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Are Future Nurses Ready for Digital Health?

Informatics Competency Baseline Assessment

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ABSTRACT

Background: Research continues to show significant gaps in nursing graduates' preparedness in digital health.

Purpose: The aim of this study was to explore nursing students' self-perceived nursing informatics competency and preparedness in digital health, describe learning opportunities available, and identify perceived learning barriers and facilitators to developing informatics competency.

Methods: A sequential mixed-methods design, using a cross-sectional survey and interviews, was used. Senior undergraduate students (n = 221) in BScN programs in a Western Canadian Province participated.

Results: Participants self-reported being somewhat competent in nursing informatics. Three themes were identified: struggling to make sense of informatics nursing practice; learning experiences; and preparedness for future practice.

Conclusion: Addressing inconsistencies in informatics education is an urgent priority so that nursing graduates are competent upon joining the workforce. Implications for nursing education, practice, and policy are discussed.

Keywords: competency, nursing education, nursing informatics, workforce readiness

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Significant gaps in the informatics and digital health (DH) preparedness of nursing students and graduates are a growing concern for educators, program administrators, researchers, policy makers, and employers. Despite being described as digital natives, students generally do not express positive views about technology use for care provision.[1,2] They also often experience challenges in transferring their digital skills to clinical contexts[3] and tend to overrate their computer literacy skills.[4] Evidently, nursing graduates are also exiting undergraduate programs with deficient knowledge in core informatics competencies needed in the workplace and have limited confidence in using DH tools such as electronic health records (EHRs).[5,6]

The World Health Organization defines DH as "the field of knowledge and practice associated with any aspect of adopting digital technologies to improve health."[7(p39)] Nursing informatics (NI), a specialty practice and a field of nursing knowledge,[8] is also a required core competency for safe care in digitally enabled health care environments. Nearly 20 years ago, Staggers et al defined NI competency as the "integration of knowledge, skills, and attitudes in the performance of nursing informatics activities within prescribed levels of nursing practice"[9(p306)] and as having 3 domains: computer skills, informatics knowledge, and informatics skills. Since then, competency development work has evolved worldwide.[10] Nursing education programs do not adhere to standardized criteria for teaching NI, which is further compounded by a lack of NI competency requirements to support educators' NI competency development.[11] These curricular gaps negatively impact students' learning and the ability of educators to infuse informatics into nursing education.[10,11]

In Canada, entry-to-practice NI competencies for registered nurses (RNs) were approved by the Canadian

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Association of Schools of Nursing (CASN).[12] These include the use of DH tools to support information synthesis in accordance with professional and regulatory standards in care delivery. Research has examined DH and NI integration in Canadian schools of nursing[13,14]; however, limited research has examined nursing students' perspectives and self-perceived NI competency relevant to entry-to-practice requirements.

Purposes

This study aimed to explore undergraduate nursing students' self-perceived NI competency and preparedness in DH, describe learning opportunities available to students to acquire NI competency during their educational programs, and identify perceived learning barriers and facilitators to developing core NI competency.

Methods

A sequential mixed-methods design, using a cross-sectional online survey and semistructured one-to-one telephone interviews, was used. The target population for this study was senior-level undergraduate nursing students (in their final year of study) enrolled in Alberta's BScN programs based on having a high school diploma or a degree in a field of study other than nursing. Using historical data[15] of nursing graduates (n = 1465), a confidence level of 95% and a 5% margin of error, a total of 305 respondents were determined to be a representative sample for the survey component.[16] Purposeful sampling was used for the qualitative component, and a total of 20 to 25 one-to-one interviews were planned in consideration of data saturation. The research protocol was approved by an ethics review board of the principal investigator's institution and review boards of the schools of nursing that participated in the study.

Instrumentation and Data Collection

The survey component of the study consisted of 3 parts. Part 1 included a preamble with information about required NI competencies, a glossary of terms relevant to NI/DH, and instructions for completing the survey. Part 2 included 14 questions related to demographics, NI awareness, learning and education, and overall perceptions of confidence before joining the workplace. Part 3 included a 26-item NI self-assessment instrument that was an adapted version of the Canadian Nurse Nursing Informatics Competency Assessment Scale (C-NICAS).[17] The C-NICAS has 21 items developed on the basis of the CASN's entry-to-practice NI indicators. Initial validation of the C-NICAS revealed high internal consistency reliability (0.93)[17,18]; however, the instrument had a few items with parallel verbs. In the current study, C-NICAS items with parallel verbs were kept but revised, resulting in an additional 5 items on the scale. Furthermore, the language of some of C-NICAS items was simplified because nursing students have different levels of knowledge and clinical experience compared with practicing nurses. Four-point Likert-type criteria were applied (1 = not competent; 2 = somewhat competent; 3 = competent; 4 = very competent). C-NICAS items were grouped into 4 subscales: Foundational Information and Communication Technology (ICT) Skills (items 1-4), Information and Knowledge Management (items 5-13), Professional Responsibility and Regulatory Accountability (items 14-20), and Use of ICTs in Delivery of Patient/Client Care (items 21-26). The resulting adapted scale and the survey were evaluated for face and content validity using expert feedback (10 NI educators and researchers) and cognitive interviews (10 volunteering third-year students). Recommendations from students and expert reviewers were analyzed and incorporated.

Research Electronic Data Capture Software (REDCap; Vanderbilt University, Nashville, Tennessee) was used to administer the survey. Deans and directors of schools of nursing were asked to assist in distributing to their students a study poster with an embedded link to the anonymous online survey. As part of completing the survey, participants who expressed interest were invited to take part in a 20- to 30-minute one-to-one telephone interview to glean a deeper understanding of their perceived understanding of core NI concepts, as well as barriers and facilitators to the development of NI competencies. A semistructured interview guide was used to facilitate discussion. Interviews were audio recorded and transcribed verbatim.

Data Management and Analyses

Survey data were exported from REDCap to SPSS V. 26 (IBM, Armonk, New York) for analysis. After data cleaning, frequency descriptive statistics were employed for categorical variables. Mean scores and standard deviations were calculated for the total C-NICAS items and for each subscale. Comments and suggestions provided in the open-ended question section of the survey were collated and reported. For interview data, transcripts were imported into NVivo 12 data management software (QSR International Pty Ltd, Doncaster, Victoria, Australia). Qualitative content analysis was inductively performed using the following steps: (1) open coding, (2) categorization, and (3) theming.[19] Rigor was enhanced by repeatedly reading the transcripts, by keeping a record of the analytic decision trail, and by crystallization with multiple researchers involved in discussions of evolving categories and emergent themes.[19]

Results

Response Rate and Respondent Characteristics

Of the 232 returned surveys, 11 largely incomplete surveys were excluded. Results are reported on the basis of 221 completed surveys, noting this was less than the projected sample size. Most participants (58.37%; n = 129) were in the 18 to 23 years age category; 91.4% (n = 202) were enrolled in programs located in universities. About two-thirds (73.30%; n = 162) were enrolled in a 4-year nursing program (see Supplemental Digital Content, Table 1, available at: http://links.lww.com/NE/B107).

Table 1. Learning About Digital Health Technologies Prior to and During Clinical Placements

Technology and Functionality	Prior, n (%)	During, n (%)
CIS	86 (38.91)	118 (53.39)
Results review in CIS	68 (30.77)	113 (51.13)
Documentation or charting in CIS	68 (30.77)	102 (46.61)
Care planning in CIS	51 (23.08)	83 (37.56)
Medication administration and dispensing in CIS	70 (31.67)	103 (46.61)
Order entry in CIS	46 (20.81)	81 (36.65)
Clinical alerts and reminders in CIS	48 (21.72)	81 (36.65)
Smart infusion pumps	133 (60.18)	141 (63.80)
Hemodynamic monitoring devices	68 (30.77)	108 (48.87)
Telehealth or tele-home care monitoring tools	43 (19.46)	52 (23.53)
Patient portals or personal health records	43 (19.46)	75 (33.94)
Other	21 (9.50)	31 (14.03)

Abbreviation: CIS, Clinical Information Systems.

Education and Learning About NI and Perceived Readiness

Only 41.63% (n = 92) of participants indicated being familiar with NI competencies, mostly receiving education about these through their nursing professors. Almost half (46.15%; n = 102) self-rated their ability to use DH technologies as they prepare to join the workplace as somewhat confident. Only 38.01% (n = 84) of the participants reported having access to a training version of an EHR. In the clinical setting, only 39.82% (n = 88) of the participants had permission to document aspects of patient care electronically with instructor or preceptor supervision but to varying degrees.

With respect to the allowed use of mobile devices (eg, smartphone) while in the clinical sites, those who used their mobile devices indicated their usage was primarily for communicating with the instructor or peers (n = 27) and for learning purposes and conducting patient research (n = 77). A few participants emphasized how they accessed their devices only when it was most needed and in a private location, acknowledging the importance of professionalism.

Participants (n = 66) also shared reasons that prevented them from using mobile devices at clinical sites. Many participants pointed to variations in policies across clinical sites as well as in the preferences and practices for using these devices among their instructors and unit managers. Some explained mobile device use was permissible in cases of emergency or if they were used privately, for example, in the report room. Otherwise, participants were told mobile devices should not be used, as it might be perceived by patients and families as unprofessional or could jeopardize patient safety, privacy, and confidentiality. In lieu of that, they were instructed to use computers available on the unit when searching for information. Some participants argued clinical time should be used for providing care, not for researching information, as this could cause a distraction.

As shown in Table 1, most participants reported learning about applications and functionalities of DH tools during clinical placements rather than in the classroom. Although some learning about EHR, documentation, medication administration, and smart infusion pumps is taking place in the clinical sites, there is less learning about care planning and more specialized applications and functionalities including telehealth, decision support, order entry, and personal health records.

Participants' overall self-perceived NI competency was at the level of somewhat competent (Table 2). Participants' mean scores were highest on ICT use competency and lowest on information and knowledge management. A preliminary evaluation of the C-NICAS V2 scale and its subscales before factor analysis revealed high internal consistency reliability. Exploratory factor analysis testing of the C-NICAS V2 is reported in a separate publication.

One-to-One Telephone Interviews

Nineteen participants expressed interest in interviews, but only 9 students from one university participated. The analysis of interview data resulted in 3 prevailing themes (see Supplemental Digital Content, Figure, available at: http://links.lww.com/NE/B108). The first theme, *Struggling to Make Sense of Informatics Nursing Practice*, clusters data into 3 categories: *fragmented integration between theory and practice in informatics*; *narrow view of the changing digital landscape*; and *challenges in understanding reasons for technology use*. Participants tended to describe a general awareness of their knowledge deficits, focusing on hands-on or clinical practicums with reference to some theoretical or classroom-based NI learning. Their wording suggested

Table 2. Self-perceived Informatics Competency and Preliminary Internal Consistency Reliability of C-NICAS V2 Scale and Subscales

Variable	n	Mean (SD)	Cronbach α
Overall perceived informatics competency (26 items)	141	2.93 (0.46)	0.916
Foundational ICT skills (items 1-4)	152	3.27 (0.50)	0.716
Information and Knowledge Management (items 5-13)	152	2.79 (0.52)	0.821
Professional Responsibility/Accountability (items 14-20)	145	2.84 (0.57)	0.800
Use of ICTs in Delivery of Patient/Client Care (items 21-26)	141	2.97 (0.59)	0.836

Abbreviations: C-NICAS, Canadian Nurse Nursing Informatics Competency Assessment Scale; ICT, Information and Communication Technology.

a lack of clarity with respect to understanding basic NI concepts with sufficient depth, yet a broad awareness regarding technology use in nursing practice. Similarly, participants frequently identified digital tools being used to support care delivery; however, at the same time, their reflections often exposed visible limitations in the breadth and depth of their knowledge about the use of these tools in care delivery.

Participant experiences also reflected challenges in attempting to make sense of how technology supports health care delivery overall. When participants discussed how these tools support practice environments, their focus was often restricted to the bedside, individual patients, or the technology itself, rather than a broader care delivery lens embedded in relevant theoretical concepts. To illustrate, one participant exposed challenges when asked to describe their understanding of DH:

> I'm not quite sure if this counts but blood pressure monitors, like machines to read vital signs, or the IV pump. I'm guessing now as well, Connect Care, would also be a part of the patients' care in informatics because the patient themselves can be interactive with their medication history.

Another participant explained:

> The reason why I think of NI as having to do with information technology is because any time it's being mentioned to me, it has to do with electronic medical records and the online charting, so I just automatically associate your ability as a nurse to gather all that information and properly use it and apply it when using whatever kind of "technology" you have.

When asked to differentiate between instructional technologies used within educational contexts versus using technology intended to support care delivery, participants tended to recognize differences. However, their responses demonstrated a consistent inability to articulate how their experiences in using both forms of technology were transferable from one context to another.

The second theme, *Learning Experiences*, clusters data into 2 categories: *barriers* and *facilitators*. Among key barriers frequently discussed by participants was the insufficient exposure to learning experiences whether within their courses or the clinical environment. This barrier negatively impacted participants, resulting in an inability to fully comprehend the meaning of NI. An obvious disconnect was evident between awareness of technological advancements and application within clinical practice. According to one participant:

> In my education, I would've liked more opportunity to [actually] use a lot of the online patient care systems that we hear about nowadays. I feel like I only got to use it because I chose to participate in elective studies, or at clinical placements I was at, I was fortunate enough to be with staff who were willing to teach me.

Although participants appreciated the support nurses provided, other participants noted challenges due to limited hands-on experiences as they were not permitted to use these DH technologies when providing care to their patients during their clinical practicums. A participant explained: "Whatever another nurse does, you can, just watch [more or less]. But you're not allowed to really touch anything. You can ask questions but that cuts into your patient care time as well. So, it's just very limited."

Participants reflected on the value of NI learning offered through leadership and research courses, yet they also valued the importance of making theoretical connections about NI practice. There was emphasis upon specific learning experiences that helped them understand, noting the importance of practice opportunities before entering clinical settings. Simulation experiences were viewed as facilitators of essential knowledge acquisition, linking hands-on practice to their ability to be safe within the clinical practice environment. According to one participant: "Being exposed to it is huge…. I mean you can conceptualize all this but until you start to, for instance, use an EMR versus looking through a paper chart, it's day and night."

The last theme, *Preparedness for Future Practice*, clustered data into 3 categories: *overwhelming*, *limited knowledge*, and *training*. Participants reflected on the changing health care context and the expansive use of varied technologies. Feeling overwhelmed about transitioning to the work setting, participants generally hoped learning about NI will continue in the workplace and include supports and resources to build their competence. Although they viewed their computer technology skills as a strength, they questioned their ability to lead. They also voiced concerns regarding being able to work together with more senior nurses, who also continue to struggle with the use of technology.

Discussion

Participants' overall self-perceived NI competency and confidence in their abilities to use DH tools were at the level of somewhat competent/confident. Regarding NI competency domains, participants' mean scores were lowest on the information and knowledge management domain and highest on ICT use domain. Although it could be argued these participants are learning toward building NI competency, these results are concerning and indicate inadequate preparedness for practice considering they were in their final year of study and soon to be qualified as RNs.

Survey results corroborated interview findings showing gaps and inconsistencies in student understanding of NI and DH concepts. Although participants indicated receiving education about NI competency domains, a little over half of the participants when asked about their familiarity and understanding of NI entry-to-practice competency requirements indicated not being familiar or being unsure. These results indicate participants had a general awareness as opposed to a comprehensive understanding of NI and DH concepts and application in nursing practice and patient care delivery. These findings are further supported by previous research showing NI integration within Canadian schools of nursing is still suboptimal. In the study by Nagle et al,[13] only 31% (n = 360) of educators moderately to extensively used NI competencies to support student learning.

Our results also reveal limited use of simulated records to support student learning prior to clinical practicums. Rather, student learning is largely taking place once they are in clinical environments. Although some participants were grateful for opportunities to learn from nurses, these experiences were sporadic and not without challenges. These findings are congruent with previous research reporting limited use of simulated records[13,20,21] and other research in which students reported challenges in using mobile devices and having varied access and permissions to use EHR systems to retrieve data, document, and use medication administration systems during their clinical placements.[22-24] Most participants indicated less exposure to specialized applications (eg, telehealth) than mainstream applications such as medication administration.

Those interviewed struggled recalling the different technologies associated with DH. Their descriptions often gravitated toward Connect Care and NetCare, as 2 forms of electronic records used in Alberta, as well as toward commonly used medical devices such as intravenous pumps. These findings suggest participants had rather a narrow view of DH technologies available to support clinical practice and care delivery. Furthermore, participants' self-rating of their ICT use competency, which was the highest compared with other domains, could be an indication that they are more focused on technical mastery. Despite that and the resounding/underlying sense of inadequacy in what is currently known, there is a visible interest or desire among participants to make sense of NI and DH.

Nurses, as a large group of care providers, are increasingly required to use DH tools in their day-to-day practice.[25] Educating nurses about NI and DH is vitally important so they can safely use these tools when providing care, meaningfully participate in DH initiatives within their organizations, and critically examine benefits and impacts of current and new technologies on patient safety and nurses' professional responsibilities.[26]

Nursing leadership and curriculum committees may use these findings to systematically evaluate the level of NI integration in their programs. Nurse educators in laboratory, theory, and clinical courses are encouraged to engage their students in learning about and discussing DH and NI concepts. This knowledge is critical so that students have sufficient understanding as opposed to general awareness. Nursing students need to know about DH as a model of care. Furthermore, learning about DH should not be driven by the types of technologies available, because these will eventually change and continue to evolve over the coming years. In contrast, students need to know that DH technologies are only tools that complement nurses' actions and thinking; they do not control what nurses can or cannot accomplish with DH. For nurse educators to be able to address gaps in student learning, they will also need to work on expanding their own understanding of DH and its application in practice, which is different from using the technology to support learning and teaching.[27] Nurse administrators are encouraged to facilitate educators' access to professional development opportunities in DH and NI so they can convey this understanding to their students.[14]

The variability in the technology infrastructure across clinical settings and use of hybrid systems (a combination of paper and electronic data management systems) pose significant challenges to nurse educators with respect to teaching students about DH and for nursing students to understand these systems.[13,14,28,29] Furthermore, reliance on clinical agencies to teach nursing students about DH is not ideal. Research shows that nurses do not consistently mentor nursing students in learning about technology.[30] Use of simulated EHR for student training has been shown to improve consistency in assisting them to develop NI competency; yet, it continues to be underutilized in undergraduate programs.[13,20,31,32]

Nurse educators and administrators worldwide and across Canadian schools of nursing are called upon to continue advocating for DH simulation infrastructure within their schools to bridge the theory-practice gaps relevant to NI and DH education and assist students in developing required core NI competencies. This will also help reduce pressure on clinical facilities with respect to student education about DH. Because of recent pandemic-related restrictions on in-person teaching, most nursing schools have had to adapt to a virtual format to maintain continuity of clinical education. Hence, this is an

ideal time to build on those successes. Furthermore, health service organizations need to consider that continuing to teach about DH through vendor-based training models might serve short-term goals but could also have unintended consequences on patient and organizational outcomes. Through partnership with educational institutions, alternative approaches to NI and DH education can be codeveloped and designed to achieve better outcomes.

Revisiting existing practices and policies relevant to student learning about DH in clinical sites is also paramount. In partnership with clinical agencies, nurse educators and administrators can lead conversations relevant to clinical policies on the use of mobile devices. These conversations should also examine clinical policies around student access to and permissions to use DH tools during clinical practicum. Finally, further research examining nursing student preparedness in DH using similar or other methods in other Canadian provinces is recommended.

Limitations

Response rate was less than projected sample size; however, this was an exploratory study without hypothesis testing, and the use of interviews enabled the collection of rich data. Furthermore, response bias may have influenced respondents in the survey component. Hence, generalizability of findings should be done with caution.

Conclusion

Understanding future nurses' readiness for practice in technologically enabled care environments is key for informing policy and forecasting NI competency trends in nursing education and practice. This project was an opportunity for nursing students to have their voices represented. Findings show students have an inconsistent and fragmented understanding of DH and NI, support the need for sufficient depth in both clinical and theory/laboratory learning, improved consistency, and greater frequency in linking theory to practice relevant to DH. Addressing gaps and inconsistencies in nursing students' readiness in NI and DH is an urgent priority to ensure graduates are adequately prepared in DH upon joining the workplace.

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TEACHING TIP

Innovative Strategies for Engaging Overwhelmed Students

Students come to class overwhelmed from multiple stressors and competing demands. These students describe feeling saturated, like a "wet sponge," unable to absorb any more content. The Wet Sponge Lecture is a teaching technique to reengage students. Start class with a visual mood scale such as images showing a variety of emotional states. This quick assessment strategy provides insight into emotional readiness to learn. This breaks the ice and allows for tailoring depth of content and length of activities to match student energy level. Student coping strategies, such as memes and social support, are elicited and integrated into teaching methods. Memes relating to the course content and nursing student life are interspersed throughout PowerPoint slides for humor. Opportunities for relationship building and social support are incorporated into learning activities. For example, an ungraded quiz can be discussed in small groups before it is reviewed in the larger class. These strategies build class around engagement first, rather than content first. Student feedback indicated the class was "engaging and stress relieving," "the memes really helped make the class seem a bit lighter even when the content is a bit heavy," and the technique "kept things light and fun making me want to learn." Using the Wet Sponge Lecture technique supports learning in times when heightened emotional loads and mental fatigue dominate.

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TEACHING TIP

Use of a Simulated Medication Administration Scenario With Embedded Errors to Foster a Culture of Safety

An assignment was created to foster a culture of safety and improve clinical judgment skills. Using the simulation center, a 10-minute video was created demonstrating a nurse making errors while caring for a patient recovering from a motor vehicle accident. Fifteen errors were made, including no hand hygiene, no read-back of a physician order, failure to identify a relative calling the unit, failure to wear gloves, failure to assess for allergies, wrong medication given, wrong medication route, and wrong patient. Prior to class, students made a list of errors they observed in the video. During class, students worked in small groups to identify errors that were the fault of the nurse versus those with a systemic cause. Students were asked to identify the most dangerous error, to use a fishbone diagram to identify systemic causes for the error, and to develop an intervention that might prevent the error from happening again. The RaDonda Vaught case, in which a nurse was convicted of a felony for the death of a patient who was given the wrong medication, was discussed as well. Students reported a high level of engagement and enjoyment with this activity and expressed an increased understanding of safety culture concepts critical to preventing medical error.

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