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Research Paper

A blueprint for integrating nursing informatics into undergraduate nursing programs: A multiple-case study in Australia and South Africa

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ABSTRACT

Objectives: This study aimed to develop a blueprint based on empirical data to guide the integration of nursing informatics (NI) into undergraduate nursing programs.
Methods: This study employed a qualitative, holistic multiple-case study design, allowing each case to be examined as an integrated contextual system. Data were obtained from four cases—two from Australian universities and two from South African universities—all of which were public institutions offering undergraduate nursing programs. Twenty-one academic staff participated. Data collection involved semi-structured interviews, document review, and field observations. The documents reviewed included national digital health strategies, health informatics and NI standards, nursing education policies, accreditation standards, and curriculum guidelines. Materials from institutions—including subject outlines, program handbooks, and teaching policies—were also reviewed to gain a better understanding of how NI was integrated in each case. An individual case analysis employed conventional content analysis, followed by a cross-case thematic comparison. Data collection and analysis were conducted iteratively until saturation was achieved.
Results: This study highlighted the need for NI in undergraduate nursing programs. Foundational competencies, such as computer and information literacy, and advanced NI competencies, including digital health literacy, data security, and privacy literacy, alongside other competencies, were identified across varying levels of proficiency. Data from four cases led to the development of a blueprint to guide the integration of NI into undergraduate curricula. It comprises eight context-responsive steps, including situational and training needs analysis, NI competency identification and mapping against national and international standards, NI content development, sequencing NI content and experience, NI content review, implementation, and evaluation. The blueprint promotes responsive curricula that strengthen NI capabilities and readiness for digital healthcare.
Conclusion: The blueprint aligns with nursing education priorities, workforce needs, and emerging technologies, thereby supporting NI competency development that advances digitally transformed healthcare.

What is known?

- Nursing informatics (NI) is essential for preparing graduates for digital healthcare, yet many programs struggle to integrate NI effectively.
- There is a lack of clear guidelines and standardized frameworks to support institutions in systematically embedding NI into undergraduate nursing curricula.
- Faculty knowledge gaps and students' low baseline NI competency continue to limit the quality and consistency of NI education across contexts.

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What is new?

- An empirically derived eight-step NI integration blueprint to guide structured and iterative incorporation of NI into undergraduate nursing programs.
- A two-tier NI competency framework differentiating foundational and advanced/specialized competencies to support progressive learning.
- A practical method for mapping NI competencies to national and international standards, while considering micro- and macro-contextual factors across diverse settings.

1. Introduction

Nursing informatics (NI) competency is crucial for providing high-quality care in digital healthcare environments [1]. Additionally, NI skills are indispensable across various nursing domains, including clinical care, management, education, and research [2,3]. Scholars, alongside digital health and professional bodies, have outlined the informatics competencies and standards required for contemporary nursing practice, including computer literacy, information literacy, health information management, health service literacy, and patient or citizen digital health literacy [4–9]. In response to directives from professional and accreditation bodies, many universities are revising their curricula to incorporate NI [10–12]. The Australian Nursing and Midwifery Accreditation Council (ANMAC) [12] defines NI as "the knowledge and skills registered nurses require to integrate nursing science, computer science, and information science to manage and communicate data, information, and knowledge in nursing practice." The Australian College of Nursing (ACN) [13] extends this view by emphasizing the need for nurses to develop advanced digital and analytical capabilities to manage information effectively in modern healthcare settings. Similarly, the International Medical Informatics Association and Nursing Informatics (IMIA-NI) working group [14] offers an international perspective, highlighting NI as the integration of nursing knowledge with digital and communication technologies to improve health outcomes.

Targeted educational interventions can significantly strengthen NI competencies [15]. Experts recommend integrating informatics throughout the curriculum, along with ongoing training, to prepare students for digital health practice [16–19]. Various strategies have been proposed to support this integration, including curriculum mapping, collaboration with NI specialists, and alignment with international standards such as the Technology Informatics Guiding Education Reform (TIGER) and the Canadian Association of Schools of Nursing (CASN) [20]. Constructivist approaches that build on students' existing digital skills, combined with the use of learning management systems and other interactive digital learning tools, further enhance informatics learning [20,21]. These efforts highlight the importance of coordinated planning and global standards to prepare graduates for technology-enabled care, a priority reinforced by national bodies such as ACN, Australian Digital Health Agency (ADHA), and Australian Nursing and Midwifery Federation (ANMF) [9,13,22].

Developing NI competencies requires instructional approaches that combine theory with authentic, practice-based learning, as widely emphasized in the literature [23–25]. Simulation and hands-on activities are consistently identified as core strategies for strengthening NI capability because they expose learners to realistic digital workflows and clinical decision-making processes [24,25]. Integrating Electronic Health Records (EHRs) into simulation further supports competency development by providing a safe, low-risk environment for practising clinical reasoning, documentation, and information management using tools comparable to those found in practice settings [23,25]. This approach also addresses the documented limitations of retrospective or paper-based documentation in developing real-time charting skills essential for patient-centered care [25]. The literature also highlights the need for structured, competency-based NI instruction that progressively builds foundational informatics knowledge and applied technical skills [24,25]. EHR practice and data-focused activities strengthen applied skills [24], while inquiry-driven, design-oriented learning deepens understanding through authentic informatics challenges and mentored, iterative feedback [23].

Strengthening NI necessitates both strong workforce advocacy and clear national standards supported by nursing unions and health agencies. Nursing unions, such as the ANMF, play a central role in shaping nursing and midwifery policies, ensuring that digital advancements align with the professional interests, safety, and well-being of nurses and midwives [4,22,26]. Their involvement promotes fair working conditions, adequate training, and resources that enable nurses to utilize informatics tools effectively, while ensuring patient care is safeguarded and ethical practice is upheld. In Australia, the ANMF and ADHA have outlined essential NI domains and established national expectations for digital capability in nursing practice [4,9]. In South Africa, the national digital health strategy emphasizes the necessity for a competent digital workforce. Although NI integration in universities remains limited, efforts are focused on assessing students' skills, offering short courses, and supporting digital health research [16,27–29].

Although substantive progress has been made in delineating informatics competencies for novice nurses and proposing strategies for embedding NI within undergraduate nursing curricula, the literature consistently highlights persistent systemic gaps. These include limited conceptual clarity regarding the informatics competencies required of nurse educators and students, insufficient standardization of NI competency frameworks, and inconsistent use of curriculum guidelines across jurisdictions [3,17,21,30]. A further challenge is the lack of consensus—locally, nationally, and internationally—on the core informatics concepts that should be prioritized in pre-registration programs [2]. Empirical studies report that nursing students frequently demonstrate low baseline competency in clinical informatics and information management, while curricular adoption remains slow and fragmented [15,21,31]. Exposure to technology alone does not guarantee digital literacy, reinforcing the need for intentional, structured pedagogy [19]. Researchers therefore emphasize curriculum innovation, program-wide integration, and cross-institutional collaboration as essential mechanisms for strengthening NI education [18,32]. Establishing foundational informatics domains and competency standards is crucial for curriculum coherence and accreditation [33], as well as for faculty development and interprofessional approaches to build capacity [2,21].

This study was informed by two scoping reviews conducted in Australia and Africa [17,30], which shaped its objectives, research questions, and methodological approach, including case selection. The selection of South African and Australian cases was guided by contrasting developments in NI across the two countries. In South Africa, and more broadly across African countries, the literature indicates that NI is still in its early stages, with limited incorporation into undergraduate nursing programs despite a growing political commitment to producing digitally competent nurses [2,17,34,35]. In contrast, Australia has made substantial progress in defining NI competencies and embedding them within nursing curricula, supported by national informatics standards, a digital health capability framework, and accreditation requirements mandating NI inclusion [4,9,12,13,30]. Given the disparities in NI

integration between Australia and South Africa [16,17,30], this study aimed to develop a blueprint based on empirical data to guide the integration of NI into undergraduate nursing programs.

2. Methods

2.1. Research design

This study employed qualitative methods and a holistic multiple-case study design [36] to analyse NI within undergraduate nursing curricula in Australia and South Africa, and to develop an evidence-informed blueprint to support its integration into nursing programs. Furthermore, the present study adhered to the Consolidated Criteria for Reporting Qualitative Research (COREQ) guidelines to ensure transparency and methodological rigor in reporting [37].

2.2. Description of cases

This study incorporated four cases, each representing an undergraduate nursing program offered at a public tertiary education institution in Australia or South Africa. The selection of these cases was intended to capture both metropolitan and rural/regional contexts. Two cases were drawn from universities in Australia—the Metropolitan Australian University (MAU) and the Regional Australian University (RAU)—and two from South Africa—the Metropolitan South African University (MZA) and the Rural South African University (RZA). Selection criteria included geographical location, level of technology integration, and practical considerations related to feasibility and logistics.

Across the four cases, the duration of the undergraduate nursing program differed by country: the Australian programs (MAU and RAU) were three-year full-time degrees, whereas the South African programs (MZA and RZA) were four-year programs. Credit loads reflected these differences, with Australia requiring 240 credit points (MAU and RAU) and South Africa requiring 480 (MZA) and 516 (RZA) credits. All programs led to a Bachelor of Nursing qualification and were accredited by their respective national bodies—ANMAC in Australia, the South African Nursing Council (SANC), and the Council on Higher Education (CHE) in South Africa. Professional recognition aligned with the Nursing and Midwifery Board of Australia (NMBA), Australian Health Practitioner Regulation Agency (AHPRA), or SANC. Notably, NI was an accreditation requirement in Australia but not in South Africa. Furthermore, to better understand the study context, which is essential in multiple-case study research, two scoping reviews were conducted in Australia and Africa [17,30].

2.3. Participants and data sources

Participants were academic faculty members from four cases who met the following inclusion criteria: employment at the selected university during data collection, a minimum of six months of experience in the research setting, and willingness to participate in the study. Twenty-one participants were included in this study across four cases. The primary data collection tool for this study was a semi-structured interview guide, complemented by document analysis and field notes. This guide (Appendix A) was meticulously developed to align with the research questions and relevant literature. The principal investigator (A. Harerimana) drafted the guide with contributions from the advisory panel (K. Wicking, N. Biedermann, K. Yates). To ensure clarity, sequencing, and usability, a mock interview was conducted, and insights from this pilot study were published [38]. Following this, the guide received expert review and approval from the James Cook University Human Research Ethics Committee (HREC), which confirmed its clarity, readability, and comprehensiveness. Document analysis used publicly available government and institutional documents to support triangulation and cross-case comparison. The documents included national digital health strategies, health informatics and NI standards, nursing education policies, accreditation standards, and curriculum guidelines. Institutional materials, such as subject outlines, program handbooks, and teaching policies, further contextualize NI integration in each case.

2.4. Data collection

Participant recruitment and data collection occurred from August 2020 to December 2022 via videoconferencing. The timeline was extended due to COVID-19 restrictions, political instability, the July 2021 riots, electricity load shedding, and institutional disruptions in South Africa. Data collection began after obtaining the ethics approval and the gatekeeper's permission. The principal investigator (A. Harerimana) conducted the interviews, starting with a brief review of the study's purpose and an overview of the interview process. Verbal and written consent were obtained from the participant before the interview commenced and the recording began. Participants were interviewed using open-ended questions (Appendix A), with probes added as needed to clarify or elaborate on their responses. After each interview, the principal investigator promptly wrote field notes to prepare for subsequent interviews and support memo writing. Each interview lasted between 30 and 60 min and only the audio was recorded, with no video capture. The interviews were conducted in a quiet, private environment, based on the participants' preferences and internet access. No third parties were involved. At the time, A. Harerimana (PhD, RN) was pursuing a second PhD in Health at James Cook University's College of Healthcare Sciences. He is a male with significant qualitative research expertise, gained from his prior PhD and advanced training at James Cook University and other institutions.

2.5. Data analysis

The study employed conventional content analysis [39] for individual case analysis, comprising three phases: preparation, organization, and reporting (Appendix B). This was subsequently followed by cross-case analysis and categorical aggregation [36,40].

2.5.1. Content analysis

(1) First phase: preparation. The preparation phase began by identifying the unit of analysis—NI within undergraduate nursing curricula. The principal investigator immersed himself in the data by repeatedly reading interview transcripts, documents, and field notes to gain an overall understanding of the material [39]. Transcripts were broken down into meaning units, defined as sentences or paragraphs that reflected aspects relevant to the research questions [41,42]. Initial familiarization occurred during and after the interviews. Meaning units were manually organized using paper notes and MS Whiteboard® to identify early patterns and monitor saturation before subsequent data collection.
(2) Second phase: organizing. During the organizing phase [39], open coding, categorization, and abstraction were conducted. All materials were uploaded into NVivo, facilitating systematic coding and linking of data segments. Coding was

performed line by line for each transcript, field note, and document. Similar codes were grouped into subcategories and then broader categories, ensuring that no data extract appeared more than once. Extended meaning units were condensed without losing their essence [41], and categories were labelled using content-characteristic words drawn directly from the data.

(3) Third phase: reporting. In the reporting phase [39], categories and subcategories were described in narrative form, supported by quotations from multiple participants. Visual tools—including matrices, charts, and conceptual maps developed in MS Excel®, MS Visio®, Whiteboard®, Lucidchart®, and NVivo—were employed to display relationships and collaboratively refine constructs with the advisory panel, thereby strengthening analytic rigour and confirmability.

2.5.2. Cross-case analysis and formulation of the blueprint

A cross-case analysis was conducted using a case-oriented approach [43] to maintain the integrity and contextual depth of each case before comparison. Categorical aggregation [40] facilitated the grouping of similar meanings and interpretations across cases, enabling the identification of recurring patterns and the development of broader cross-case themes and categories [44]. Data derived from individual and cross-case analyses [16,45–47], together with the contextual insights gained from two scoping reviews [17,30], collectively informed and strengthened the development of the NI blueprint. The blueprint design followed established curriculum frameworks, including Kern's [48] approach and Richards's [49] systematic model, both of which emphasize needs and situational analyses to guide learning outcomes, content organization, instructional strategies, and ongoing formative and summative evaluation to support continuous curriculum improvement. The blueprint was further influenced by the principal investigator's pragmatic orientation, emphasizing context-sensitive, solution-focused inquiry [50].

2.6. Ethical considerations

Ethical standards were rigorously upheld throughout the research process. Approval was obtained from the James Cook University's Human Research Ethics Committee (H8144). Eligible participants received information sheets and provided consent. All identifying details were removed, with only de-identified codes used. Aggregated demographic data are reported to ensure anonymity and prevent identification. The secondary data used in this study were publicly available online and were analyzed as part of the document analysis. Only textual content was examined, and no private information was involved. There was no unauthorized use, illegal dissemination, or copyright infringement.

2.7. Trustworthiness

Trustworthiness in this study was established through strategies addressing credibility, transferability, dependability, and confirmability [51]. Credibility was strengthened through prolonged contextual engagement, persistent observation, triangulation (interviews, documents, field notes, and the literature review), debriefing sessions, and the incorporation of participants' own language. Overlapping methods and thick description supported transferability, demonstrated through comprehensive case reports, detailed study design documentation, scoping reviews, and the discussion of findings. Dependability was ensured through the maintenance of an audit trail, triangulation, detailed methodological descriptions, and peer debriefing, with evidence including advisory panel reviews of coding, weekly meetings, and transparent reporting of procedures. Confirmability was promoted through audit trails, triangulation, and reflexivity, as evidenced by NVivo coding, advisory panel oversight, and confirmatory examination of interpretations and recommendations.

3. Results

3.1. Demographics of the participants

All participants were employed full-time, with the majority ($n = 14$) having more than five years of academic work experience. Four participants from metropolitan universities had over 10 years of academic experience. Among the academics, a significant proportion ($n = 12$) held a PhD, with most ($n = 8$) working in metropolitan universities, compared to only four ($n = 4$) in regional or rural universities. The data showed that 66.6 % ($n = 14$) of participants were over 40 years old, and ten were over 50 years old. This trend was observed across all four cases. Most participants ($n = 13$) were female, with the majority working at metropolitan universities ($n = 10$).

3.2. Nursing informatics blueprint overview

The NI blueprint illustrated in Fig. 1 serves as a flexible foundational guide rather than a rigid model. It offers a structured yet adaptable approach to integrating NI, acknowledging the necessity for ongoing refinement as technologies and educational needs evolve. Grounded in Kern's [48] and Richards' [49] curriculum development models, the blueprint consists of eight interconnected steps that progress iteratively, with each stage shaping the next. The process begins with a situational and needs analysis, establishing the contextual foundation for identifying relevant NI competencies. These competencies guide the mapping process to ensure alignment with national and international standards, which in turn inform the design and sequencing of NI content and learning experiences. Sequencing leads to the review stage, where internal and external stakeholders evaluate relevance and feasibility, often prompting revisions that reinforce the model's cyclical nature. Implementation operationalizes the blueprint, while formative and summative evaluations provide evidence for ongoing refinement. Throughout the process, contextual macro- and micro-factors influence decisions, ensuring alignment with institutional realities and workforce needs. Ultimately, the model supports outcomes such as enhanced NI competency, improved documentation, strengthened collaboration, and readiness for digitally enabled healthcare practice.

3.3. Operationalizing the eight steps of the nursing informatics blueprint

3.3.1. Step 1: situational and training needs analysis

Situational and needs analysis is essential for identifying gaps between current and required NI knowledge and skills. Factors influencing NI integration operate at both macro and micro levels. At the macro level, regulatory standards, national digital health priorities, and global technological trends shape expectations for undergraduate nursing programs. As the ANMF [22] notes in Australia, *"digital technology is transforming and improving healthcare outcomes,"* making alignment with systems such as electronic medical records (EMRs), electronic health records (EHRs), integrated electronic medical records (iEMRs), and telehealth increasingly important. Micro contextual factors relate to institutional readiness, including infrastructure, resource availability,

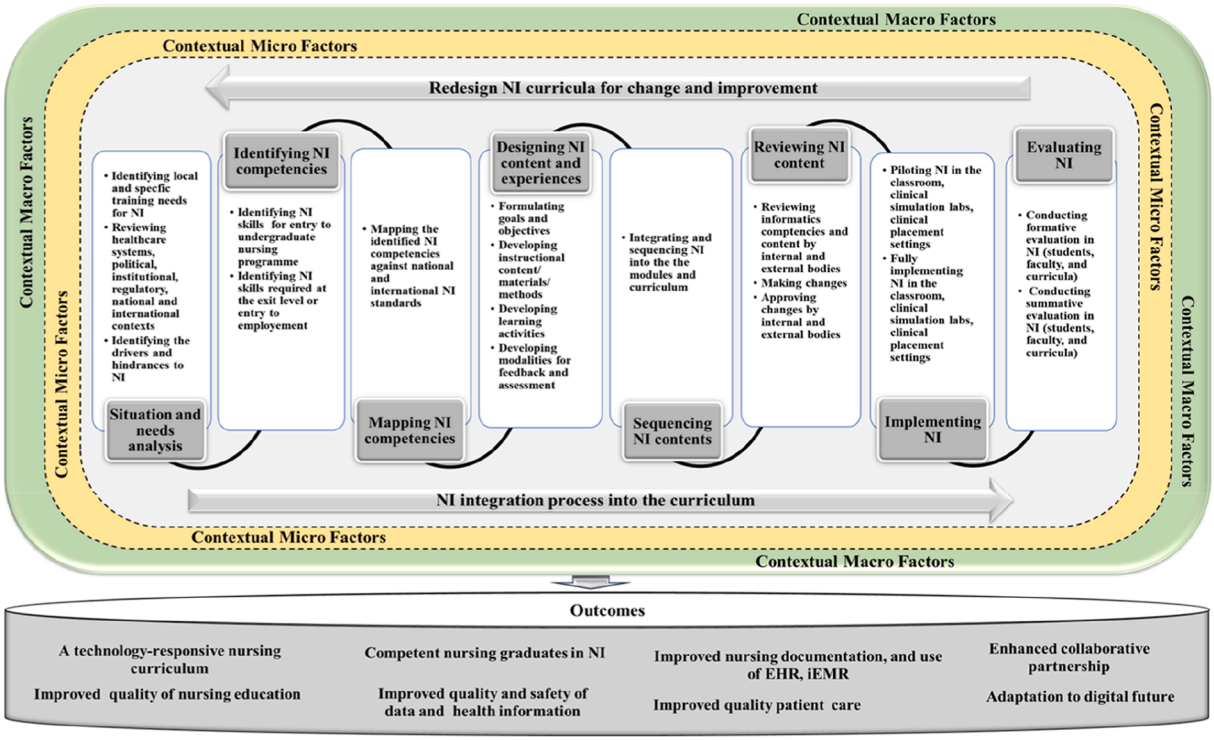

Fig. 1. A blueprint for guiding NI integration into the undergraduate nursing curricula. *Note*: NI = Nursing Informatics. EHR = Electronic Health Record. iEMR = Integrated Electonic Medical Record.

and the capacity to enhance digital learning environments. Nursing schools often strive to meet evolving digital standards, reflecting the expectation that *"all nurses must integrate information and information technology into routine practice"* (ACN et al., [13]). This imperative is echoed in South Africa's commitment to leveraging digital health to improve service access and quality [29]. These contextual influences collectively shape NI curriculum planning and implementation.

3.3.2. Step 2: identifying nursing informatics competencies

The blueprint emphasizes the critical importance of clearly defining NI competencies, as these represent the digital capabilities required for contemporary nursing practice. Table 1 outlines the competencies and their definitions, comparing them with national and international standards (Step 3). These NI competencies were derived from both individual case analyses and cross-case comparison [16]. As illustrated in Fig. 2, the competencies are organized into two progressive tiers to reflect the developmental pathway from basic digital proficiency to advanced informatics expertise. Foundational competencies (1–3) address core areas of computer literacy, information literacy, and digital communication literacy. These skills are essential for engaging with basic technologies, consistent with expectations that nurses *"manage a range of information systems"* (RAUP6) and understand *"the basic concepts of computers, electronic devices, operating systems, hardware, software, and peripheral devices"* ANMF [4]. They also enable students to communicate effectively in digital environments and navigate essential information sources.

Advanced competencies (4–8) encompass more specialized areas, including digital health literacy, data security and privacy literacy, clinical judgement in digital environments, digital leadership, and adaptive expertise in emerging technologies. A participant highlighted the need for graduates to manage patient information efficiently: *"They need just the computer skills to capture the patient's data … connect with the laboratories …"* (MZAP3). Others identified the importance of understanding evolving digital practices, such as students' familiarity with *"how issues* like *telemedicine or teletreatment work"* (MZAP4). Collectively, NI competencies form a coherent developmental pathway from essential digital proficiency to higher-order informatics capabilities that support complex clinical decision-making and leadership. Mastery of these integrated competencies prepares students to work confidently with EHRs, EMRs, and related systems, strengthening their capacity to deliver efficient, accurate, and ethically governed digital care.

3.3.3. Step 3: mapping nursing informatics competencies

Mapping NI competencies to national and international standards is crucial for ensuring that students develop the digital capabilities necessary in modern healthcare. In this study, NI competencies [16] were aligned with Australian standards, including those from the ANMF [4] and the ADHA [9], as well as global frameworks such as TIGER [52–54], IMIA [55], and CASN [5] (Table 1). This alignment ensures that curriculum content reflects contemporary expectations for nursing practice and supports the development of competent, digitally capable graduates. A participant recognized this necessity, noting, *"we have got to ensure that whatever we do is consistent with the ANMAC and Nursing Board"* (MAUP3), which highlights the centrality of regulatory alignment to curriculum credibility and approval processes.

Developing context-specific NI competencies also ensures that educational programs address the unique digital health needs and workforce priorities of each country, particularly in settings where digital health integration is still emerging. As one participant observed, *"the South African Nursing Council … needs to understand [the importance] for nursing informatics"* (RZAP1), underscoring a broader call for regulatory recognition of NI within accreditation frameworks. By mapping competencies to recognized standards, programs strengthen their relevance, meet accreditation expectations, and prepare graduates to participate effectively in evolving digital health environments.

Table 1
Mapping NI competencies emerging from cross-case analysis to national and international standards.

NI competencies from cross-case analysis [16]		International organizations			National organizations	
Competency	Definitions	TIGER [52–54]	IMIA [55]	CASN [5]	ANMF [4]	ADHA [9]
Competency 1 Computer literacy	Ability to use the computer and related technologies.	Basic computer competencies [54]	Using personal computers; use of personal application software; basic informatics terminologies.	Foundational ICT skills	Computer literacy (Standard 1)	Appropriate technologies
Competency 2 Information literacy	Ability to find, evaluate, use and communicate information in all its various formats.	Information literacy [54]	Information literacy; Principles of evidence-based practice.	Information and knowledge management	Information literacy (Standard 2, 3, 4)	Information creation and use
Competency 3 Digital communication literacy	Ability to use digital tools for academic and therapeutic communication.	Electronic communication [54]	Communicate electronically	Using intranet and extranet networks; using electronic communication	Communicate with other healthcare professionals (Standard 5); communicate and collaborate with other stakeholders (Standard 6)	Maintains the ability to communicate appropriately
Competency 4 Digital health literacy	Ability to see, find, understand and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem.	Using Electronic Health Records (EHR) [54]; Information exchange and information sharing (IEIS) [53]; data, information and Knowledge [53]; nursing documentation, information and knowledge management, principles of NI [52] Ehealth, telematics and telehealth [52].	Information systems in healthcare; management of information systems; regional networking and shared care (e-health, health telematics applications).	Information and communication technologies (in the delivery of patient care)	Information management (Standard 5, 6, 7)	Data and information quality Information-enabled care
Competency 5 Data security and privacy literacy	Ability to store, use, protect and share electronic health information safely, confidentially and with respect to policies and procedures.	Information management (Security) [54]; laws [54]; ethics and legal issues, data protection and security, ethics and IT [52,53].	Policy and regulatory frameworks; ethical and security issues, confidentiality, privacy and security of patient data.	Professional and regulatory accountability	Information management (Standards 8 and 9)	Procedural knowledge; digital health governance; data management
Competency 6 Clinical judgement skills	Ability to understand the decision-making process and its applications in clinical practice.	Decision support [54]; decision support by IT [52,53]	Principles of clinical/medical decision-making, methods of decision support and their applications	Professional and regulatory accountability (professional judgement)	Collection, use and management of data and information to support decision-making in practice (Standard 5)	Problem-solving
Competency 7 Leadership skills in digital health	Ability to use digital tools to manage resources, promote digital health and lead innovations.	Management in informatics [53]; principles of management, change and stakeholder management, strategic management and leadership, project and process management [52]	Health administration, health quality management	Professional and regulatory accountability (advocate the use of ICTs)	Advocate using innovative ICT to support nursing and midwifery practice (Standard 5)	Leadership and advocacy; extending practice
Competency 8 Adaptive expertise in technology advancement	Ability to respond effectively and flexibly to disruptive, innovative technologies.	Biostatistics, statistics, and information management in research, teaching, training and education [52,53]	Evaluation and assessment of information systems; informatics methods and tools to support education	Professional and regulatory accountability (involvement in the design, selection, implementation and evaluation of applications and systems in healthcare)	Ability to include research, evidence-based and quality improvement in supporting the use of ICTs. (Standard 10)	Digital professionalism; professional development; digital identity; digital governance

Note: ADHA = Australian Digital Health Agency. ANMF = Australian Nursing and Midwifery Federation. CASN = Canadian Association of Schools of Nursing. ICT = Information and Communication Technology. IMIA = International Medical Informatics Association. IT = Information Technology. NI = Nursing Informatics. TIGER = Technology Informatics Guiding Education Reform.

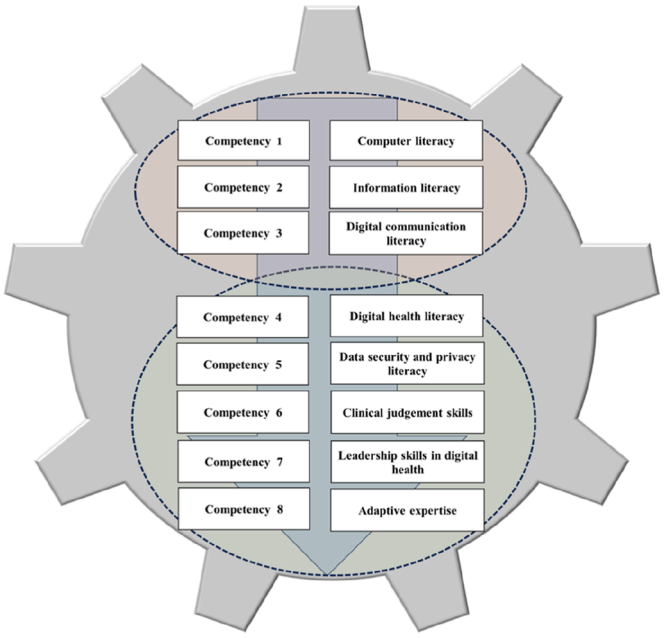

Fig. 2. Nursing informatics competencies for undergraduate nursing students.

3.3.4. Step 4: designing nursing informatics content and experiences

The blueprint emphasizes the importance of intentionally designing NI content and learning experiences that are guided by clear goals and measurable objectives. This step ensures that curriculum content, teaching strategies, and assessment processes are coherent and aligned with competency-based education principles, consistent with WHO recommendations for developing cognitive, affective, and psychomotor competencies [56]. Aligning NI teaching with regulatory expectations is essential, as ANMAC [12] states that NI content must ensure graduates are *"adequately prepared to use an array of technologies and informatics in nursing and midwifery contexts."*

The blueprint recommends selecting instructional materials and learning activities that are feasible, context-appropriate, and responsive to student needs. Active and flexible strategies—such as hybrid learning, problem- and case-based learning, peer teaching, and structured discussions—are encouraged to promote deeper engagement. Participants described how blended approaches support learning, explaining that students *"do some online reading, and then they come in for an on-campus experience …"* (MAUP1). Digital skills and professional attitudes are further strengthened through exposure to clinical simulations, digital health systems, audiovisual materials, and supervised clinical mentoring. These approaches align with broader digital health priorities, reflecting the views of ADHA [57] that incorporating digital health across nursing programs *"will ensure students are empowered to* confidently *and effectively use digital technologies upon graduation."*

3.3.5. Step 5: sequencing nursing informatics content and experiences

Sequencing NI content and learning experiences is crucial for effective curriculum design, ensuring that students develop competencies logically and progressively. The blueprint recommends introducing foundational NI skills at early academic levels and gradually advancing to more specialized competencies as students progress through their programs. Although elements from each competency tier may be integrated at different stages, the Action Prioritization Matrix provides a systematic way to determine when competencies should be introduced, emphasized, reinforced, or advanced. This tool helps faculties consider both the impact and the effort required for integration within a 3-year program in Australia and a 4-year program in South Africa. A participant highlighted the need for the NI content and experience to align with accreditation standards, noting that *"when we develop the subject, we have to make sure that it aligns with our learning outcomes and with ANMAC …"* (MAUP4). The structured process of content development and approval was described as *"a very transparent process"* (MAUP2), which further reinforces the importance of deliberate sequencing. Appendix C offers a matrix to help faculty evaluate how NI is addressed across modules and academic years, using the legend 'I' (Introduced), 'E' (Emphasized), 'R' (Reinforced), and 'A' (Advanced).

3.3.6. Step 6: nursing informatics content review

Internal and external quality assurance and accreditation bodies play a crucial role in reviewing NI content to ensure curricular relevance and compliance. Because the addition of new technologies or content constitutes a formal curriculum change, institutions must document these modifications and submit them to the appropriate nursing education regulatory authorities. This rigorous process safeguards consistency in teaching and learning, ensuring that students' progression is not disrupted and that educational standards remain aligned with professional expectations. As one participant explained, *"if we were to change one of our courses, take out content and put in nursing informatics, that would be a curriculum change … it would go to ANMAC because we are externally accredited"* (RAUP6). External advisory bodies also contribute oversight and industry perspectives, with participants noting that schools of nursing *"get industry input … through representatives from a range of our clinical partners"* (RAUP6). Such accreditation and consultation processes are essential for maintaining high-quality, coherent, and contemporary NI education.

3.3.7. Step 7: implementation of nursing informatics

Effective implementation of NI requires careful planning, including identifying necessary resources, anticipating challenges, conducting pilot testing, and establishing mechanisms for ongoing curriculum updates. To ensure students are adequately prepared, the blueprint recommends integrating both theoretical and practical components of NI education. Training in EMR and EHR systems should be integrated with classroom teaching and reinforced during clinical placements. Practical application is increasingly incorporated into coursework, with faculty noting that *"more and more, we are trying to integrate that into each course …"* (MAUP3). Schools are further encouraged to design academic health records (AHRs) that mirror clinical EHR systems to build familiarity and confidence. Clinical sites support this process through structured pre-placement preparation, as *"different hospitals [will] develop the pre-brief orientation for students to complete before they are out on placement"* (MAUP4). Students are often required to complete mandatory online modules before their placement. *"Queensland (QLD) Health has an online module that students have to undertake and pass before they can go on placement"* (RAUP6), and are expected to document within hospital systems, such as recording *"clinical tasks and interventions under [their] Student Nurse ieMR access"* QLD Gov [58]. Collaboration between nursing schools, health departments, and regulatory agencies is therefore essential to ensure system access and to support the seamless integration of NI into clinical learning environments.

3.3.8. Step 8: evaluation of nursing informatics

Evaluating NI is essential for meeting accreditation standards and strengthening students' knowledge, skills, and attitudes in digital health. The blueprint recommends both formative and summative evaluation to support ongoing improvement. Formative evaluation identifies gaps in NI teaching, guides enhancements to content delivery, and informs faculty development, thereby improving the integration of NI across the undergraduate program. Summative evaluation assesses students' achievement of NI competencies, determines grades, certifies performance, and reviews the overall effectiveness of NI implementation to ensure compliance with internal and external requirements. As one participant explained, curricular adjustments require rigorous oversight: "*If you need to make a change in the new curriculum at any stage, there is a review process … So we have to rewrite it, submit it to ANMAC, and they will review it*" (RAUP6). This structured evaluation process ensures that NI integration remains accountable, relevant, and aligned with regulatory expectations.

4. Discussion

This article presents a blueprint for integrating NI into undergraduate nursing programs, developed through a detailed comparative analysis of NI incorporation in Australia and South Africa. The contrasting regulatory environments of the two countries offer essential insights into the factors that enable or hinder NI integration. In Australia, NI is embedded within the accreditation requirements of the ANMAC, which mandates NI as essential for program approval and nursing education [12]. This is reinforced by the Australian government's substantial commitment to digital health, as reflected in federal and state-level initiatives aimed at strengthening the digital capabilities of the health workforce [9,57–60]. These regulatory and policy mechanisms ensure consistency, accountability, and national alignment in NI integration, signaling to institutions that digital competence is both a legislative expectation and an accreditation priority [4,12,61].

Conversely, South Africa lacks legal or regulatory mandates compelling nursing schools to incorporate NI into their undergraduate curricula [16]. Although the National Department of Health has emphasized the importance of digital technologies in enhancing education and clinical practice [29,62], the absence of statutory requirements has significant implications. In the absence of regulatory enforcement, nursing schools in South Africa tend to integrate NI inconsistently, often relying on individual faculty interests, institutional priorities, or available resources. This inconsistency results in fragmented implementation, variability in student competencies, and weak accountability structures, rendering NI susceptible to being overshadowed by other curricular demands [16]. The lack of legal requirements also diminishes the impetus for regulatory bodies, such as the SANC, to prioritize NI during program approvals, thereby contributing to a sluggish national transition towards digital health readiness.

The findings suggest that South Africa could benefit from adopting selected best practices evident in the Australian approach to NI integration. However, advancing beyond conceptual comparisons requires examining how these practices can be effectively implemented in the South African context. The integration of NI into Australia's nursing schools is the result of sustained advocacy and coordinated collaboration among multiple organizations, including regulatory bodies, professional associations, government agencies, and academic institutions [4,9,22,58,59,61]. Australia's requirement for universities to demonstrate alignment between NI content and national digital health strategies [9,12,13,59,61] could be adapted to reinforce coherence between South Africa's nursing curricula and the national digital health strategy [29,62]. To enhance the accreditation processes in South Africa, SANC could establish NI-specific indicators that align with national digital health strategies and require substantiation of NI content, digital skills training, and competency attainment during program accreditation and review cycles. Formalized partnerships and collaboration between nursing schools and health partners are essential for integrating digital interventions and advancing NI [16,63]. Evidence shows that coordinated academic–practice collaboration reduces theory–practice gaps, enhances patient safety, and improves students' readiness for professional roles [64,65]. Furthermore, partnerships across high- and low-income countries further strengthen capacity [30].

Australian and South African universities could learn from one another, as both countries are responding to global shifts in digital healthcare, including the transition to electronic records and the growing use of digital tools to support patient care [9,29,57,59]. As healthcare delivery becomes increasingly digitally enabled, equipping nursing graduates with the requisite informatics competencies is imperative to ensure safe and effective practice [7]. McBride and Tietze [66] underscore that institutions responsible for training healthcare professionals must adopt innovative strategies to prepare digitally competent graduates.

Effective NI integration necessitates aligning curriculum development with best practices, commencing with a comprehensive needs analysis. This should account for institutional capacity, faculty readiness, technological infrastructure, and national priorities. As Uys and Gwele [67] observe, curricula must reflect not only external standards but also the values, belief systems, and sociopolitical contexts in which educators operate. Competency standardization constitutes another critical element of coherent NI integration. Mapping NI competencies against national and international standards ensures alignment with professional expectations and accreditation requirements. Scholars such as Hughes [68] and Kokol et al. [69] emphasize the need for standardized competency sets that evolve in response to rapid advancements in digital health. While numerous NI competency frameworks exist internationally, such as those from TIGER [54], IMIA [55], CASN [5], and ANMF [4], they share common themes [70]. However, the coexistence of multiple frameworks may create confusion among educators and practitioners regarding the selection of appropriate standards. Kleib et al. [32] argue that competencies should align with nurses' roles rather than specific technologies, and that globally harmonized domains could accelerate the adoption of NI worldwide.

Mapping competencies is foundational for curriculum mapping, ensuring that content, learning activities, and outcomes are consistently aligned with program objectives. Curriculum mapping is widely acknowledged as a tool for visualizing and organizing the introduction, reinforcement, and assessment of NI content throughout a program [71]. This is essential for promoting high-quality, coherent NI education [24], particularly in contexts with limited digital infrastructure or faculty expertise, such as South Africa, where structured mapping could alleviate inconsistencies and ensure minimum standards across institutions.

The design of NI content requires strong alignment among learning objectives, teaching strategies, and assessment methods. Liu et al. [72] illustrate how multidisciplinary collaboration enhances the design of NI curricula by integrating expertise from nursing, medicine, informatics, and computer science. Similarly, Thomas and Abras [73] emphasize the significance of well-defined objectives in guiding content selection and pedagogical approaches. Logically sequencing content—whether by complexity, prerequisite learning, or spiral development—ensures the

progressive acquisition of competency [49,74]. Clearly defined entry and exit levels further enhance program coherence and facilitate the attainment of higher-level competencies.

NI implementation must comply with accreditation and quality assurance requirements [20]. Findings from South Africa indicate that while foundational NI elements are present across undergraduate nursing programs, advanced competencies and exposure to clinical information systems remain limited [8,16]. This shortfall reflects broader challenges identified in the literature, including limited faculty expertise [75] and the rapid evolution of digital technologies that outpace existing curricula [76,77]. Evaluation remains an area necessitating enhancement. Although NI competency assessment tools exist, many rely on self-reporting, which may compromise accuracy [70]. Studies, such as those conducted by Liu et al. [72], demonstrate how structured questionnaires can inform curriculum improvement; however, broader adoption of objective measures is warranted.

This study underscores the need for a structured, context-responsive framework for NI integration. South Africa, in particular, stands to gain from adopting practical strategies employed in Australia—such as regulatory mandates, competency standardization, and structured curriculum mapping—while also drawing from international standards and adapting them to local circumstances. Fortifying NI education is essential for preparing future nurses to provide safe, efficient, and technology-enabled care in rapidly evolving digital health environments.

5. Limitations and recommendations

This article examined the integration of NI into undergraduate nursing programs, and the following limitations must be acknowledged. Faculty had limited exposure to NI, which may have constrained the depth of insights, and the qualitative design limits generalisability. Nursing students were omitted, meaning their digital learning needs and readiness may not be fully represented. Targeted NI capacity-building for faculty is recommended to strengthen competence and confidence. Future studies should include students, pilot the blueprint in varied settings, and employ mixed-methods or quantitative designs to assess feasibility, effectiveness, and competency outcomes. Adoption of the blueprint is encouraged to improve curricular coherence and the quality of NI education.

6. Conclusions

In conclusion, integrating NI into undergraduate nursing curricula is essential for preparing nurses for the digital healthcare landscape. A comprehensive blueprint facilitates the integration, aligning with nursing education standards and workforce demands. This blueprint provides a structured methodology for addressing deficiencies in NI education, ensuring consistency with professional and regulatory standards. By incorporating NI into curricula, nursing graduates acquire the competencies needed for digital healthcare systems, thereby enhancing patient safety, documentation, and the overall quality of care. The success of embedding NI into education requires collaboration among academia, clinical settings, and policymakers to optimize NI content and ensure its relevance. Regular evaluations and updates to the blueprint are imperative to address emerging technologies and maintain adaptability in nursing education.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

CRediT authorship contribution statement

Alexis Harerimana: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Project administration. **Kristin Wicking:** Conceptualization, Methodology, Validation, Formal analysis, Writing - review & editing, Supervision, Project administration. **Narelle Biedermann:** Conceptualization, Methodology, Validation, Formal analysis, Writing - review & editing, Supervision, Project administration. **Karen Yates:** Conceptualization, Methodology, Validation, Formal analysis, Writing - review & editing, Supervision, Project administration.

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Declaration of competing interest

The authors declare there is no conflict of interest.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2025.12.004.

References

[1] Guo J, Liu J, Liu C, Wang Y, Xu X, Chen Y. Nursing informatics competency and its associated factors among palliative care nurses: an online survey in mainland China. BMC Nurs 2024;23(157):1–9. https://doi.org/10.1186/s12912-024-01803-5.
[2] O'Connor S, LaRue E. Integrating informatics into undergraduate nursing education: a case study using a spiral learning approach. Nurse Educ Pract 2021;50:102934. https://doi.org/10.1016/j.nepr.2020.102934.
[3] Kinnunen U-M, Rajalahti E, Cummings E, Borycki EM. Curricula challenges and informatics competencies for nurse educators. Forecasting informatics competencies for nurses in the future of connected health, vol. 232. IOS Press; 2017. p. 41–8. https://doi.org/10.3233/978-1-61499-738-2-41.
[4] Australian Nursing and Midwifery Federation. National informatics standards for nurses and midwives: Australian nursing and midwifery Federation. 2015 [Accessed 4 March 2025], https://www.anmf.org.au/media/wordogiz/national_informatics_standards_for_nurses_and_midwives.pdf;.
[5] Canadian Association of Schools of Nursing. Nursing informatics entry-to-practice competencies for registered nurses. Ottawa, Canada: Canadian Assoc School Nurs 2015 [Accessed 6 December 2023], https://www.casn.ca/wp-content/uploads/2014/12/Nursing-Informatics-Entry-to-Practice-Competencies-for-RNs_updated-June-4-2015.pdf.
[6] Jedwab RM, Gogler J, Redley B, Nagle L, Strudwick G. Validation and prioritization of health informatics competencies for Australian nursing and midwifery leaders: a modified Delphi study. Int J Med Inf 2023;170:1–9. https://doi.org/10.1016/j.ijmedinf.2022.104971.
[7] Honey M, Collins E, Britnell S. Guidelines: informatics for nurses entering practice. The University of Auckland Journal Contribution; 2018. p. 1–24. https://doi.org/10.17608/k6.auckland.7273037.
[8] le Roux L, Bimerew M, Chipps J. Preparation of nursing students in nursing informatics competencies for the South African healthcare practice environment. BMC Nurs 2024;23(923):1–9. https://doi.org/10.1186/s12912-024-02614-4.
[9] Australian Digital Health Agency. National nursing and midwifery digital health capability framework. Sydney: Australian Digital Health Agency; 2020.
[10] Park M, Dlamini BB, Kim J, Kwak M-J, Cho I, Choi M, et al. Development of a standardized curriculum for nursing informatics in Korea. Healthc Inform Res

2022;28(4):343–54. https://doi.org/10.4258/hir.2022.28.4.343.
[11] Cummings E, Borycki EM, Madsen I. Teaching nursing informatics in Australia, Canada and Denmark. In: Borycki EM, Kushniruk AW, Kuziemsky CE, Nøhr C, editors. Context sensitive health informatics: many places, many users, many contexts, many uses, vol 218. IOS Press; 2015. p. 39–44. https://doi.org/10.3233/978-1-61499-574-6-39.
[12] Australian Nursing and Midwifery Accreditation Council. Health informatics and health technology. An explanatory note. Australian Nursing and Midwifery Accreditation Council; 2014 [Accessed 27 January 2021], https://anmac.org.au/.
[13] Australian College of Nursing, Health Informatics Society of Australia, Nursing Informatics Australia. Nursing informatics position statement: Australian college of nursing. https://www.acn.edu.au/wp-content/uploads/joint-position-statement-nursing-informatics-hisa-nia.pdf. [Accessed 4 March 2025].
[14] International Medical Informatics Association—Nursing Informatics. Definition of nursing informatics updated. https://imianews.wordpress.com/2009/08/24/imia-ni-definition-of-nursing-informatics-updated/. [Accessed 4 March 2025].
[15] Almarwani AM. Evaluation of the nursing informatics competency among nursing students: a systematic review. Nurse Educ Pract 2024;78:104007. https://doi.org/10.1016/j.nepr.2024.104007.
[16] Harerimana A, Wicking K, Biedermann N, Yates K. Click, care, connect: incorporating nursing informatics into undergraduate nursing curricula. Informatics for health and social care. 2025. p. 1–27. https://doi.org/10.1080/17538157.2025.2582852.
[17] Harerimana A, Wicking K, Biedermann N, Yates K. Integrating nursing informatics into undergraduate nursing education in Africa: a scoping review. Int Nurs Rev 2021;68:420–33. https://doi.org/10.1111/inr.12618.
[18] Lee KH, Kim M-G, Lee J-h, Lee J, Cho I, Choi M, et al. Empowering healthcare through comprehensive informatics education: the status and future of biomedical and health informatics education. Healthc Inform Res 2024;30:113–26. https://doi.org/10.4258/hir.2024.30.2.113.
[19] Reid L, Button D, Brommeyer M. Challenging the myth of the digital native: a narrative review. Nurs Rep 2023;13:573–600. https://doi.org/10.3390/nursrep13020052.
[20] Cummings E, Shin EH, Mather C, Hovenga E. Embedding nursing informatics education into an Australian undergraduate nursing degree. Stud Health Technol Inf 2016;225:329–33. https://doi.org/10.3233/978-1-61499-658-3-329.
[21] Foster M, Sethares K. Current strategies to implement informatics into the nursing curriculum: an integrative review. On-Line J Nurs Inf 2017;21(3):1–8. https://www.proquest.com/openview/69f284621076c7d61409684e6be12ef9. [Accessed 29 May 2020].
[22] Australian Nursing and Midwifery Federation (ANMF). Digital health: ANMF policy. Australian Nursing and Midwifery Federation; 2018.
[23] Shen M, Feng Z, Shen Y, Shi Z. Enhancing undergraduate nursing informatics literacy through design-based learning: a mixed-methods participatory action research study. BMC Nurs 2025;24(1268):1–13. https://doi.org/10.1186/s12912-025-03927-8.
[24] Vottero B. Teaching informatics to prelicensure, RN-to-BSN, and graduate level students. Nurse Educ 2017;42(5S):S22–6. https://doi.org/10.1097/NNE.0000000000000414.
[25] Thomas L, McBride S, Decker S, Pierce M, Tietze M. Developing competencies in nursing for an electronic age of healthcare. In: McBride S, Tietze M, editors. Nursing informatics for the advanced practice nurse: patient safety, quality, outcomes, and interprofessionalism. New York, NY: Springer; 2016. p. 558–71.
[26] Litwin AS. Collective bargaining and technological investment: the case of nurses' unions and the transition from paper-based to electronic health records. Br J Ind Relat 2017;55(4):802–30. https://doi.org/10.1111/bjir.12249.
[27] Chipps J, Le Roux L, Agabus J, Bimerew M. Nursing informatics skills relevance and competence for final year nursing students. Curationis 2022;45(1):1–8. https://doi.org/10.4102/curationis.v45i1.2277.
[28] Harerimana A, Duma SE, Mtshali NG. First-year nursing students' digital literacy: a cross-sectional study. J Nurs Educ Pract 2023;13(1):31–7. https://doi.org/10.5430/jnep.v13n1p31.
[29] National Department of Health. National digital health strategy for South Africa 2019-2024. Pretoria: National Department of Health; 2019.
[30] Harerimana A, Wicking K, Biedermann N, Yates K. Nursing informatics in undergraduate nursing education in Australia before COVID-19: a scoping review. Collegian 2022;29:527–39. https://doi.org/10.1016/j.colegn.2021.11.004.
[31] Raghunathan K, McKenna L, Peddle M. Baseline evaluation of nursing students' informatics competency for digital health practice: a descriptive exploratory study. Digital Health 2023;9:20552076231179051. https://doi.org/10.1177/20552076231179051.
[32] Kleib M, Arnaert A, Nagle LM, Ali S, Idrees S, da Costa D, et al. Digital health education and training for undergraduate and graduate nursing students: scoping review. JBI Evidence Synthesis 2024;21(7):1469–76. https://doi.org/10.11124/jbies-22-00266.
[33] Khairat S, Feldman SS, Rana A, Faysel M, Purkayastha S, Scotch M, et al. Foundational domains and competencies for baccalaureate health informatics education. J Am Med Inform Assoc 2023;30(10):1599–607. https://doi.org/10.1093/jamia/ocad147.
[34] Achampong EK. Assessing the current curriculum of the nursing and midwifery informatics course at all nursing and midwifery institutions in Ghana. J Med Educ Curric Dev 2017;4:1–4. https://doi.org/10.1177/2F2382120517706890.
[35] Harerimana A, Wicking K, Biedermann N, Yates K, Pillay JD, Mchunu G. Adoption of electronic health records by nurses in Africa: a scoping review. Digital Health 2025;11:1–16. https://doi.org/10.1177/20552076251357401.
[36] Yin RK. Case study research and applications: design and methods. London: Sage Publications; 2018.
[37] Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care 2007;19(6):349–57. https://doi.org/10.1093/intqhc/mzm042.
[38] Harerimana A, Wicking K, Biedermann N, Yates K. Preparing for data collection: the mock interview as a researcher's training tool. Educ Res 2024;66(1):68–85. https://doi.org/10.1080/00131881.2024.2302156.
[39] Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs 2008;62(1):107–15. https://doi.org/10.1111/j.1365-2648.2007.04569.x.
[40] Stake RE. The art of case study research. London: Sage Publications; 1995.
[41] Bengtsson M. How to plan and perform a qualitative study using content analysis. NursingPlus Open 2016;2:8–14. https://doi.org/10.1016/j.npls.2016.01.001.
[42] Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Educ Today 2004;24(2):105–12. https://doi.org/10.1016/j.nedt.2003.10.001.
[43] Yin RK. Applications of case study research. London: Sage Publications; 2012.
[44] Zarate Montero LH. Social capital development: a case-based qualitative study on the internationalization process of Costa Rican knowledge-intensive SMEs [Doctoral Thesis]. Universitat Autònoma de Barcelona; 2017.
[45] Harerimana A, Wicking K, Biedermann N, Yates K. How do we fit informatics into the undergraduate curriculum? Nursing as a case study. In: HERDSA 2022 Annual Conference. Melbourne, VIC, Australia: Melbourne Convention & Exhibition Centre (MCEC); 2022.
[46] Harerimana A, Wicking K, Biedermann N, Yates K. My understanding of informatics: nursing as a case study. The National Nursing Forum 2022. Darwin, NT, Australia: Darwin Convention Centre; 2022.
[47] Harerimana A, Wicking K, Biedermann N, Yates K. Ready, set, go! fostering nursing informatics integration into our curricula. National nursing forum 2023. Adelaide, SA, Australia: Adelaide Convention Centre; 2023.
[48] Kern DE. A six-step approach to curriculum development. In: Thomas PA, Kern DE, Hughes MT, Tackett SA, Chen BY, editors. Curriculum development for medical education: a six-step approach. JHU press; 2016.
[49] Richards JC. Curriculum development in language teaching. Cambridge University Press; 2001.
[50] Bell R, Warren V. Illuminating a methodological pathway for doctor of business administration researchers: utilizing case studies and mixed methods for applied research. Soc Sci Humanit Open 2023;7(1):1–8. https://doi.org/10.1016/j.ssaho.2022.100391.
[51] Forero R, Nahidi S, De Costa J, Mohsin M, Fitzgerald G, Gibson N, et al. Application of four-dimension criteria to assess rigour of qualitative research in emergency medicine. BMC Health Serv Res 2018;18(1):1–11. https://doi.org/10.1186/s12913-018-2915-2.
[52] Healthcare Information and Management Systems Society. TIGER international competency synthesis project: global health informatics competency recommendation frameworks. Healthcare Inform Manag Syst Soc 2020 [Accessed 4 March 2025], https://cdn.sanity.io/files/sqo8bpt9/production/34b116238a7161827dd93cf8f5689d3de8de6211.pdf.
[53] Hübner U, Shaw T, Thye J, Egbert N, Marin HdF, Chang P, et al. Technology informatics guiding education reform - TIGER. Methods Inf Med 2018;57(S 01):e30–42. https://doi.org/10.3414/ME17-01-0155.
[54] Technology Informatics Guiding Education Reform (TIGER). Informatics competencies for every practicing nurse: recommendations from the TIGER collaborative. 2009 [Accessed 4 March 2025], https://www.tigersummit.com/uploads/3.Tiger.Report_Competencies_final.pdf.
[55] Mantas J, Ammenwerth E, Demiris G, Hasman A, Haux R, Hersh W, et al. Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics - 1st revision. Methods Inf Med 2010;49(2):105–20. https://doi.org/10.3414/me5119.
[56] World Health Organization. Four-year integrated nursing and midwifery competency-based prototype curriculum for the African region. Brazzaville: World Health Organization, Regional Office for Africa; 2016.
[57] Australian Digital Health Agency. Australia's national digital health strategy. Sydney: Australian Digital Health Agency; 2017.
[58] Queensland Government. Nursing student orientation manual. https://www.health.qld.gov.au/__data/assets/pdf_file/0025/1006477/nursing-student-orientation-manual.pdf. [Accessed 29 September 2021].
[59] Australian Digital Health Agency. Australian national digital health strategy: framework for action. Sydney: Australian Digital Health Agency; 2018.
[60] Australian Government. Digital health blueprint 2023-2033. Canberra ACT. Department of Health and Aged Care; 2023.
[61] Australian Nursing Midwifery Accreditation Council. Registered nurse accreditation standards 2012. Australian Nursing Midwifery Accreditation Council; 2012. https://www.anmac.org.au/sites/default/files/documents/ANMAC_RN_Accreditation_Standards_2012.pdf. [Accessed 4 March 2025].
[62] National Department of Health. National strategic direction for nursing and midwifery education and practice: a road map for strengthening nursing and

midwifery in South Africa (2020/21-2025/26). South Africa: National Department of Health; 2020.
[63] Walzer S, Armbruster C, Mahler S, Farin-Glattacker E, Kunze C. Factors influencing the implementation and adoption of digital nursing technologies: systematic umbrella review. J Med Internet Res 2025;27:e64616. https://doi.org/10.2196/64616.
[64] Bvumbwe T. Enhancing nursing education via academic–clinical partnership: an integrative review. Int J Nurs Sci 2016;3(3):314–22. https://doi.org/10.1016/j.ijnss.2016.07.002.
[65] Kalogirou MR, Chauvet C, Yonge O. Including administrators in curricular redesign: how the academic–practice relationship can bridge the practice–theory gap. J Nurs Manag 2021;29(4):635–41. https://doi.org/10.1111/jonm.13209.
[66] McBride S, Tietze M. Nursing informatics for the advanced practice nurse: patient safety, quality, outcomes, and interprofessionalism. New York: Springer; 2022.
[67] Uys L, Gwele N. Curriculum development in nursing: process and innovation. Routledge; 2004.
[68] Hughes MT. Step 2: targeted needs assessment. In: Thomas PA, Kern DE, Hughes MT, Chen BY, editors. Curriculum development for medical education A six-step approach. Baltimore, Maryland: Johns Hopkins University Press; 2016.
[69] Kokol P, Saranto K, Blažun Vošner H. eHealth and health informatics competences. Emerald Publ Limit : Kybernetes 2018;47(5):1018–30. https://doi.org/10.1108/K-09-2017-0338.
[70] Kleib M, Chauvette A, Furlong K, Nagle L, Slater L, McCloskey R. Approaches for defining and assessing nursing informatics competencies: a scoping review. JBI Evidence Synthesis 2021;19(4):794–841. https://doi.org/10.11124/jbisrir-2017-003889.
[71] Neville-Norton M, Cantwell S. Curriculum mapping in nursing education: a case study for collaborative curriculum design and program quality assurance. Teach Learn Nurs 2019;14(2):88–93. https://doi.org/10.1016/j.teln.2018.12.001.
[72] Liu J, Liu F, Zhang F, Fang J, Li C, Liu S. Multidisciplinary-based design of a nursing informatics curriculum. In: GSe al, editor. Innovation in applied nursing informatics. IOS Press; 2024. p. 129–33.
[73] Thomas PA, Abras CN. Step 4: educational strategies. In: Thomas PA, Kern DE, Hughes MT, Chen BY, editors. Curriculum development for medical education: a six-step approach. Baltimore, Maryland: Johns Hopkins University Press; 2016.
[74] Barthakur A, Joksimovic S, Kovanovic V, Corbett FC, Richey M, Pardo A. Assessing the sequencing of learning objectives in a study program using evidence-based practice. Assess Eval High Educ 2022;47(8):1429–43. https://doi.org/10.1080/02602938.2022.2064971.
[75] Livesay K, Walter R, Petersen S, Abdolkhani R, Zhao L, Butler-Henderson K. Challenges and needs in digital health practice and nursing education curricula: gap analysis study. JMIR Med Educ 2024;10:e54105. https://doi.org/10.2196/54105.
[76] Khakpaki A. Advancements in artificial intelligence transforming medical education: a comprehensive overview. Med Educ Online 2025;30(1):1–21. https://doi.org/10.1080/10872981.2025.2542807.
[77] Perle JG, Chandran DN, Brezler E, Coleman M, Deziel J, Nahhas P, et al. Technology-enhanced practice competencies: scoping review and novel model development. Front Digit Health 2025;7:1571518. https://doi.org/10.3389/fdgth.2025.1571518.