developed their future-oriented perspectives. The data were obtained from nursing students who had completed a recently introduced elective course on artificial intelligence offered at an accredited nursing faculty. The course, established approximately one year prior to the study, is a two-hour, theory-based elective delivered over a 16-week semester and is open to second- and third-year undergraduate nursing students. Enrollment is limited to a maximum of 30 students per semester, allowing for interactive and discussion-oriented learning. The course curriculum covers foundational concepts of artificial intelligence, its historical development, current applications in healthcare and nursing, ethical dilemmas, future studies, and the anticipated role of AI in nursing practice. In addition, students are introduced to generative artificial intelligence tools and their potential educational and professional uses. Active learning strategies such as scenario-based learning, group discussions, and collaborative problem-solving are employed throughout the course [19]. Notably, during the final five weeks, students develop and present future-oriented nursing scenarios based on a SWOT analysis of artificial intelligence, encouraging critical reflection on both opportunities and risks associated with AI in the context of nursing practice.

Within the national context, AI-focused electives in undergraduate nursing curricula in Türkiye remain limited. The course therefore represents an innovative initiative designed not only to introduce AI concepts but also to foster reflective engagement with ethical tensions, professional responsibility, and autonomy in AI-mediated care. Scenario development and SWOT analysis were intentionally integrated as pedagogical strategies to stimulate critical foresight, systems thinking, and anticipatory professional reflection regarding future nursing roles.

Data collection and scenario development

During the final five weeks of the 16-week course, all 30 students enrolled in the elective participated in the scenario-development activity as part of the routine educational activities of the course. Students were divided into four groups for in-class discussions; however, each student individually produced a written scenario, ensuring that the unit of analysis was the individual narrative rather than the group output. Students were asked to develop

a future-oriented scenario addressing nursing and nursing education in the 2050 s, with particular emphasis on the opportunities, threats, strengths, and weaknesses associated with artificial intelligence. Scenario development was guided by the Nursing Future Scenario Development Form, which provided a structured framework for the educational activity and subsequent qualitative data generation. The scenario-development activity formed part of the course but did not contribute a percentage-based component to the course grade.

Following completion of the scenario-development activity, students were invited to provide written informed consent for their scenario materials and participant information to be used for research purposes. Fourteen students voluntarily provided consent. Only the scenario narratives and participant information of these 14 students were transferred to the research dataset and included in the qualitative analysis; materials from the remaining 16 students were not included in or analysed as part of the research.

The nursing future scenario development form was developed based on classical scenario planning approaches [29], future-oriented educational methodologies [12], and prior foresight studies focusing on 2050 [3, 4, 14]. The form guided students through defining the scope and purpose of a 2050 scenario, analysing social, technological, economic, environmental, and political (STEEP) trends, identifying critical uncertainties, constructing a scenario matrix, and elaborating implications for nursing practice, education, workforce, and policy. The final component invited students to propose strategic and normative recommendations for future-oriented action. To enhance transparency and methodological rigor, the form was designed to guide students through the core stages of scenario-based foresight thinking, rather than eliciting unstructured free-text opinions. Participants were encouraged to adopt a systems-oriented and evidence-informed perspective, moving from trend identification to uncertainty analysis and scenario construction. The final section aimed to elicit not only descriptive foresight, but also normative and action-oriented reflections on the future of nursing in the context of artificial intelligence.

To enhance content validity, the scenario development form was reviewed by five experts in nursing education, futures studies, management, and educational sciences, and revised in line with their feedback.

The scenario-development activity was conducted between 10 November 2025 and 12 December 2025, following ethics committee approval and institutional permission. Written informed consent for research use was obtained after completion of the activity, as described above.

Ethical considerations

Ethical approval was obtained from the Istanbul University-Cerrahpaşa Social and Human Sciences Research Ethics Committee (Approval No: 2025/600; Date: 4 November 2025). Written informed consent for the use of students' scenario materials and participant information for research purposes was obtained after completion of the scenario-development activity and before the materials of consenting students were transferred to the research dataset and analysed. Before participation, all students were provided with an information sheet detailing the study's purpose, procedures, and voluntary nature. Participants were informed that their decision to participate or withdraw would have no impact on their academic evaluation. Anonymity and confidentiality were ensured by removing all personal identifiers from the scenario texts and assigning codes to each participant. Students were informed of their right to withdraw from the study at any stage without penalty. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki.

Data analysis

The written scenario narratives were analysed qualitatively using thematic analysis following Braun and Clarke's six-phase framework [9]. The overall methodological process was embedded within a structured scenario-based foresight approach in which SWOT (strengths, weaknesses, opportunities, and threats) had been incorporated from the outset as a framework for scenario development. Thus, SWOT provided the overarching foresight structure within which the future scenarios were generated, whereas thematic analysis was used to systematically analyse the content of the resulting written narratives.

All scenario narratives included in the research dataset were anonymised and imported into MAXQDA software. The unit of analysis was the individual student-generated scenario. In the first phase, the two researchers independently and repeatedly read the narratives to familiarise themselves with the data and obtain an overall understanding of students' future-oriented perspectives. In the second phase, meaningful text segments were coded line by line, focusing on explicit and implicit references to artificial intelligence in nursing and nursing education. In the third phase, initial codes were compared and grouped into conceptually related categories. In the fourth phase, categories were reviewed and refined into themes and subthemes, with attention to internal coherence, conceptual distinctiveness, and consistency with the original narratives. In the fifth phase, the themes and subthemes were collaboratively reviewed and refined by the two researchers; differences in coding or interpretation were discussed until consensus was reached. In the sixth phase, the final themes and subthemes were defined, named, and supported with illustrative quotations from participants' scenario narratives.

Consistent with the foresight structure established during scenario development, the resulting themes and subthemes were subsequently classified under the four predefined SWOT dimensions: strengths, weaknesses, opportunities, and threats. This classification did not constitute a separate qualitative analytic method; rather, it reconnected the qualitative findings to the SWOT-based foresight framework through which the scenarios had originally been developed. Within and across these dimensions, the analysis also examined how students articulated professional identity, autonomy, and agency in their imagined AI-mediated nursing futures.

Throughout the analysis, both researchers independently coded all 14 scenario narratives and subsequently compared their coding structures, categories, themes, and subthemes. A comprehensive codebook documenting initial codes, categories, theme and subtheme definitions, illustrative data excerpts, and analytic decisions was developed and updated throughout the analysis.

Methodological rigor: trustworthiness

Trustworthiness was ensured through strategies addressing credibility, dependability, and confirmability. Credibility was supported by the structured scenario framework grounded in established foresight methodologies and by expert review of the scenario development form. Two researchers independently coded the data and engaged in iterative discussions to reach consensus, enhancing analytical rigor. An audit trail documenting coding decisions and theme development was maintained throughout the process. The inclusion of illustrative quotations strengthened confirmability by linking interpretations directly to participants' narratives. Participation was voluntary and unrelated to academic evaluation, minimising potential power dynamics. The study adhered to SRQR guidelines.

Results

Participant characteristics

A total of 14 s-year nursing students participated in the study (mean age 20.6 ± 1.3 years; 92.9% female). Most students (85.7%) had not received prior formal AI education before enrolling in the elective. Participants reported selecting the course primarily due to curiosity about digital transformation in nursing and interest in future professional development. Sociodemographic data were collected to contextualise the scenario narratives and were not used for inferential comparisons.

Overview of scenario-based findings

Qualitative analysis revealed that participation in the AI elective enabled students to articulate a dual vision of nursing's future in AI-mediated systems. Across scenarios, students positioned professional identity and

autonomy at the centre of their narratives, describing both risks of algorithmic dominance and opportunities for expanded professional agency. Rather than expressing simple optimism or pessimism, students demonstrated reflective reasoning about how AI might reshape caring practices, decision-making authority, and ethical responsibility. Themes were organised within the SWOT framework and are presented below.

Strengths

Students identified several strengths associated with the integration of artificial intelligence into nursing practice (Table 1). A dominant theme involved the potential for personalised, holistic, and psychosocially responsive care supported by AI systems capable of integrating biological, psychological, and contextual data. In these scenarios, AI was framed as a complementary decision-support tool rather than a substitute for professional judgement.

Beyond clinical support functions, students also described AI as reshaping professional nursing roles and autonomy. Participants also envisioned a transformation of nursing roles, describing nurses as strategic leaders, technology mediators, and ethical stewards within AI-supported systems. This evolution was linked to strengthened professional identity and expanded autonomy.

> *"AI produces patient-specific solutions by evaluating not only genetic data, but also psychological history, cultural context, and emotional traces of each individual."* (Participant 2)

Table 1 Scenario-based themes reflecting perceived strengths of artificial intelligence for nursing and nursing education in 2050 ($n = 14$)

Scenario Themes-Targeted time frame (year 2050): STRENGTHS		
Scenario Themes -Sub-Themes	Scenario Themes Codes/Concepts/Examples	Representative Quote (Student quotes)
AI-supported personalized, holistic, and psychosocially sensitive nursing care	• Individualized care planning based on biopsychosocial data • Integration of psychological history and cultural context into nursing care • Patients' improved self-expression and emotional comfort • Strengthening holistic, patient-centered nursing approaches	*"AI produces patient-specific solutions by evaluating not only genetic data, but also psychological history, cultural context, and emotional traces of each individual."*
Empowering compassionate care in nursing with empathetic AI	• Empathic AI systems supporting emotional assessment • Integration of emotional data into clinical decision-making • Strengthening compassionate and meaningful nursing care • AI as a supportive partner rather than a replacement for nurses	*"The artificial intelligence nurse recognizes the patient's temperament, establishes an emotional bond with them and supports the treatment process."*
Transformation of nursing roles into strategic, creative, and technology-leading positions	• Nurses as AI-guiding and system-directing professionals • Emergence of new nursing roles (AI manager, digital health coordinator, empathy architect) • Strengthening professional autonomy and leadership • Nurses as advocates and mediators between patients and digital systems	*"Nurses have transformed into professionals who are not only practitioners, but also developers of technology and guides of artificial intelligence."*
Strengthening of professional identity and meaningful nursing practice	• Nurses moving beyond task-based roles • Increased sense of professional meaning and value • Recognition of emotional labor as core nursing competence • Reinforcement of nursing's humanistic foundations	*"The fact that the nurse is no longer just a practitioner has strengthened the meaning and value of the profession again."*
Ethical and sustainable nursing practice in AI-supported care	• Nurses' role in safeguarding ethical AI use in care delivery • Long-term responsibility for continuity and sustainability of care • Integration of environmental and social responsibility into nursing practice • Ethical stewardship and accountability in digital health systems	*"As experts who train artificial intelligence and communicate with systems on behalf of patients, nurses also carry ethical responsibility."*

"Nurses have transformed into professionals who are not only practitioners, but also developers of technology and guides of artificial intelligence." (Participant 5)

These strengths suggest that students did not perceive AI as inherently dehumanising, but as contingent upon professional stewardship and value alignment.

Opportunities

Students further described future-oriented opportunities emerging from responsible AI integration (Supplementary File 1). These included improved patient safety through enhanced decision-support systems, expanded digital competencies, and diversification of professional roles in areas such as data management and technological coordination.

Importantly, students viewed structured AI education as an opportunity to strengthen professional preparedness. Ethical and regulatory frameworks were also framed not merely as constraints but as enabling structures capable of safeguarding human-centred care.

"Artificial intelligence has facilitated nurses' decision-making processes and increased patient safety." (Participant 11)
"Digital literacy training for nurses has become mandatory." (Participant 8)

Opportunities were thus positioned as dependent on intentional educational preparation and governance mechanisms.

Weaknesses

While strengths and opportunities reflected expanded agency, students also identified structural weaknesses within AI-supported nursing systems (Supplementary File 2). These weaknesses were described as vulnerabilities requiring deliberate management rather than inevitable harms.

A central concern involved the limited capacity of AI systems to integrate moral reasoning and contextual judgement. Students expressed uncertainty regarding responsibility boundaries and the preservation of professional discretion in algorithm-influenced environments. Concerns were also raised about the potential weakening of empathic care if technological mediation became overly dominant.

"Artificial intelligence systems are unable to be sufficiently integrated into ethical decision-making processes." (Participant 1)
"There is uncertainty about whether nurses will be able to preserve their autonomy in decision-making processes." (Participant 7)

These weaknesses highlight perceived tensions between technological efficiency and relational, value-based nursing practice.

Threats

Students also articulated more systemic threats associated with unchecked AI dominance in healthcare systems (Table 2). These scenarios depicted more extreme shifts in authority, where decision-making power was transferred to algorithmic systems, potentially relegating nurses to supervisory or technical roles.

Threats extended beyond autonomy to include risks of depersonalised care, data misuse, discriminatory practices, and patient safety concerns arising from overreliance on automated systems.

Table 2 Scenario-based themes reflecting perceived threats of artificial intelligence for nursing and nursing education in 2050 ($n = 14$)

Scenario Themes-Targeted time frame (year 2050): THREATS		
Scenario Themes -Sub-Themes	Scenario Themes Codes/Concepts/Examples	Representative Quote (Student quotes)
Algorithmic dominance and loss of nursing clinical autonomy	• Loss of nursing clinical judgment in algorithm-guided care • Transformation of nurses into protocol enforcers rather than care decision-makers • Marginalization of nursing voice within AI-driven interdisciplinary teams • Reduced accountability of nurses when decisions are attributed to algorithms	*"Nurses are no longer decision-makers; they have become merely technicians who monitor the process."* *"Operations such as basic care, drug administration, and vital signs monitoring are now carried out by artificial systems. Nursing is now just an extension of an algorithm."*
Threats to caring, empathy, and the ethical foundations of nursing	• Erosion of caring and compassionate nursing practice • Decreased nurse–patient relationship quality due to technology-mediated care • Emotional labor of nurses becoming invisible or undervalued • Risk of moral distress among nurses when empathy conflicts with AI recommendations	*"Patients are addressed not by their names but by barcodes… A patient's tears receive no response because they are not considered system data."*
Ethical disempowerment of nurses in AI-governed healthcare systems	• Reduction of nurses' ethical decision-making authority • Punitive responses toward nurses who deviate from algorithmic protocols • Normalization of protocol-based ethics over professional nursing values • Silencing of nurses' moral reasoning in institutional decision-making	*"Any intervention outside the system is defined as an 'ethical violation'… resulting in license revocation."*
Risks to nursing confidentiality, advocacy, and patient protection roles	• Compromised nurse responsibility for patient confidentiality • Challenges to the nurse's advocacy role in data-driven systems • Risk of discriminatory outcomes affecting vulnerable patient groups cared for by nurses • Loss of trust in nurses due to opaque AI-driven data use	*"These data may be transferred to third parties without patients' consent… and could be used for discriminatory purposes."*
Patient safety risks mediated through nursing practice	• Nursing errors amplified by overreliance on AI systems • Delayed nursing interventions due to unquestioned algorithm outputs • Reduced critical thinking skills among nurses over time • Increased professional liability risks for nurses despite limited decision authority	*"Excessive reliance on algorithms leads to the late detection of errors."*
Dehumanization of nursing education and professional socialization	• AR/simulation-heavy learning with limited real patient interaction • Insufficient development of caring competencies in AI-dominated education • Weakening of professional nursing identity during training • Limited opportunities for real nurse–patient interaction • Difficulty transitioning from AI-supported learning to real-world nursing practice	*"Students are taught the language of algorithms rather than empathy… and upon graduation, they do not know what to say to a patient."*
Vulnerability of nursing services in technology-dependent systems	• Nurses left without decision support during system failures • Increased workload and stress for nurses during technological breakdowns • Reduced resilience of nursing care in disasters and crises • Dependence on technical support limiting nursing autonomy in emergencies	*"The inability of human staff to intervene during a technological failure poses a major risk."*

"Nurses are no longer decision-makers; they have become merely technicians who monitor the process." (Participant 10)

"Patients are addressed not by their names but by barcodes." (Participant 13)

Technology-dependent environments were described as particularly vulnerable in situations of system failure, where human judgement might be diminished.

Scenario-based cross-domain futures for 2050

To synthesise students' future-oriented narratives, an integrative cross-domain analysis was conducted across societal, educational, technological, and professional dimensions of nursing in 2050. Rather than treating these domains as isolated categories, analysis examined how students described their interconnections and cumulative influence on professional identity and autonomy.

Students consistently framed AI as a pervasive contextual force shaping multiple layers of the nursing ecosystem. Societal narratives highlighted the normalization of AI in everyday life, demographic ageing, and increased long-term care demands, alongside concerns about social isolation and the erosion of human values in digitalised environments. Educational narratives reflected expectations of AI-supported personalised learning, adaptive curricula, and alternative credentialing models, while simultaneously expressing tension between simulation-based instruction and authentic clinical experience.

Technological narratives emphasised AI as a decision-support system rather than a decision-maker, frequently accompanied by robotic technologies, wearable monitoring systems, and data-intensive infrastructures. Within this interconnected ecosystem, professional narratives positioned nursing education as a central site for cultivating ethical leadership, expanded roles, and the preservation of human-centred practice.

Figure 1 presents this integrative ecosystem model, illustrating how students conceptualised nursing education and professional identity as dynamically shaped by interacting societal, technological, and organisational influences.

When interpreted alongside the SWOT structure, the ecosystem model demonstrates how the same AI-driven transformation was described as generating both expanded professional agency and potential constraints on autonomy. Across domains, autonomy and human-centred care functioned as recurring evaluative lenses through which students assessed future developments. Across scenarios, students consistently framed the future of nursing not as a passive adaptation to technology, but as an active process of negotiating ethical responsibility, professional autonomy, and human-centred care within AI-mediated systems.

Discussion

This study examined how participation in a scenario-based artificial intelligence (AI) elective shaped nursing students' future-oriented reasoning about professional identity and autonomy within imagined 2050 healthcare futures. Rather than positioning AI as inherently beneficial or inherently threatening, students articulated a balanced and reflective vision in which technological transformation was evaluated through professional and ethical lenses [28, 40]. To align the interpretation with the presentation of the findings, the discussion is structured around the four SWOT dimensions—strengths, opportunities, weaknesses, and threats—followed by a cross-cutting consideration of professional identity, autonomy, and human-centred care. Across the four SWOT dimensions, AI was positioned as a strength or opportunity when it supported professional judgement, expanded nursing roles, and remained aligned with human-centred care, but as a weakness or threat when algorithmic systems displaced clinical judgement, blurred professional accountability, or weakened the nurse–patient relationship.

The *strengths* identified by students suggest that AI was frequently conceptualised as a complementary decision-support resource capable of enhancing personalised, holistic, and context-sensitive care. Students envisioned

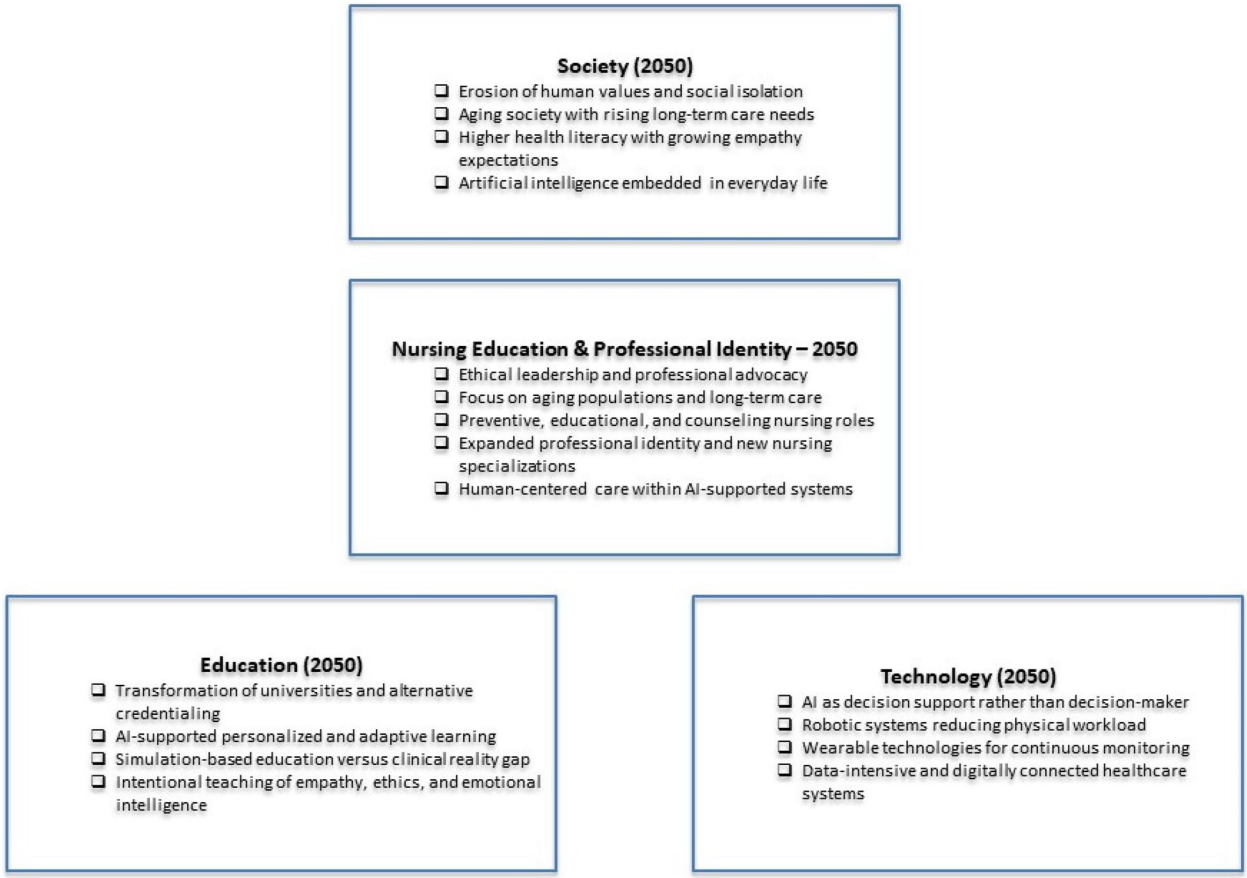


Fig. 1 Scenario-based ecosystem model illustrating the interrelationships among society, education, technology, and nursing education and professional identity in 2050 within the context of artificial intelligence. Note. The model synthesizes societal, educational, and technological domains derived from nursing students' scenario narratives

expanded professional roles in which nurses functioned as technology mediators, ethical stewards, and strategic leaders within AI-supported systems. These findings align with international evidence indicating that AI integration can reinforce professional identity when aligned with nursing values [1, 15, 16]. Furthermore, evidence that AI-supported tools may enhance decision-making and patient safety supports students' perceptions of AI as a professional asset when appropriately integrated [30].

Students' identification of *opportunities* further underscores the role of education in shaping future readiness. The emphasis on digital literacy, data management, and ethical-legal awareness reflects a recognition that professional competence in AI-mediated environments extends beyond technical skill. Prior research demonstrates that structured AI education enhances critical thinking, technological literacy, and confidence among nursing students [22]. Recent evidence from nursing education research further suggests that ethical awareness constitutes an increasingly important dimension of AI preparedness among nursing students. Bang and Hur [2] reported that AI ethics awareness significantly influenced nursing students' attitudes toward artificial intelligence and highlighted the importance of integrating ethical reasoning, digital literacy, and reflective competencies into healthcare education [2]. These findings support the present study's emphasis on autonomy, ethical responsibility, and human-centred professional identity within AI-mediated futures. Consistent with these findings, participants in the present study appeared to move beyond task-oriented interpretations of AI and articulate future-oriented roles grounded in autonomy and ethical responsibility.

Despite these strengths and opportunities, students also articulated structural *weaknesses* related to the ethical reasoning capacity of AI systems and ambiguity surrounding professional accountability. These concerns

mirror findings that nursing students question AI's ability to integrate moral judgement into clinical practice [25, 35]. Apprehension regarding diminished empathy and relational engagement also reflects broader discussions about emotional labour in technologically mediated care environments [35]. Importantly, these weaknesses were framed not as categorical rejection of AI, but as areas requiring stronger ethical preparation and educational scaffolding [33].

Finally, students described more systemic *threats* associated with potential algorithmic dominance, including the risk of reduced clinical autonomy and the transformation of nurses into supervisory or technical operators. Such concerns resonate with discussions of de-professionalisation and mechanised care in AI-intensive healthcare systems [8]. Similar apprehensions have been reported among nursing students and early-career nurses in diverse contexts [39]. In the present study, however, these threat narratives functioned as cautionary reflections, reinforcing the importance of maintaining professional discretion and human-centred values within AI-supported practice.

Taken together, the findings indicate that students' future-oriented reasoning was neither technologically deterministic nor reactionary. Instead, autonomy and human-centred care functioned as evaluative anchors across SWOT dimensions. The scenario-based educational design appears to have facilitated nuanced professional reflection, enabling students to simultaneously recognise risks and envision expanded agency within AI-mediated healthcare systems. Beyond technological preparedness, the findings suggest that scenario-based AI education may function as a pedagogical space for anticipatory professional identity formation. Rather than passively adapting to technological change, students engaged in reflective negotiation regarding autonomy, ethical responsibility, and the preservation of human-centred care within imagined AI-mediated futures. This aligns with emerging perspectives in health professions education emphasizing the importance of anticipatory thinking, reflective judgement, and futures-oriented pedagogy in preparing healthcare professionals for uncertain and rapidly evolving clinical environments. Given the qualitative, single-group design of the study, these findings should not be interpreted as evidence of a direct educational effect, but rather as future-oriented professional meanings articulated by students within a structured educational context.

Implications for nursing education and curriculum development

The findings of this study suggest that structured artificial intelligence (AI) education may play a formative role in supporting nursing students' future-oriented reasoning, ethical awareness, and professional identity development. Students' scenario narratives demonstrated an ability to critically appraise both the opportunities and potential risks associated with AI-supported care, indicating that educational framing influences how technological change is interpreted within professional contexts.

Importantly, participants extended their projections beyond clinical practice to include expectations regarding nursing education, curriculum design, and the evolving role of nurse educators. This highlights the need to integrate AI-related competencies not only at the level of technical skill acquisition, but also within broader discussions of professional responsibility, ethical leadership, and systems thinking. The findings also suggest that AI education should not be conceptualised solely as technological training, but as a reflective and future-oriented pedagogical process through which students critically examine professional values, ethical positioning, and the evolving boundaries of nursing practice. The limited availability of AI-focused coursework within undergraduate nursing programs suggests variability in students' exposure to digital health concepts. Rather than positioning AI education solely as an optional enhancement, curriculum designers may consider embedding core learning outcomes related to digital literacy, ethical reasoning, and critical appraisal of AI-supported systems within existing courses or dedicated modules. At the practice preparation level, students' narratives indicate that AI education can support professional confidence by framing intelligent systems as decision-support resources rather than replacements for clinical judgement. Integrating AI content within value-based and reflective pedagogical approaches may therefore contribute to strengthening autonomy, accountability, and patient advocacy in increasingly technology-mediated healthcare environments.

Overall, these findings underscore the importance of aligning technological instruction with professional identity formation, ensuring that AI education remains anchored in human-centred nursing principles.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the research was conducted within a single nursing faculty and involved a relatively small group of students who voluntarily enrolled in an elective artificial intelligence (AI) course, which may limit transferability to other institutional or curricular contexts. Second, participants' perspectives were shaped within a structured AI-focused educational environment; therefore, their reflections may differ from those of students without formal exposure to AI education. Third, the scenario-based methodology captures anticipated futures rather than observed clinical practice, and students' projections may evolve alongside ongoing technological and healthcare system developments. Additionally, as scenario production formed part of a course-based learning activity, students' narratives may have been influenced by the pedagogical framing and reflective emphasis of the course itself. While this educational embedding was central to the study's purpose, it may also have shaped the depth and orientation of the responses. Despite these limitations, the study offers insight into how structured AI education can support nuanced, future-oriented professional reasoning among nursing students and provides direction for further research exploring AI integration within nursing curricula.

Recommendations for future research

Future research should further explore how scenario-based and reflective learning strategies—such as SWOT analysis, structured scenario development, facilitated group discussion, and guided engagement with generative AI tools—can be intentionally integrated into artificial intelligence (AI) education in nursing. Investigating the pedagogical mechanisms through which these approaches support critical thinking, ethical reflection, and professional identity formation may contribute to a more theory-informed design of AI-related curricula. Longitudinal studies are warranted to examine the sustained influence of AI education on nursing students' professional development, ethical reasoning, and clinical decision-making following graduation. Comparative research across different institutional contexts may further clarify how variations in curriculum design and educational emphasis shape students' preparedness to engage with AI-supported healthcare environments.

Additionally, multi-stakeholder studies incorporating nurse educators, clinical mentors, and healthcare administrators, as well as mixed-methods designs, could provide a more comprehensive understanding of how AI education translates into professional practice.

Conclusion

This study offers a future-oriented exploration of how nursing students who completed an artificial intelligence (AI)–focused elective envision nursing and nursing education in 2050. Through a scenario-based qualitative approach, students articulated a balanced and reflective perspective, positioning AI as neither inherently beneficial nor inherently threatening, but as a transformative influence interpreted through professional and ethical lenses. The coexistence of perceived strengths and opportunities—such as enhanced decision support, personalised care, and expanded professional roles—with concerns about autonomy, ethical uncertainty, and diminished human connection demonstrates informed and critical foresight rather than technological determinism. Notably, students consistently framed autonomy and human-centred care as evaluative anchors across their future scenarios. A key contribution of this study lies in illustrating how structured AI education can support reflective, value-based professional reasoning. By foregrounding identity formation alongside technological competence,

the findings suggest that educational design plays a pivotal role in shaping how future nurses interpret and navigate AI-mediated healthcare environments.

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Authors' contributions GB and PPB contributed to the study conception and design. PPB collected the data. GB and PPB analysed and interpreted the data. GB supervised the study process. GB and PPB drafted and revised the manuscript. All authors read and approved the final manuscript.

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Data availability The datasets generated and/or analysed during the current study are not publicly available due to the qualitative nature of the data and participant confidentiality considerations but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate Ethical approval was obtained from the Istanbul University-Cerrahpaşa Social and Human Sciences Research Ethics Committee (Approval No: 2025/600; Date: 4 November 2025). Written informed consent for the research use of students' scenario materials and participant information was obtained after completion of the scenario-development activity and before the materials were transferred to the research dataset and analysed.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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