

Education About Digital Health and Artificial Intelligence and Learning Needs: Perspectives of Undergraduate Nursing Students

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Nurses have long used different types of technologies in clinical practice and nursing education. Technology is rapidly evolving, and nurses must keep pace. Digital health refers to “the field of knowledge and practice associated with the development and use of digital technologies to improve health” (World Health Organization [WHO], 2021, p. 39). Artificial intelligence (AI), “an area of computer science that emphasizes the simulation of human intelligence processes by machines that work and react like human beings,” is part of digital health (WHO, 2021, p. 39). In the wake of generative AI applications, scholars warned of its potential impact on nursing education (O’Connor et al., 2023). Moreover, the increased prominence of AI across health care settings has underscored the need for accelerating and strengthening the digital preparedness of nurses and their engagement in digital health across all levels of practice (Canadian Nurses Association [CNA] & Canadian Nursing Informatics Association [CNIA], 2024; International Council of Nurses [ICN], 2023). While understanding of nursing informatics (NI) and NI competency standards has increased, Canadian nurses and nursing students report significant gaps in their digital health preparedness and other challenges that continue to preclude progress in this area (Canada Health Infoway [CHI], 2024; Kleib et al., 2022).

Background

More than 3 decades ago, NI emerged as a new specialization aimed at advancing the profession and nursing roles. As a science and practice, NI “integrates nursing, its information and knowledge and their management with information and communication technologies to promote the health of people, families, and communities world-wide” (International Medical Informatics Association, 2009). The fast-paced development of technology coupled with concerns for safety and quality of care have led to the recognition of NI as a required core competency for all nurses. One early definition describes NI competency as the “integration of knowledge, skills, and attitudes in the performance of various nursing informatics activities within prescribed levels of nursing practice” (Staggers et al., 2001, p. 306). In Canadian health care, NI competency is viewed as “using information and communication technologies to support information synthesis in accordance with professional and regulatory standards in the delivery of patient/client care” (Canadian Association of Schools of Nursing [CASN], 2012, p. 5). In parallel, several NI competency frameworks, such as the Technology Informatics Guiding Education Reform, the Quality and Safety Education for Nurses, and the *CASN Nursing Informatics Entry-to-Practice Competencies for Registered Nurses*, have been proposed (Nazeha et al., 2020). While these frameworks have some variations, they provide a foundation for guiding the integration of NI and digital health in nursing curricula and training initiatives and emphasize key areas that would ensure safe and competent practice in digital health (Nazeha et al., 2020).

The use of AI in health care has become an increasingly prevalent topic among educators, policy makers, and relevant partners (Booth et al., 2021; Buchanan et al., 2021; Nashwan et al., 2025). Nursing education will need to adapt by incorporating learning experiences in academic and clinical settings to develop nurses’ competency in AI and help them understand its various applications in health care, such as robotics, virtual avatars, smart homes, and predictive analytics (Booth et al., 2021; Buchanan et al., 2021). Researchers also note that nurses need to understand the link between the data they collect and the AI technologies they use; core knowledge in AI is essential for nurses to meaningfully participate in all stages of AI initiatives so they can tap into the potential of these technologies and employ them to address global health challenges (Ronquillo et al., 2021).

The heightened attention regarding the potential impact of AI on nursing education and practice exponentially increased in response to the advent of generative AI applications. Although these applications created some excitement among the public and nurse educators, they also fuelled

speculation and concerns regarding potential risks associated with their integration in health care, nursing education, and practice, as seen with the release of the generative pre-trained transformer ChatGPT 3.5 (Castonguay et al., 2023; O'Connor et al., 2023; Thomas, 2023). ChatGPT interacts in a conversational way, can understand and assist with several tasks (e.g., answer questions, provide information, admit its mistakes, reject inappropriate requests), and constantly learns and improves by analyzing a vast amount of information from books, articles, and websites (O'Connor et al., 2023; OpenAI, 2022). With the exponential growth of several other applications such as Google Gemini and Microsoft Copilot, nurse educators will need to critically think about how this content generation is changing the educational process and, consequently, nursing and health care. These developments further affirm the need to enhance the digital preparedness among nurses and all health care providers; however, challenges persist.

According to the most recent survey of Canadian nurses' use of technology, only 6% of nurses surveyed reported that they felt knowledgeable about AI (CHI, 2024). Among physicians, only 7% indicated that they used AI or machine learning in their practice (Canadian Medical Association & CHI, 2024). These findings suggest that while there are gaps in knowledge among care providers, there is also limited or underreported integration of AI in clinical care. Among nursing students, research has identified that self-rated technological proficiency, understanding of AI-powered technologies, and perceived AI use in nursing practice are factors associated with their readiness to embrace AI; conversely, lack of computer skills, lack of knowledge, and time constraints are key barriers (Labrague et al., 2023). While health sciences students largely have positive views and attitudes towards AI, they do have significant gaps in their knowledge and require further education and training in AI (Abuzaid et al., 2022; Buabbas et al., 2023; Labrague et al., 2023; Lukić et al., 2023; Sapci & Sapci, 2020).

Despite widespread consensus on the importance of NI and digital health for contemporary nursing practice, how these concepts are addressed at the undergraduate and graduate levels is inconsistent (Kleib et al., 2024). Furthermore, most existing NI competency frameworks have not been updated to include specific indicators relative to emerging digital health technologies such as AI (Kleib et al., 2021). Because of the increased attention to AI in the media and scholarly literature, AI may be viewed as different from digital health and NI; however, these concepts are interrelated and pertain to nursing practice in digitally enabled environments (CNA & CNIA, 2024). As such, scholars have advocated for expanding NI competencies to include the integration, use, applications, and ethics of AI technologies in nursing practice so that nurses are better prepared to not only use these technologies but also contribute to the evolving digital health ecosystem (Booth et al., 2021; Nashwan et al., 2025). In that regard, CASN recently reviewed and upgraded its *Nursing Informatics Entry-to-Practice Competencies for Registered Nurses* to ensure Canadian nursing education keeps pace with advances in the field (CASN, 2025).

Furthermore, recognizing NI competencies as a core requirement in Canadian nursing is on the rise. For example, the College of Registered Nurses of Alberta has endorsed specific NI competencies (2.8, 3.6, 8.5, 9.4) in its *Entry-Level Competencies for the Practice of Registered Nurses* (College of Registered Nurses of Alberta, 2019). As the national voice for nursing education, research, and scholarship in Canada, CASN updated the *National Nursing Education Framework* in 2022 based on an extensive environmental scan to determine what graduates needed to know in the next 5 years, identifying several areas needing more emphasis at different levels of nursing education, including virtual care and digital care (CASN, 2022). However, NI competencies continue to be inadequately addressed in the national licensure examination for graduates from undergraduate nursing programs.

Considering that digital health continues to evolve with implications for nursing, this study aimed to explore the perspectives of undergraduate nursing students on their preparedness for digital health. This research is part of a larger case study project informed by social learning theory, wherein human

learning is shaped by interactions, observations, and self-regulation (Stanley et al., 2020), and the NI competency framework for Canadian nurses (CASN, 2012). In this study, we addressed the following research questions: 1) What type of experiences in the classroom and clinical settings do nursing students perceive as influencing their knowledge acquisition and understandings about digital health? 2) What are nursing students' perceived knowledge and opinion(s) about digital health and AI, and related educational needs?

Methods

Design and Theoretical Support

We used an exploratory mixed-methods design (Creswell & Hirose, 2019). This design enables qualitative data collection and analysis followed by quantitative data collection and analysis to inform the development of instruments. In this study, we conducted focus group interviews to collect qualitative data. Interview data and insights from the literature then informed the development of a cross-sectional questionnaire survey to collect the quantitative data. Both data sources were given equal value. In addition, we reviewed 24 course syllabi to identify how digital health concepts are being incorporated into undergraduate nursing curricula.

Participants and Sampling

The target population for the study was senior-level nursing students in their final year of study in undergraduate nursing programs from one school of nursing in Eastern Canada (EC) and one school of nursing in Western Canada (WC). For the qualitative component, three focus group interviews were planned per research site with five to seven participants in each and in consideration of data saturation and the concept of information power (Malterud et al., 2016; Vasileiou et al., 2018). Because we were interested in students who were close to completing their programs, we opted for purposeful sampling to ensure those expressing interest could provide rich and insightful data for the research questions under investigation. For the survey component, an estimated sample size of 169 participants was projected based on a 95% confidence level, a 5% margin of error, and 300 eligible participants from both research sites (Nulty, 2008). We used a census approach to maximize participation in the survey by sending the survey invitation to all potential participants.

Data Collection Materials

To facilitate the focus groups, we developed an interview guide based on a review of relevant literature and the aims of the study. For example, an open-ended question and prompt included: Could you please share your experiences of learning about digital health in the classroom, lab, and clinical setting during your educational program? An example of a probing question included: Could you share some examples? What do you believe to be your main strengths and limitations regarding digital health? We also used a few sociodemographic questions—including age (year born), gender, and program—to understand the characteristics of participants.

We developed the cross-sectional survey questionnaire based on information from other published surveys on the topic (Edirippulige et al., 2018; Swan, 2021; Vossen et al., 2020) and findings from focus group interviews. In particular, the survey was guided by topics of discussion frequently brought up by the participants of the focus groups to gather additional robust data on and understanding of these topics. Questions were related to digital health confidence, preparedness, the pros and cons of digital health, and educational needs. Demographic details consisted of four questions related to

participants' age, gender, school of nursing, and program of study (2-to-4-year programs). The survey consisted of 45 questions organized into four sections: section one: self-rated knowledge about digital health and confidence (five questions rated on five-point rating criteria whereby 1 = very low, 2 = low, 3 = neutral, 4 = high, and 5 = very high); section two: opinions regarding perceived digital health preparedness (12 questions); section three: perceived benefits and concerns and relevance of digital health to nursing and future practice (22 questions); and section four: digital health education needs (6 questions). These last three sections were rated using a five-point rating criteria scale whereby 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. These questions were presented to participants without section heading titles. The survey also included a preamble with clear instructions on how to complete the survey and a glossary of terms related to digital health and associated technologies and other pertinent definitions and terms used in the survey.

We reviewed the initial survey draft for grammatical errors and logical sequencing. Face validity was established by asking three members of the research team (who are also experts in the field) and the data analyst to evaluate the quality of questions (e.g., leading questions) and whether the questions captured the research focus. Pilot testing was completed by asking volunteer third-year nursing students to review and complete the survey, which also helped to determine the time required to complete the survey. However, the number of participants was not sufficient to conduct statistical tests. Nevertheless, their feedback was useful in identifying minor editorial errors, which were incorporated. The survey was then prepared for online distribution using the REDcap data management software because it houses data on Canadian servers (see Appendix A). For curricular data, we contacted directors of the undergraduate programs at both sites to obtain access to course syllabi for all courses taught at the undergraduate level, with considerations for broad reporting on these findings.

Recruitment and Data Collection

To mitigate issues with perceived power imbalances in doing research with students, no recruiting was done during class time, and all communications regarding the study clearly communicated that participation in the study was purely optional and extracurricular with no impact on grades or attendance. To recruit interview participants, we obtained permission from the dean or director at each university to disseminate study poster invitations to potential participants, by an administrative staff member on behalf of researchers, via email and an announcement within the e-learning environment. Students who expressed interest were provided with an information letter and the opportunity to ask questions. Those who agreed to participate were enrolled on a first come, first served basis and asked to provide written consent. Multiple reminders were sent, and the scheduling of interviews largely depended on the students' availability. The interviews were held via Zoom, and participants were informed to turn off their cameras if they wished to do so and to use a pseudonym. Interviews were completed in late 2022 and early 2023, and each interview lasted between 60 and 90 minutes. Audio-recorded interviews were downloaded and deleted from the Zoom cloud and then securely saved in a de-identified format. Verbatim transcription was completed by a professional transcription service provider.

To recruit participants for the survey, an email invitation with a link to the survey was circulated to all enrolled fourth-year nursing students by an administrative staff member at each school. The survey took 15 to 20 minutes to complete. Implied consent was obtained through the submission of completed surveys. Two reminder emails were distributed 2 weeks apart after the date of initial survey distribution (mid-2023).

Data Analysis

Interview transcripts were uploaded into the NVivo 12 software (QSR International/Lumivero) for data management and thematic analysis (Braun & Clarke, 2006). To enhance rigour, two members of the research team independently read and reread all transcripts to achieve immersion and get a sense of the whole. Each investigator then thoroughly read the data word by word to derive initial codes that captured key thoughts of participants. Initial coding was then discussed to identify similarities and differences between coders, and consensus was achieved through discussion with the third author. The final coding scheme was applied to all interviews; after all the transcripts were coded, similar codes were grouped and assessed to determine how they were related. Subthemes and themes that captured the meaning in the data were then constructed and labelled.

For the survey, after data cleaning, we applied a basic descriptive statistical analysis (mean/standard deviation) to analyze and summarize the data using SPSS Statistics Version 23.0 (Armonk, NY, IBM Corp). Further inferential analysis was not feasible due to the small sample size and missing data on some of the survey items. The analysis of the course syllabi was summarized in a spreadsheet. A research assistant scanned each of these documents to identify learning outcomes, assignments, and other learning activities offered regarding digital health and NI. Cross-mapping of these offerings was then completed against CASN's NI competencies to understand how core competency domains were being addressed. These findings were reported broadly and were useful in describing the context and the interpretation of interviews and survey results. The merging of quantitative and qualitative findings took place in the discussion of the results to achieve a comprehensive understanding and answer the research questions.

Ethical Considerations

Ethical approval was obtained from an Ethics Research Review Board at the Western Canada research site (Pro00112596), and a secondary approval was obtained from an ethics board at the university in Eastern Canada (A12-E69-21B). Interview participants received a small gift card as a token of appreciation for their time.

Results

Qualitative Findings

Seven participants from EC participated in one focus group interview, while 11 participants from WC took part in three interviews with three to four participants in each. These participants were all women under the age of 25 who were enrolled in a 4-year nursing baccalaureate program. Two main themes were constructed: 1) experiences influencing students' learning about digital health, comprising two subthemes (enabling and hindering experiences); and 2) suggestions for improving learning about digital health.

Theme 1: Experiences Influencing Students' Learning About Digital Health

This theme included two subthemes: enabling and hindering experiences. Each subtheme is discussed below with supporting quotes from participants.

Subtheme 1: Enabling Experiences. Enabling experiences pertained to having digital skills and being in the clinical setting. According to one WC participant:

We took computer classes in elementary school, and I took all my notes in university on an iPad and used virtual flashcards and this kind of stuff. ... Where to click, where to look, and how to use a computer in general is more intuitive for us, because we're just so used to doing it all day, every day.

Being in clinical settings outside the structured clinical practicum hours was another enabling factor. One WC participant explained, "I definitely learned most of my digital learning from actually working as a UNE (undergraduate student employee) in a hospital as opposed to listening to lectures." An EC participant added, "It's really when you work you get to think critically.... I found that when I work, I learn so much more than what we learn in clinical and in school." While they faced challenges in these settings, they discussed strategies that helped them thrive. One EC participant described, "We don't have access to the resources, but in my own personal time, when I was exploring one of the computers at the hospital, I was able to see some of those resources for myself." Another EC participant added, "We're already so much in touch with technology.... It's intuitive. So, we can figure it out."

Subtheme 2: Hindering Experiences. Participants also discussed several factors that hindered their learning about digital health. Within the academic setting, participants described their learning about digital health as being broad and topical in scope, delivered mostly in a lecture format within some of the theory courses. A WC participant described it as follows:

They don't give us any training about informatics.... The only thing that they harped on was confidentiality and that's about it. Then they usually just leave a PDF or a video on eClass and say, "Watch this if you want to learn how to use the software." That's literally all the training you get before you go to clinical.

An EC participant reasoned as to why that might be the case:

I do understand.... The field keeps expanding and changing quite rapidly. So, it's hard to, like, to make a class, but at least just help us understand the main programs, or just, like, an introduction so that when we go to the clinical settings we don't really look as lost. But again, I don't know.... I just feel like there's a lack of education.

Another WC participant added, "We're very focused on lecture-related things, which, honestly, my brain can't grasp."

Gaps in classroom teaching and understanding of digital health concepts along with limited hands-on application created challenges for students, especially when they were in the clinical settings for their practicum. A WC participant shared:

I did not know anything that [had] to do with the digital machines (e.g., ECG machine, telemetry, diagnostic procedures) that you use for nursing until I was there, and I don't know if my nurse just assumed that I already knew, but I just didn't.

Another EC participant said, "We didn't have any training.... It was really, like, you try to figure out how this works as you go." An EC participant described their experience: "It was scary.... The first week I was thrown off, like, truly thrown off." Another EC participant suggested, "It's good to have students figure things out because it's a skill that you need as a nurse, but it shouldn't be like that." Another EC participant added, "[For] students, there's so much added stress that we should be better prepared for clinical settings, especially with, like, technologies and machines."

Participants also discussed the breadth and depth of technology training they received. An EC participant shared, "Whenever we go for day one of clinical, the onboarding mandatory session is just a

bunch of troubleshooting.” On the other hand, participants who were exposed to a more condensed technology training also felt it was overwhelming:

For me, I didn’t understand a lot of the things, and the classroom was really hard because they tell you all these things and you have to try [to] absorb all the information in 16 hours, but then you go into practice and you have to do it, like, actually do it, so it’s, like, completely different. (WC participant)

Participants also discussed the different technology platforms and devices and variability between the clinical facilities for their practicum training. An EC participant noted, “It’s just the different platforms that vary between the settings.” Another WC participant explained:

For me it feels like it’s all over the place, so even if I wanted to focus on one thing, I didn’t even have the opportunity or allowance to do that.... Like, I was on VAX [a clinical information system for encounters, admission, transfers, and discharges] for years and I still didn’t get it.

Other participants alluded to the added effort when new units used technologies they had not been exposed to. An EC participant described, “It does have an impact on the learner.... We didn’t know how to use the machines. We had to spend, like, the first couple of weeks just learning about that.” Another WC participant elaborated, “Because every site has something different ..., once you start getting comfortable with something and you change, it’s a whole learning curve all over again.”

Other participants discussed the different digital technologies that support nursing care and the importance of being familiar with them and adapting; however, these technologies also added another layer of complexity for the students as learners. A WC participant went on to say:

All nurses chart differently.... That’s honestly what I’ve gotten the most feedback on, like, “Oh, I wouldn’t say this” or “I would say that.” Whereas, like, the next day a different buddy nurse will say the opposite or say a different thing.

Another EC participant added, “[For] a new nursing student, it’s really overwhelming because you have no idea what you’re doing.”

Participants also discussed aspects related to expectations and interactions, and learning from clinical instructors in their nursing program and nurses on the units. An EC participant stated, “It all depends on the nurses or the clinical instructors that you have. Some of them expect you to be already ready, while others don’t have that [expectation,] so, like, we can have that pressure.” Another WC participant added:

I have a lot of older nurses coming up to me and asking, “Oh, how do I do this on the [clinical information system]?” ... Even though I haven’t been there for very long, they kind of just assume that [I’ll] have the answer because I should know how to work with technology.

With respect to nurses’ interactions with the students, an EC participant mentioned:

Depending on which nurse we’re paired with, some nurses don’t want to answer us.... Others have, like, this attitude because they see students, and they don’t want to have students.... You are kind of stuck in that loop where you have a clinical instructor that doesn’t know what to do.

Another WC participant shared the following regarding their buddy nurses:

The majority are, like, you’re still learning, and they kind of take you under their wing and show you how it should be done or how to improve, which is great.... I have had a couple of nurses,

like, shouting, “Why are you even here?” ... I don’t know if they were just having a really rough time.

Another EC participant noted, “Nurses don’t really have time to teach [us] much.”

Regarding clinical instructors, according to one EC participant: “I was brand new to a unit, no idea how [the technology] worked, and neither did my clinical instructor.... It’s kind of a pressure because they would second guess.” Other participants mentioned the skills of the educators in their nursing programs:

Our lab teachers are great women, but they were nurses, like, years ago. So, when I went to practice and I was trying to do something, they’re like, “Why are you doing it like that? That is, like, from, like, 1960.” And I’m like, “Well, this is what my lab instructor taught me.” (WC participant)

Theme 2: Suggestions for Improving Learning About Digital Health

Participants agreed that technology is becoming central to care delivery and offered suggestions to improve students’ learning about digital health. A WC participant explained, “If we had ... a smaller course, or, like, an elective kind of dedicated to it, then we could explore those topics a little more in-depth, which might help some people’s understanding.” Another WC participant explained:

It would help students to have a little bit more knowledge before going into clinical so they can focus more on their skills, or other knowledge, rather than being lost not knowing how to use the technology.... I think learning how different technologies are used in different areas is also important.

This education should also include “practical hands-on experience with different technologies and not reading it in a textbook but applying it to real-life scenarios” (WC participant). An EC participant expanded on this thought:

If we have the actual platform during simulations, it would be fantastic to have a baseline ..., like, this is how it works, because it’s becoming a revolution in the medical world and it’s just going to keep on getting more and more complex.

Other participants emphasized making learning more relevant and realistic. A WC participant described it as “the integration piece ..., like, here’s what they do in real life now.” Participants also emphasized the importance of having “more clinical instructors or more who are familiar with the unit and technologies on the unit” (EC participant).

Participants also discussed the responsibilities of nursing schools and hospitals with respect to students’ education about digital health. One EC participant explained, “The school cannot do all the orientation for each hospital ..., for each unit where you go or each hospital where you go. It’s always different.” A WC participant added, “It’s a lot of learning the system in order to use the system.... I feel like it saves time in the end, but initially, you do have to take some time to understand the system and see how it works.” Another EC participant stated:

It is like a cycle. ... Are we optimizing the use [of technology] in the hospital by not providing adequate education? It’s quite challenging and counterintuitive, because you’re just not going to use it properly, and then you’re wasting millions of dollars.... There’s not enough education.

Quantitative Findings

Despite the researchers sending reminders and extending the duration of recruitment, only 135 students responded to the survey. Of these, 86 surveys were used to report demographic data, and 74 fully completed surveys were used to report responses to the questions within the survey main parts. Most participants (79%; $n = 68$) were from WC and women (87%; $n = 75$). Regarding participants' age, 44.2% ($n = 38$) were born before the year 2000 and 55.8% ($n = 48$) were born in the year 2000 or after. Table 1 shows participants' responses to the main survey questions.

Table 1

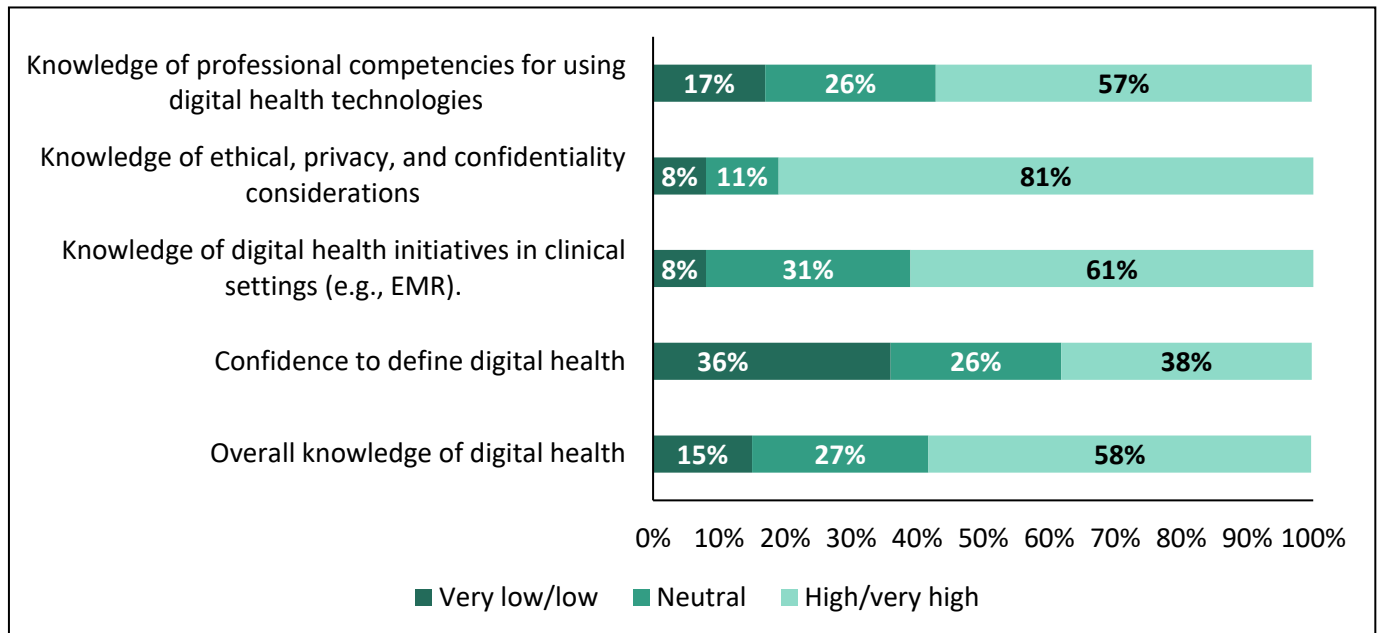
Summary Statistics of Survey Responses

	All ($n = 74$)	WC ($n = 68$)	EC ($n = 18$)
Survey questions per section	Mean (SD)	Mean (SD)	Mean (SD)
Self-rated knowledge about digital health and confidence (5 questions) Possible total score = 25	17.50 (3.30)	17.88 (3.32)	16.06 (2.82)
Perceived digital health preparedness and current nursing education opportunities (12 questions) Possible total score = 60	43.65 (6.90)	44.68 (5.76)	38.50 (9.81)
Perceived benefits and concerns and relevance of digital health to nursing and future practice (22 questions) Possible total score = 110	82.92 (6.18)	83.18 (5.66)	81.83 (8.24)
Digital health education needs (6 questions) Possible total score = 30	23.31 (4.59)	23.54 (4.61)	22.33 (4.60)

Note. WC = Western Canada; EC = Eastern Canada.

Perceived Knowledge About Digital Health and Confidence. As shown in Figure 1, overall, participants self-rated their knowledge and confidence in digital health as high/very high (mean = 17.50, $SD = 3.30$).

Figure 1

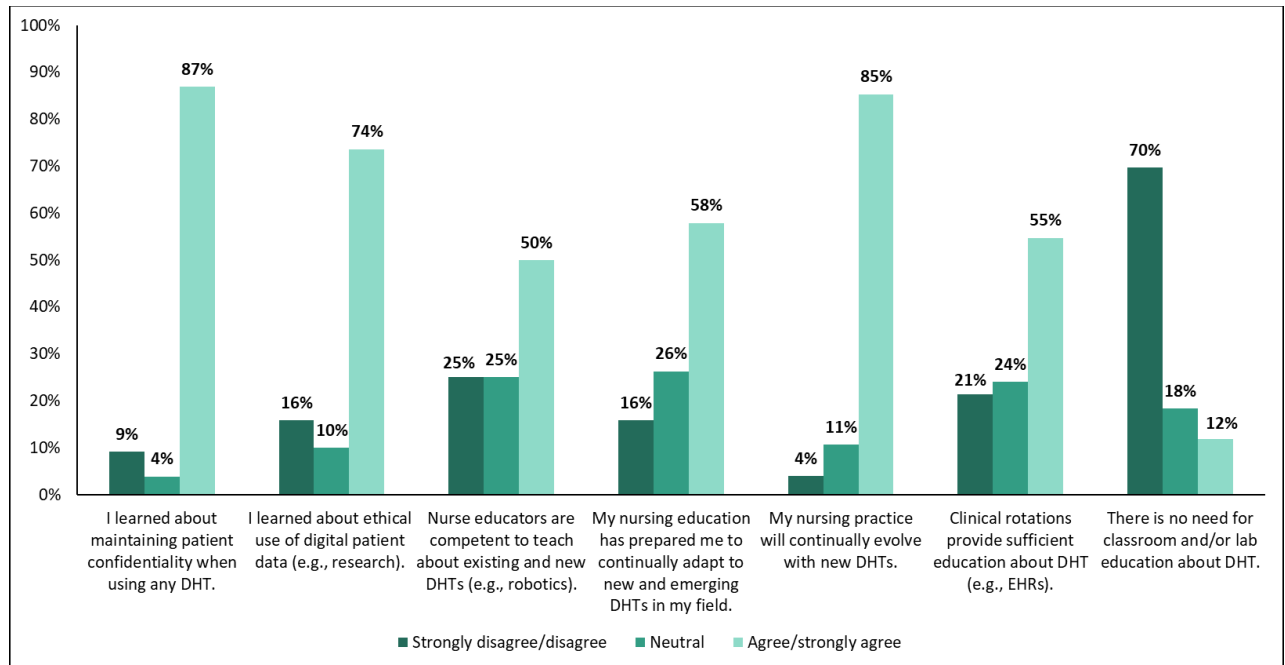
Self-Rated Knowledge and Confidence in Digital Health (n = 74)

Note. EMR = electronic medical record.

Perceived Preparedness in Digital Health and Current Nursing Education Opportunities.

Overall, participants agreed/strongly agreed (mean = 43.65; $SD = 6.90$) that their preparedness in digital health was somewhat good, emphasizing the importance of education in the classroom, in the laboratory, and during clinical practica (see Figure 2).

Figure 2

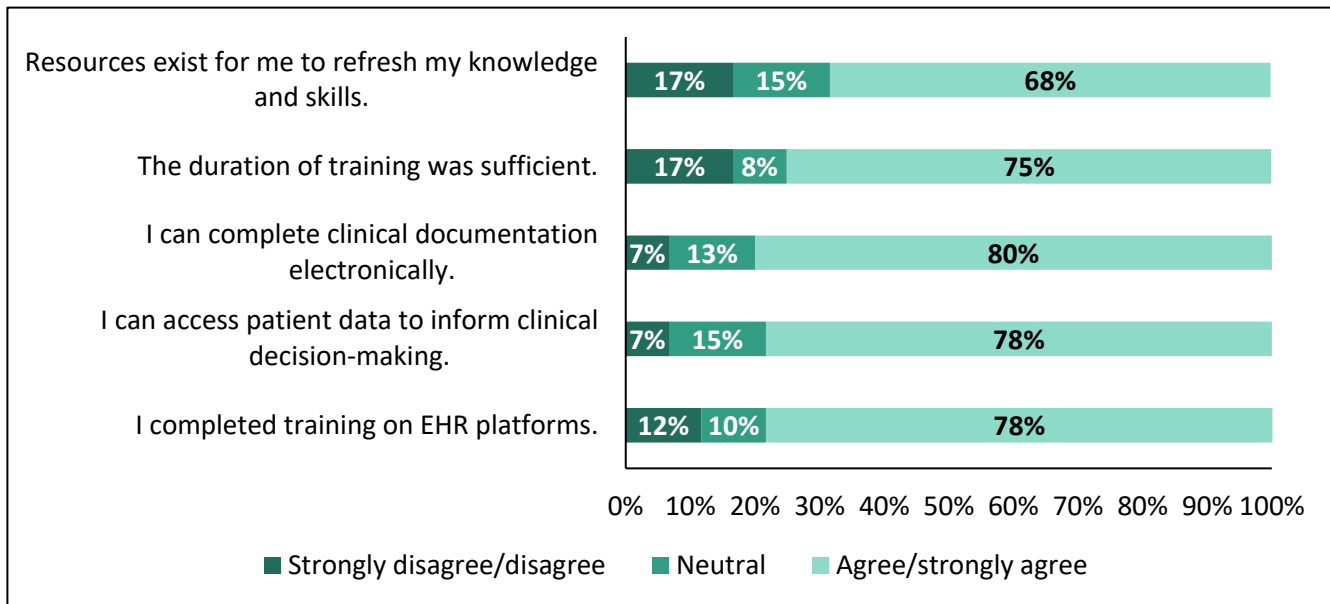
Perceived Preparedness in Digital Health and Education (n = 74)

Note. DHT = digital health technology; EHR = electronic health record.

A subset of questions in this section focused on views related to the quality and duration of the training available in the clinical settings, specifically on the use of the electronic health record (EHR). As shown in Figure 3, participants rated these experiences as adequate.

Figure 3

Evaluation of Training Received in Clinical Sites About Use of Electronic Records (n = 60)

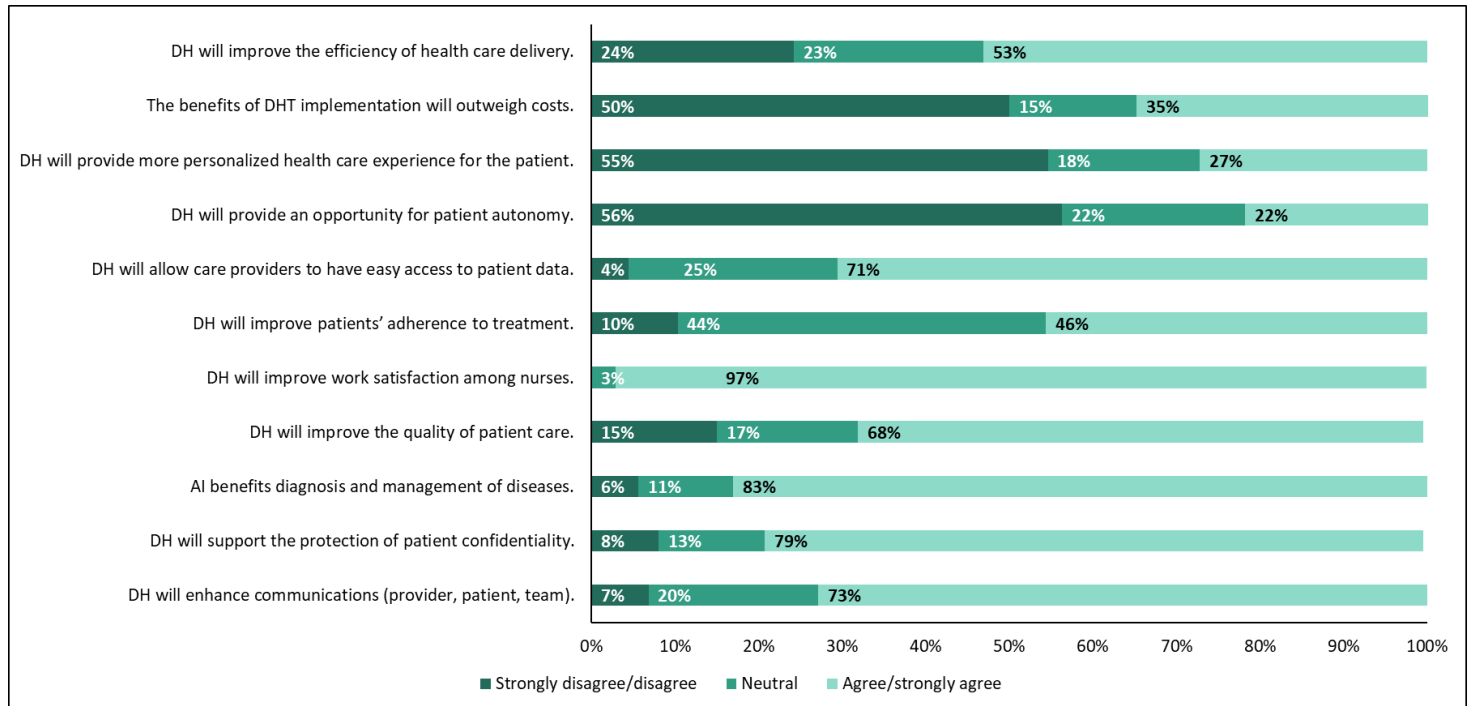


Note. EHR = electronic health record.

Perceived Benefits, Concerns, and Relevance of Digital Health to Nursing and Future Practice.

Overall, participants agreed/strongly agreed (mean = 82.92; *SD* = 6.18) that digital health and AI will be beneficial to improve the quality of health care, professional practice, and the patient experience and care options (see Figure 4).

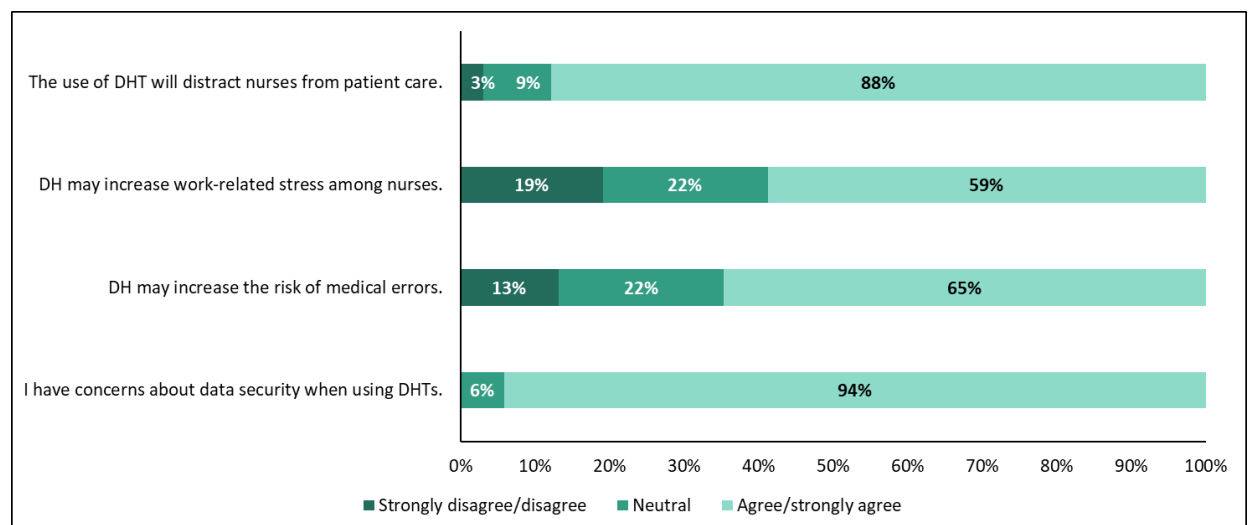
Figure 4

Perceived Benefits of Digital Health (n = 74)

Note. DH = digital health; DHT = digital health technology; AI = artificial intelligence.

Despite acknowledging potential benefits, participants also expressed concerns and risks with digital health—most notably, its potential impacts on the nurse–patient relationship and concerns related to data security (see Figure 5).

Figure 5

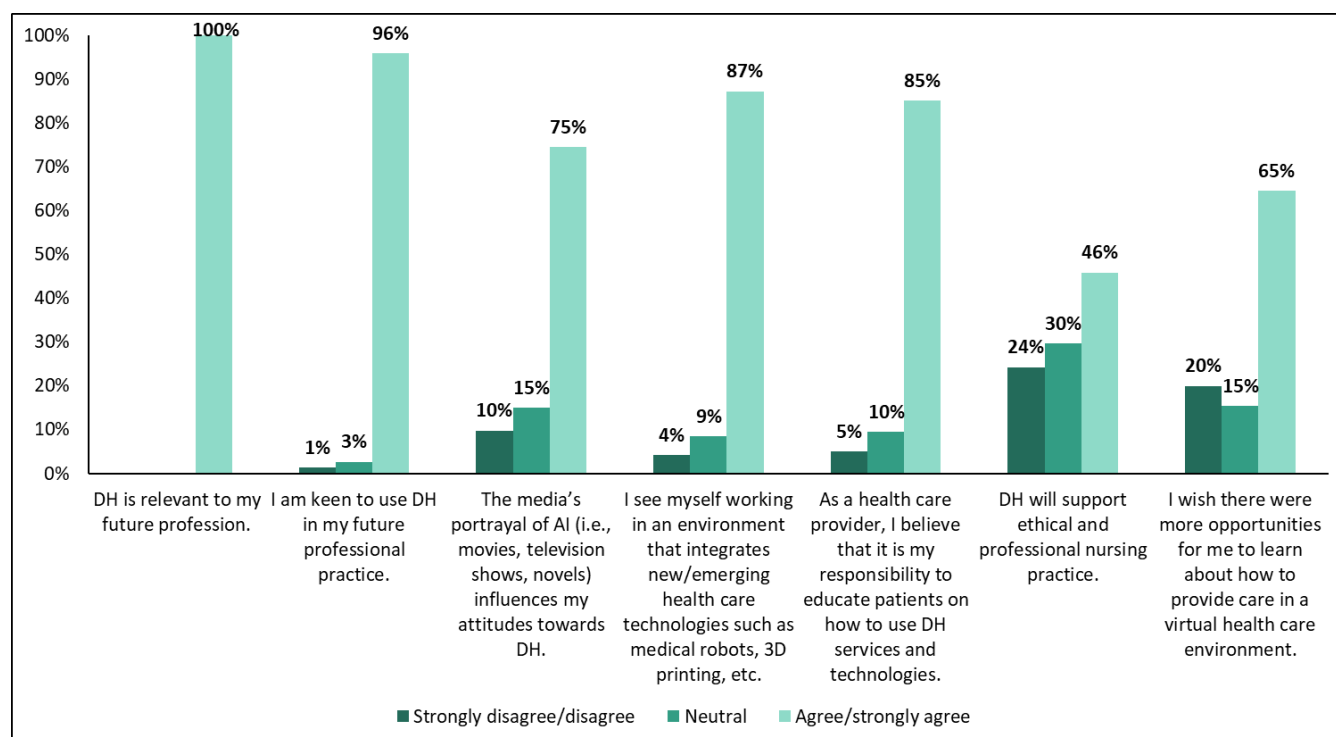
Perceived Concerns of Digital Health (n = 74)

Note. DH = digital health; DHT = digital health technology.

While all participants agreed/strongly agreed that digital health will be part of their future practice, slightly less than half agreed/strongly agreed that digital health can support ethical and professional nursing practice. Three-quarters noted the influence of media's portrayal of AI on their attitudes towards digital health (see Figure 6).

Figure 6

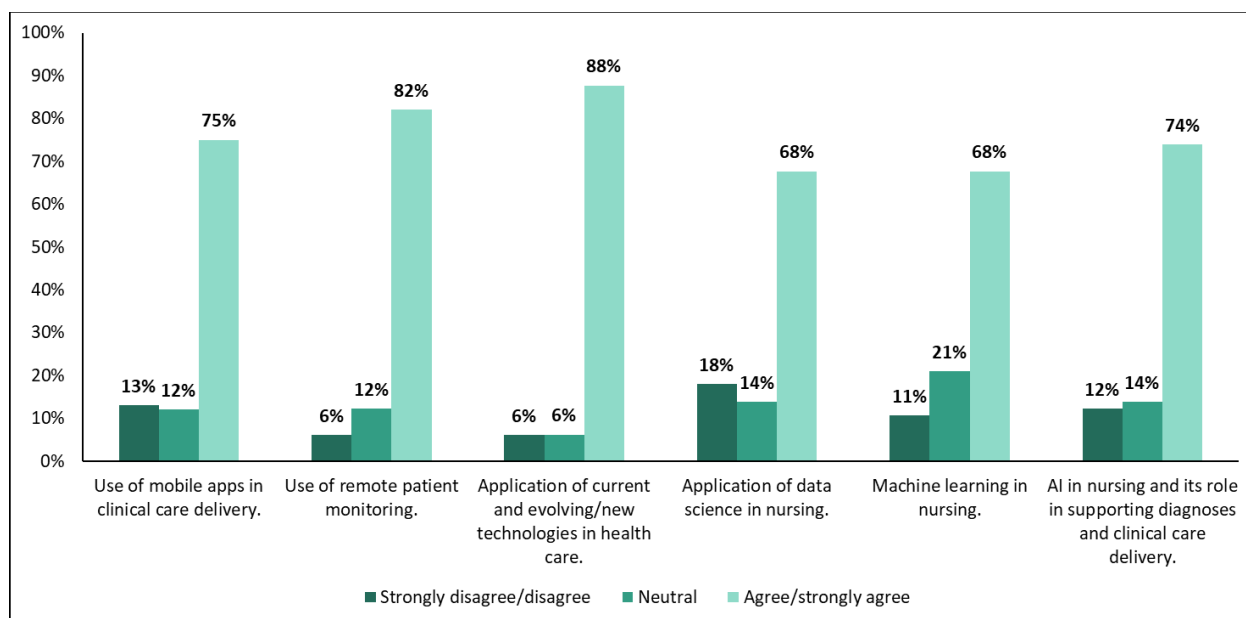
Relevance of Digital Health to Nursing and Future Practice (n = 74)



Note. DH = digital health; AI = artificial intelligence.

Digital Health Education Needs. Participants agreed/strongly agreed (mean = 23.31; *SD* = 4.59) that more education is needed about digital health and AI concepts, technologies, and services and how they are used in the clinical environment (see Figure 7).

Figure 7

Participants' Perceptions of Digital Health Education Needs (n = 74)

Note. AI = artificial intelligence.

Discussion and Implications

Overall, the participants in this study self-rated their knowledge and confidence in digital health as somewhat good, with particular strength in understanding privacy, confidentiality, and ethical use. This finding aligns with interview findings that most nursing education tends to focus on these concepts. Only 38% felt confident in defining digital health, and 58% felt as knowledgeable overall. Under two-thirds indicated that they were knowledgeable about digital health initiatives taking place in the clinical setting. This finding could be attributed to the fact that health care settings in WC were transitioning to a new clinical information system at the time of conducting this study.

The survey results were congruent with the interview findings regarding factors influencing learning about digital health, specifically having limited and mostly didactic theoretical content, limited hands-on experiences about technology, and the capabilities of nurse educators. A total of 70% of the participants disagreed/strongly disagreed that digital health education in the nursing program is not needed. These findings also corroborated findings from course syllabi reviews, which revealed that no specific course on digital health or NI is offered in either school. Integration occurred mainly through lectures embedded within nursing courses or as part of written assignments. These activities addressed some of the CASN's NI competency indicators, specifically under the "professional responsibility and accountability" and "information and knowledge management" competencies. There were no reports of hands-on practice in the use of digital health technologies through simulation.

The participants in this study compensated for the gaps in their learning by honing their digital skills, figuring things out on their own, and finding opportunities to work with technology in the clinical setting outside the structured lab and clinical learning experiences in their programs. Theoretical education is currently the cornerstone for understanding how technology intersects with nursing practice and the different dimensions of digital health, including current and emerging technologies and services

(Chauvette et al., 2022; Nazeha et al., 2020). While participants felt the training they received on using the EHR while in clinical sites was good, they also believed prior hands-on practice with technologies that nurses are expected to use in clinical practice is most ideal. This finding is congruent with findings from other research highlighting the benefits of using simulation as a strategy to help bridge the gap between theory and practice relative to digital health technologies and to help students develop their confidence in using these technologies when providing patient care (Kleib et al., 2024; Mollart et al., 2020).

Participants were aware of the challenges that nursing schools face in providing comprehensive education about digital health to their students (e.g., technology infrastructure lacking in nursing programs, variability of technologies available in the clinical sites, and inconsistent nurse educators' knowledge about NI). These challenges are not unique to participants' programs; rather, they are common challenges faced by most nursing programs globally, as reported in the general literature (Bove & Sauer, 2023; Chauvette et al., 2022; Nagle et al., 2020; Shin et al., 2018). Participants in this study valued the training opportunities they received in the clinical setting, but they also felt it should not replace learning in the nursing school.

Supportive and mentoring behaviours of nurses towards nursing students are critical for facilitating students' learning and their transition to practice once they join the workplace; most nurses willingly engage in these activities. Nursing is a practice-based profession, and learning from nurses is encouraged to socialize students for their future roles. However, these practices add pressure on nurses, whose primary responsibility is patient care (Ewertsson et al., 2017; Masso et al., 2022; Murray et al., 2020). Persistent staffing shortages and heavy workloads add burden and stress to nurses' work (Health Canada, 2024), which may explain some of the negative interactions that participants in this study encountered. Another plausible explanation is the possible impact of digital health on nurses themselves. Nurses reported factors such as lack of education and training related to digital health and the quality of technologies available were reported by nurses (CHI, 2024). These findings suggest that practising nurses are also struggling and could benefit from similar support and education about digital health so they are better able to support the learning of nursing students and their own practice with technology.

The participants' concerns regarding the cost of digital health technology, risk for errors, data security, and impact on nurses' well-being and interactions with patients are also congruent with the findings of previous research (Caton et al., 2024; Rouleau et al., 2017; Saraswasta & Hariyati, 2021). The participants also note that limited education and support about using these technologies will likely result in care providers misusing these expensive technologies, describing that as "counterintuitive" and unsustainable in the long term. Participants also appear to understand and foresee that nursing practice is becoming increasingly intertwined with technology and will likely become much more complex across all practice settings with newer technologies.

As health care continues to evolve rapidly with digital health and AI integration, the education of the next generation of nurses must evolve as well (Booth et al., 2021). This evolution should include curricular integration of theoretical content about digital health and exposure to clinical applications and a wide range of technologies and machines used in the delivery of care. Given the considerable risks associated with AI integration in digital health technologies such as electronic records, nursing education should also emphasize the core concepts and processes that underpin AI use, including the importance of data quality, data standardization, data mining, data analytics, digital equity, and clinical judgement as well as education on other, newer technologies that may be used in the future, such as robotics (Abuzaid et al., 2022; Booth et al., 2021; Buchanan et al., 2021; CNA & CNIA, 2024; Nashwan et al., 2025; von Gerich et al., 2022). These inclusions would better prepare students for the technological advancements in their field, ensuring they are equipped with the knowledge and skills necessary for safe, ethical, and responsible

use and for meaningfully leveraging AI-enabled technologies to improve patient outcomes and nursing practice (CASN, 2025).

While participants in this study noted more hindering than facilitating learning experiences, it is encouraging that they viewed digital health and AI as catalysts for advancing the nursing profession and improving health care while also not discounting potential risks of these technologies. These perspectives and the digital capabilities of nursing students will be important drivers that will facilitate the profession's transition to digital health and AI-enabled care. Although AI integration is not at full scale yet, increasing overall understanding of digital health and AI core concepts among nurses and nursing students and providing access to practical experiences should be priorities (Labrague et al., 2023; Swan, 2021). While the primary onus for enhancing nurses' digital preparedness rests on academic institutions (Booth et al., 2021; CASN, 2022), the rapid pace of digital health evolution and integration across practice settings requires collective engagement from all involved parties to accelerate the process and maximize nurses' involvement and their contributions to shaping the future of health care and nursing education (CNA & CNIA, 2024; ICN, 2023).

Limitations

This study had a small sample size compared to the estimated sample size for the survey component (74 complete surveys compared to an estimated 169). Comparing the two nursing schools, the response rate to the survey and participants in interviews were lower in EC. Furthermore, the views, opinions, and experiences of those who chose to participate in interviews and the survey may be different from those who chose not to participate. Additionally, only two Canadian nursing schools were sampled in this study. While these are large institutions in different provinces, they may not reflect the level of digital health education or preparedness at other institutions nationally and internationally.

Conclusion

The findings from this study correspond with and add to the existing body of literature about nursing students' preparedness for digital health, revealing new insights regarding prospects of AI in nursing and educational needs. Although nursing students have strong digital capabilities and access to some educational opportunities in their schools and in the clinical setting, there is a need for more systematic education and improved learning experiences about digital health (existing and emerging technologies) so that the next generation of nurses is better prepared for this era of digital revolution.

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Appendix A: Digital Health Questionnaire Survey for Nursing Students

Self-Rated Knowledge About Digital Health and Confidence

Please self-rate your knowledge and confidence in digital health next to each item.

		Very low	Low	Neutral	High	Very high
1	In general, I would rate my knowledge in digital health as...					
2	If someone asks me to provide a definition of digital health, my confidence in responding to this question will likely be...					
3	Thinking about your past and current clinical experiences, how would you rate your knowledge of the digital health initiatives in these settings (i.e., electronic medical record development or electronic charting platforms)?					
4	How would you rate your knowledge regarding ethical, privacy, and confidentiality considerations relating to digital health?					
5	How would you rate your knowledge of the professional competencies required for safe and effective use of digital health technologies?					

Opinions Regarding Perceived Preparedness in Digital Health and Current Nursing Education Opportunities

Please indicate your agreement/disagreement next to each item.

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6	I learned how to maintain patient confidentiality when I use any digital health technology.					
7	I learned how to ensure ethical use of digital patient data (e.g., research).					
8	I am confident that nurse educators are able to competently teach the next generation of nurses on how to use existing and new/emerging digital health technologies (e.g., robotics).					

9	I believe that my nursing education has prepared me to continually adapt to new and emerging digital health technologies in my field.					
10	I am comfortable with my nursing practice continually evolving/changing with the introduction of new digital health technologies.					
11	I believe that my clinical rotations are providing sufficient education about digital health technologies such as electronic health records.					
12	I believe there is NO need for classroom and/or lab education about digital health technologies.					

Self-Rated Evaluation of Training Received in Clinical Sites About Use of Electronic Patient Records

13. Have you completed training on one or more of the following EHR platforms?

☐ No. ☐ Yes. If yes, proceed to **question 14.**

	After completing the onboarding training requirements within the clinical facility during the clinical practicum, I feel I am able to use the system to:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
14	Access patient data to inform clinical decision-making.					
15	Complete clinical documentation electronically.					

	Thinking about the training you completed, please rate your agreement with the statements below.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
16	The duration of training I received was sufficient for me to understand how to use the electronic medical record.					
17	Resources exist for me to refresh my knowledge and skills on how to use the electronic record system and further expand my knowledge so that I can use the full system functionalities.					

Opinions Regarding Perceived Benefits, Concerns, and Relevance of Digital Health to Future Practice

Please indicate your agreement/disagreement next to each item.

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
18	I believe that digital health is relevant to my future profession.					
19	I am keen to use digital health in my future professional practice.					
20	I believe that the media's portrayal of artificial intelligence (AI) (i.e., movies, television shows, novels) contributes to my attitudes towards digital health.					
21	I see myself working in an environment that integrates new/emerging health care technologies such as medical robots, 3D printing, etc.					
22	As a health care provider, I believe that it is my responsibility to educate patients on how to use digital health services and technologies.					
23	I am confident that digital health will support ethical and professional nursing practice.					
24	I wish there were more opportunities for me to learn about how to provide care in a virtual health care environment.					
25	I believe that digital health will enhance the quality of communications (i.e., between the health care provider and patient, members of the health care team).					
26	I am confident that digital health will support the protection of patient confidentiality.					
27	I believe that using AI technologies in health care will be beneficial for diagnoses and management of diseases.					
28	I believe that digital health will improve the quality of patient care.					
29	I believe that digital health will improve work satisfaction among nurses.					

30	I believe that digital health will improve patients' adherence to treatment.					
31	I believe that digital health will allow care providers to have easy access to patient data.					
32	I believe that digital health provides an opportunity for patient autonomy.					
33	I believe that digital health allows for a more personalized health care experience for the patient.					
34	I believe that the benefits of digital health technology implementation will outweigh the costs.					
35	I believe that digital health will improve the efficiency of health care delivery.					
36	I have concerns about data security when using digital health technologies.					
37	I am concerned that digital health may increase the risk of medical errors.					
38	I am concerned that digital health may increase work-related stress among nurses.					
39	I am concerned that the use of digital health technologies will distract nurses from patient care.					

Opinions About Digital Health Education Needs

Please indicate your agreement/disagreement next to each item.

	During undergraduate nursing education:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
40	There should be more education about the use of mobile apps in clinical care delivery.					
41	There should be more education about the use of remote patient monitoring.					
42	There should be more education about applying current and evolving/new technologies in health care.					
43	There should be more education about the application of data science in nursing.					

44	There should be more education about machine learning in nursing.					
45	There should be more education about AI in nursing and its role in supporting diagnoses and clinical care delivery.					

Thank you for completing this survey. Your participation is greatly appreciated.