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Review

Nursing informatics in undergraduate nursing education in Australia before COVID-19: A scoping review



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ABSTRACT

Background: Technology can support transformational outcomes of high quality and evidenced-based care and education. Embedding nursing informatics into the undergraduate nursing curriculum enhances nursing students' digital health literacy, whilst preparing them to use health information systems and technological innovations to support their learning both at university and in the clinical environment.

Aim: This scoping review aimed to provide an overview of the published literature on how nursing informatics was embedded and integrated into the undergraduate nursing curriculum in Australia before coronavirus disease (COVID-19).

Methodology: A scoping review approach guided this study using the Levac, Colquhoun, and O'Brien framework, and the following databases were searched: CINAHL Plus, EMCARE, MEDLINE Ovid, Scopus, ERIC ProQuest, and Web of Science. A total of 26 articles were included: Five quantitative studies, eight qualitative studies and 13 mixed-methods studies.

Findings: Few studies focused on the concept of nursing informatics itself, and only two studies described the process of developing curricula that contain nursing informatics competencies and their implementation: the educational scaffolding and modular development approach and a Community of Inquiry Framework (COI). Most studies centred on nursing informatics tools to facilitate teaching and learning in classrooms and skills laboratories. The reported pedagogical strategies were online learning, blended learning, and technology-enabled simulations. Hindrances to nursing informatics being integrated into undergraduate curricula were disparities of the informatics content, a lack of guidelines and/or frameworks, and poor digital literacy.

Conclusion: This study provided a baseline perspective of how nursing informatics was embedded and integrated into nursing education in Australia before COVID-19. Overwhelmingly, the focus of research to date was found to be mainly on the utilisation of technological tools to support learning and teaching.

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Summary of relevance

Problem or issue

Healthcare professionals work in a technology-challenging environment. Preparing a digitally literate nursing workforce is a central requirement of Australian undergraduate nursing programs.

What is already known

The Australian Government, peak nursing organisations and accreditation bodies all emphasise the need to integrate nursing informatics into nursing education to produce digitally competent nurses.

What this paper adds

Nursing informatics integration in Australian undergraduate nursing programs is hindered by a lack of standards for teaching nursing informatics along with students' and teachers' readiness to use technology.

1. Background

Healthcare professionals work in a technology-challenging environment (Jabareen, Khader, & Taweel, 2020; Knox, 2019). Nurses are the largest health professional group in all healthcare contexts, and their digital health-related roles and capabilities are essential in providing quality care in a dynamic healthcare environment (Australian Digital Health Agency, ADHA, 2020). Nursing education institutions are expected to embed nursing informatics into their undergraduate nursing curriculum to prepare students to use technological innovations to support their learning both at university and in the clinical environment (Australian Nursing and Midwifery Federation, ANMF, 2019). With the advent of the coronavirus disease (COVID-19) pandemic, nursing education institutions rapidly pivoted to online delivery, which required significant confidence and competence in digital literacy (Ekert et al., 2020; Morin, 2020; Seah, Ang, Liaw, Lau, & Wang, 2021). This scoping review explores how nursing informatics was embedded and integrated into the undergraduate nursing curriculum in Australia before COVID-19.

Nursing Informatics (NI) is an emerging concept. NI was created by the merge of three well established scientific fields: information science, computer science and nursing science (Aathi, 2014; Topaz, 2013). Defining NI is vital to guide the role delineation for nurses interested in nursing informatics and suggest a direction for the practice, education, training and research (Hunter & Bickford, 2011; Stagers & Thompson, 2002). The Australian College of Nursing (ACN, 2017, p. 1) defined nursing informatics as “the speciality that integrates nursing science with multiple information and analytical sciences to identify, define, manage and communicate data, information, knowledge, and wisdom in nursing practice.”

Globally, the definition of NI has evolved over the past few decades; however, a universal definition is still not recognised in the academic arena. Scholars have clustered NI definition into three main themes: information technology oriented, conceptually oriented, and role oriented definitions (Faustorilla, 2020; McGonigle, Hunter, Sipes, & Hebda, 2014; Stagers & Thompson, 2002). The information technology-oriented definition asserts that NI is used in all fields of nursing. NI is used in nursing practice to track patient outcomes, find data trends, and assess workload and interventions (McGonigle et al., 2014). NI in education supports virtual teaching and learning, assessment, and analytics associated with educational outcomes. Nurse executives use NI to improve workflows, decision support, and manage resources. NI supports nursing research by evaluating patient outcomes, evidence-based practice, standardised terminologies, and virtual knowledge bases (McGonigle et al., 2014).

The conceptually oriented NI definition demonstrated a shift from technology-focused definitions to pro-active and model-driven definitions, which combine computer science, information science, and nursing science to support the practice of nursing and the delivery of nursing care (Faustorilla, 2020). The role oriented definition views NI as a speciality where the role of NI specialists is primarily related to the insertion of computer technologies into the healthcare system to support patients, nurses and other healthcare professionals in decision-making in all roles and settings to achieve the desired outcomes (American Nurses Association, 2015; Stagers & Thompson, 2002).

Using informatics tools in nursing practice has been a driving force for tertiary educational institutions to devise approaches to produce nursing graduates who have adequate digital skills and competencies to use technological innovations in health information systems (Brown, Morgan, Mason, Pope, & Bosco, 2020; Collins, Britnell, Ditzel, & Honey, 2017; Knox, 2019; Pearce, 2017). Digital literacy refers to the capabilities which “fit an individual for living, learning and working in a digital society” (Terry, Davies, Williams, Tait, & Condon, 2019, p. 258). Digital literacy also refers to “competencies on the use of digital technologies for searching, organising, understanding and creating information with digital devices” (Khosrow-Pour, 2013). Digital literacies have multiple facets and encompass information literacy—capabilities to find, interpret, evaluate, manage, and share information (JISC, 2014); ICT literacy—capabilities to adapt and use digital devices, applications and services (JISC, 2014); learning skills—capabilities to study and learn effectively in a technology-rich environment, formal and informal (JISC, 2014). Furthermore, digital literacy includes digital communication and collaboration, career and identity management, media literacy, and digital scholarship (JISC, 2014). Digitally literate nurses are capable of providing quality care in clinical settings (Brown et al., 2020). Embedding NI within undergraduate nursing curricula is important to develop nursing students' digital skills (Brown et al., 2020; Cummings, Shin, Mather, & Hovenga, 2016; Honey, Collins, & Britnell, 2020), and NI competencies should meet demands from practice through education (Peltonen et al., 2019).

Internationally, developed countries such as Australia, Canada, Denmark, New Zealand, and the United States of America have undertaken reforms to undergraduate nursing curricula to include NI (ADHA, 2020; Borycki, Cummings, Kushniruk, & Saranto, 2017; Cummings, Borycki, & Madsen, 2015; Monsen et al., 2019). In those countries, schools of nursing are required to provide evidence that NI has been included in their curricula in order to obtain accreditation of the nursing program (Borycki & Foster, 2014; Cummings et al., 2016). However, in developing countries such as those from Africa, nursing informatics is scarce in undergraduate nurse education due to the implementation and adoption challenges (Harerimana, Wicking, Biedermann, & Yates, 2020).

Meeting international health informatics education standards is desirable due to the health industry's globalisation and increased workforce mobility across countries (Hübner et al., 2018). Hence, the design of NI content is encouraged to be in line with international standards, such as those from Technology Informatics Guiding Education reforms (TIGER), the Canadian Association of School of Nursing (CASN), and the American Medical Informatics Association (AMIA) (Cummings et al., 2016; Cummins, Gundlapalli, Murray, Park, & Lehmann, 2016; Hübner et al., 2018).

In Australia, NI's integration in nurse education is underpinned by the country's health and education context. The Australian Government is committed to achieving an optimum healthcare system and ensuring a digitally connected healthcare system (Australian College of Nursing, ACN, 2017; Australian Digital Health Agency, ADHA, 2017; ADHA, 2020). Australian health policy reform focuses on health informatics requirements in the health sec-

tor (ADHA, 2017, 2020; Australia Nursing and Midwifery Federation, ANMF, 2015; Foster, 2015). Furthermore, the healthcare system is phasing out paper-based documentation (ACN, 2017) and adopting electronic health records (ACN, 2017; Borycki, Foster, Sahara, Frisch, & Kushniruk, 2013). Hence, an increasing need exists to train digitally literate healthcare professionals (ADHA, 2017, 2020; Kuek & Hakkennes, 2020; Mather, Douglas, & Jacques, 2018).

In the context of nurse education in Australia, nursing organisations and accreditation bodies lead the reforms in education to equip nursing students with informatics skills, enabling them to work in digitalised health environments (ACN, 2017; Australian Nursing and Midwifery Accreditation Council, ANMAC, 2014; ANMF, 2015). There are increasing demands for universities to produce digitally-competent graduates who can use ICT to deliver quality healthcare (ACN, 2017; ADHA, 2020; Borycki et al., 2013).

The development of a nursing curriculum inclusive of NI is a rigorous process to meet national and international requirements (Cummings et al., 2016). A study conducted in Australia by Cummings et al. (2016) found that this process requires mapping all content against nursing competencies and recommendations from ANMAC. Furthermore, the course content and the context of each NI component are checked to ensure the alignment with the degree requirements (Cummings et al., 2016). ANMAC (2018, p. 13) recommends that nursing programs should “reflect contemporary practices in health education and respond to emerging trends including health informatics and digital health technologies and is based on research or other forms of evidence.” Hence, this recommendation establishes the baseline for NI competencies to be taught as an important step in developing the curriculum—computer literacy, information literacy and information management (ANMF, 2015; Choi & De Martinis, 2013).

There are challenges in creating a proficient nursing workforce with adequate skills and comfort to use technology (ACN, 2020). Globally, there is “a gap in informatics expertise among nursing students, practising staff and faculty” (O’Connor & LaRue, 2021, p. 1). A distinct lack of guidelines for developing NI content and non-adherence to standards and criteria for teaching nursing informatics hinders the development of NI competencies in nursing education (Atthill, 2015; Forman, Armor, & Miller, 2020). Furthermore, NI definition’s ambiguity significantly impacts informatics practice and education (Staggers & Thompson, 2002). In light of those challenges, a broader literature review is required to explore the body of knowledge around the integration of NI into undergraduate nursing education.

2. Aim of the study

The scoping review aims to provide an overview of published literature about how NI was embedded and integrated into the undergraduate nursing curriculum in Australia before COVID-19.

3. Methodology

3.1. Methods

In order to understand the state of the integration of nursing informatics in Australian undergraduate nurse education before COVID-19, the authors conducted a scoping review. Scoping reviews map a given field, summarising a range of evidence to convey the field’s breadth and depth (Levac, Colquhoun, & O’Brien, 2010). This study followed a scoping review framework from Levac et al. (2010). In scoping reviews, guidelines are recommended to facilitate the scoping review reporting and transparency. Furthermore, a methodological framework for scoping reviews provides recommendations for clarity at each stage, which increases consistency (Brien, Lorenzetti, Lewis, Kennedy, &

Ghali, 2010; Levac et al., 2010). The scoping review framework by Levac et al. (2010) is a refined framework from Arksey and O’Malley, which has six steps describing the methodological approach to use when conducting a scoping review. For this study, the following essential five steps were used:

- 1 Identifying the research questions;
- 2 Identifying relevant studies;
- 3 Selecting the studies;
- 4 Charting the data;
- 5 Collating, summarising, and reporting the results (Levac et al., 2010, p. 3).

In this study, the following inclusion criteria were used: peer-reviewed articles on the integration of NI in nurse education in the context of Australia, published in English between 1 January 2010 and 31 January 2019. Exclusion criteria included discussion papers and peer-reviewed articles of studies conducted outside Australia, published in languages other than English and studies about NI in postgraduate or postregistration curricula.

This scoping review focused on Australia due to its rapid advancement of digital health, both in clinical practice and in the education of healthcare professionals. The 2018 World Health Organization Collaborating Centre (WHOCC) for Education and Research Capacity conference demonstrated that Australia was a role model in the region, with the presence of NI in undergraduate curricula being a requirement for nursing program accreditation. Due to multiple educational systems across the globe, choosing one exemplar country with a strong educational system and a track record in digital health was crucial for this scoping review to enable learning best practice approaches. This scoping review provides a foundation for a broader PhD cross case analysis study, investigating how NI is embedded into undergraduate nursing education in low and high-income regions, for which the authors also conducted a similar scoping review in Africa (Harerimana et al., 2020).

3.2. Step one: Identifying the research questions

Identification of relevant research questions provides “a roadmap for subsequent stages. Research questions are broad and seek to provide a breadth of coverage” (Levac et al., 2010, p. 3). The following research questions were addressed in this scoping review:

- 1 What were the expectations for integrating NI into undergraduate nursing programs in Australia before COVID-19?
- 2 How was nursing informatics integrated into undergraduate nursing education in Australia before COVID-19?
- 3 What were the factors facilitating and hindering the integration of NI in undergraduate nursing education in Australia before COVID-19?

3.3. Step two: Identifying relevant studies

Before the identification of relevant studies, search strategies were developed, which included where to search, what terms to use, sources to be searched, time span and language as recommended by Levac et al. (2010). Publication dates were limited to a period ranging from 1 January 2010 to 31 December 2019. The beginning of 2020 marked the beginning of the impact of COVID-19 on the way nursing education was delivered in the 2020 academic year, in which ICT uptake by nursing education providers was obligatory.

The following electronic databases were searched: CINAHL Plus, EMCARE, MEDLINE Ovid, Scopus, ERIC ProQuest, and Web of Science. Additionally, a search was conducted in Google Scholar to obtain additional articles which might have been missed with the other electronic database searches.

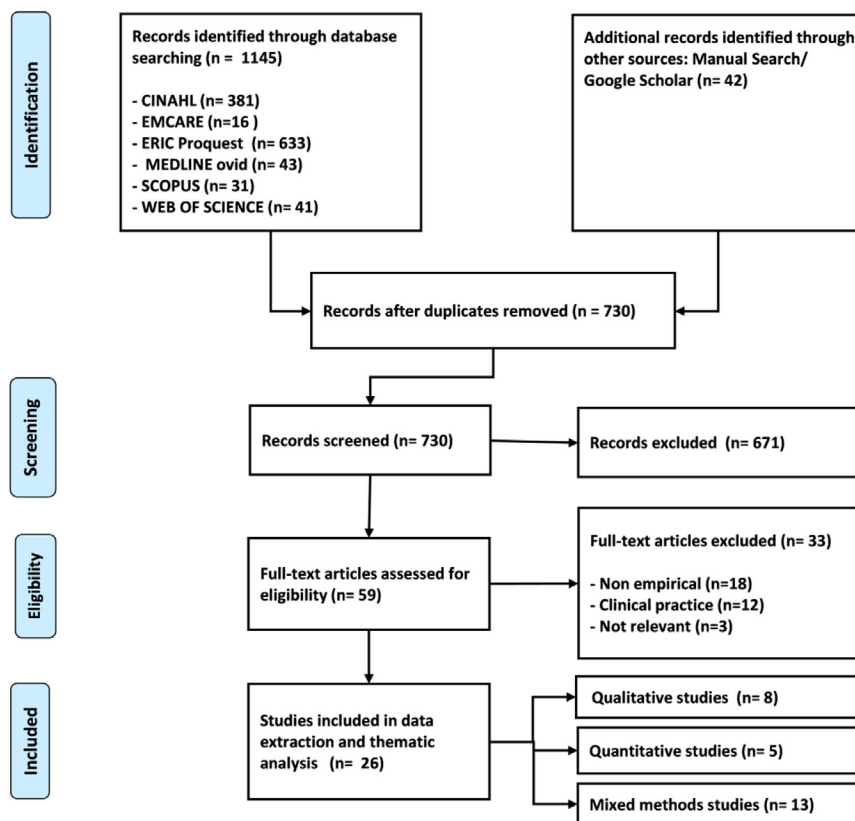


Fig. 1. PRISMA flowchart.

Key terms were developed mainly from MeSH Headings (MH) and customised keywords to suit the search strategies of different databases. The following were the key terms used in this study:

- Search 1: exp education, nursing/ or education, nursing, baccalaureate/ or education, nursing, graduate/
- Search 2: exp Medical Informatics/ or exp Nursing Informatics/
- Search 3: exp Australia/
- Search 4: Search 1 AND Search 2
- Search 5: Search 3 AND Search 4

3.4. Step three: Selecting relevant papers

A total of 1187 articles were retrieved, including 1145 from databases and 42 from Google Scholar searches. After removing the 457 duplicates, 730 remained for title screening. Fifty-nine articles were chosen for further screening of the abstract based on the inclusion and exclusion criteria. After the abstract screening and assessing the full-text, 26 articles were considered relevant to be included in the data set for collating, summarising, and reporting the results. A Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram was used to report the final number once the review had been completed (Fig. 1). The selection of articles was based on the research questions and minimum standards of quality were considered based on the Mixed Methods Appraisal Tool. Qualitative, quantitative, mixed methods were all considered in this study. The selection of relevant papers was in line with the recommendations from Levac et al. (2010, p. 3) who stated that the selection of the studies should be guided by the inclusion and exclusion criteria, research questions, and the familiarity of the subject matter through reading the title, abstract and the full paper.

3.5. Step four: Charting the data

Twenty-six articles included in this study were read several times, to ascertain that all necessary information was included. Ac-

cording to Levac et al. (2010, p. 3), it is vital to develop a data-charting form and use it to extract the information from each study. In this study, extracted data were presented in the form of a table which contained: Authors, year of publication, study design, population and sample size, and key findings (Table 1).

3.6. Step five: Collating, summarising and reporting the results

In this stage, extracted data were analysed using descriptive analysis and an inductive thematic synthesis approach recommended by Cruzes and Dyba (2011). To extract data, an organising matrix was created into which relevant segments of the text of each study were inserted, and later condensed (Table 1). Each study report was uploaded into NVivo (version 12), and the findings for each study were systematically coded and later grouped into common themes related to the research objectives. Themes were created from a comprehensive review of all the codes from all selected papers. Themes were then organised into higher-order themes, and their relationships described. To achieve trustworthiness, each step of the framework for a scoping review was followed (Levac et al., 2010). The research questions were answered based on the evidence obtained from a collaborative synthesis of the data.

4. Results

Of the 26 empirical studies included in this study, 50% (n = 13) used mixed methods, 30.8% (n = 8) used qualitative, and 19.2% (n = 5) used quantitative methods. The majority of the selected studies were conducted with a focus on nursing students (76.9%; n = 20), followed by faculty (15.4%; n = 4); of both faculty and students (3.8%, n = 1), and lastly, one study focussed on the undergraduate nursing curriculum itself (3.8%, n = 1). The majority of nursing students in the dataset were female, representing 80 to 90%. The age group ranged from 18 to 50 years, with the major-

Authors, year, country	Aim	Topic focus	Research design	Population/ sample	Intervention	Key findings
Andrew, Maslin-Prothero, and Ewens (2015), Australia	"To enhance online learning in two nurse theory units through a pilot project to design, implement and evaluate the introduction of interactive classroom technology."	Interactive learning, Online/Virtual learning	Quantitative, descriptive cross-sectional	Undergraduate nursing students (n = 144)	Adobe Connect Interactive tutorial	Students learned through interactive video, audio, text and presentations. The perceived benefits included: Academic engagement, active participation, collaboration and access to electronic resources. Students suggested that more classes should be offered online and guidelines for socialisations provided.
Bogossian et al. (2018), Australia and New Zealand	"To describe the current use of simulation in tertiary nursing education programs leading to nurse registration Australia and New Zealand, and determine whether investments in the simulation have improved uptake, quality and diversity of simulation experiences."	Clinical simulation	Quantitative, cross-sectional electronic survey	Nursing academics (n = 22); Institutions (n = 32)	n/a	The simulation was perceived to develop generic and advanced technical skills and behavioural skills. Positive perception of the role of simulation before or as a substitute for clinical placement. Nurse educators use self-made and commercial scenarios for simulation. Issues included: Inadequate staff development, lack of support, insufficient resources and time to develop simulation experiences and weak quality assurance and evaluation of simulations.
Brown and McCrorie (2015), Australia	"To explore the impact of tablet technology, in the form of iPads, on undergraduate nursing and midwifery students' learning outcomes."	Clinical simulation, Digital tools	Mixed methods	Undergraduate nursing and midwifery students (n = 45)	Clinical simulation using iPads	Students had their own iPads. Students used iPads to access information and learning resources in the classroom and clinical laboratory. Students perceived that iPads allowed them to obtain immediate formative feedback. Issues included: Inaccessibility to Internet and/or WIFI.
Carlson et al. (2019), Australia, Hong Kong, and Sweden	"To explore nursing students' perception of peer learning during cross-cultural learning activities through student-led webinars."	Online/Virtual learning, Peer learning	Qualitative, exploratory	Undergraduate nursing students (n = 31)	Student-led webinars using the Zoom platform for audio and video conferencing.	Students perceived that webinars promoted the creation of friendship among peers by forming social connection, learning from peers through interactions and discussion and empowered learning by helping students to build their knowledge together.
Cummings, Shin, Mather, and Hovenga (2016), Australia	"To describe one university's journey in the process of integrating NI in the design phase of a new undergraduate curriculum."	Curriculum, Nursing informatics	Qualitative, constructivist approach for curriculum development	Undergraduate nursing degree curriculum	Integrating of NI in undergraduate nursing curriculum using the educational scaffolding and modular development process	NI was overtly found in 21 units out of 25 across the 3-year degree. The units where NI was not found were those where students are on clinical placement. The process of integrating NI in the curriculum was built on the premise that students have experiences to use technologies in their daily lives but are not expert on their use and concepts in the workplace. The lead role was undertaken by the faculty member with responsibility for and expertise in the development and content for individual units. Multidisciplinary collaboration was important to the integration of NI. Issues included: Lack of accepted NI competencies in Australia, and lack of the faculty's understanding and confidence about NI.
Ferguson et al. (2016), Australia	"To explore first-year nursing student experiences with social media in supporting student transition and engagement into higher education."	Online/Virtual learning	Qualitative descriptive	Undergraduate nursing students (n = 10)	n/a	Nursing students used Facebook for social media, followed by Skype. Students perceived that social media facilitated safe collaboration, independent learning, access to resources and peer support during group work and assignments. Issues included: Lack of physical interactions with peers, frustration due to loneliness, lack of privacy in the Facebook posting and inappropriate posted content.
Kable, Arthur, Levett-Jones, and Reid-Searl (2013), Australia	"To test the application of the evidence-based quality indicator statements as an effective guide for simulation design, implementation, and evaluation in undergraduate nursing programs."	Clinical simulation	Mixed methods	Undergraduate nursing students (n = 85)	Clinical simulations using Laerdal SimMan 3G Mask-Ed Silkon mask (KRS simulation) and simulation of mental health by professional actors	Simulations assisted in developing students' skills in different clinical situations. Students received adequate theoretical preparation before simulation. Students perceived that simulation was realistic. Debriefing session allowed students to address their feeling after the simulation sessions.
Klein et al. (2019), Australia	"To examine the use of three computer programs designed for the study of gross anatomy; An@tomedica Online, AnatomyTV, and Thieme, as in-class learning support programs within the newly adopted "Block model" of teaching delivery at Victoria University."	Blended learning, Computer based learning	Mixed methods, intervention study	Undergraduate nursing students (n = 179)	Computer-based Learning (CAL) using AnatomyTV®, An@tomedica® and Thieme®	The majority of students (94.8%) indicated that the computer-based anatomy program was useful. Students preferred An@tomedica® Online and Thieme® compared to AnatomyTV®. Students perceived that An@tomedica® and Thieme® provided valuable learning experience, class participation and were user-friendly programs.

Table 1 (continued)

Authors, year, country	Aim	Topic focus	Research design	Population/ sample	Intervention	Key findings
Koch, Andrew, Salamonson, Everett, and Davidson (2010), Australia	"To explore students' utilisation and perceptions of the benefit and value of a web-based intervention developed for a first-year Bachelor of Nursing bioscience unit."	Online/Virtual learning	Mixed methods, intervention study	Undergraduate nursing students (n = 553)	Web-based intervention to support learning through multimedia	The majority of students (81%) stated that web-based activities enhanced their learning, learning at their own pace (78%), and responding to their learning needs. Students positively perceived the use of glossary, quizzes, videos, learning resources and content delivery. Students suggested the integration of similar web-based activities in all modules.
Mather, Douglas, and Jane (2017), Australia	"To identify the opportunities to integrate digital professionalism into the curriculum: A comparison of social media use by health profession students at an Australian University in 2013 and 2016."	Online/Virtual learning, Social media use	Mixed methods, a cohort study	Undergraduate nursing students (n = 310 in the 2013 cohort; and n = 430 in the 2016 cohort)	n/a	Students used online media, journals, television, radio as a source of information. Students used mostly Facebook followed by Twitter, YouTube and LinkedIn. Students used social media to study and collaborate on group work and assignments.
Mawson (2014), Australia	"To determine if simulation aided by media technology contributes towards an increase in knowledge, empathy, and a change in attitudes in regards to auditory hallucinations for nursing students."	Clinical simulation	Quantitative, pre-post matched design	Undergraduate nursing students (n = 60)	Scheduled classroom learning activity using iPods	A simulation using iPods was an authentic learning experience of hallucination. iPods facilitated the development of compassion for patients with auditory hallucinations (from a score of 64% in the pre-test to 86% in the post-test). iPods improved students understanding of how they can interact therapeutically with the patient and a better understanding of the patient situation. The simulation increased the students' knowledge of auditory hallucinations. Students chose Bachelor of Nursing (BN) program due to previous experiences with nurses and doctors, and the ability to secure a job upon graduation. Blended learning was used to teach students. Students indicated that blended learning was flexible in terms of meeting their learning needs and facilitated access to learning resources. There is an assumed level of students' skills to use technology at entry level. Students received an insufficient orientation to the nursing program. International students found it difficult to adapt to the Australian educational system. Some students joined the program in the second year as a direct entry and missed the orientation provided in the first year. The programs such as Professional Communication Academic Literacy (PCAL) and Support and Peer Assisted Study Sessions (PASS) were beneficial to their learning. In the clinical placements, students put into practice the acquired knowledge. Clinical placement was an opportunity to improve oral communication skills for international students and to experience cultural differences and expectations.
McNally, Az-zopardi, Hatcher, O'Reilly, and Keedle (2019), Australia	"To explore the perceptions and experiences of students enrolled in the Bachelor of Nursing (BN)."	Bachelor of Nursing (BN) program, Blended learning	Qualitative, descriptive	Undergraduate nursing students (n = 30)	Blended learning was used to teach students	Blended learning was used to teach students. Students indicated that blended learning was flexible in terms of meeting their learning needs and facilitated access to learning resources. There is an assumed level of students' skills to use technology at entry level. Students received an insufficient orientation to the nursing program. International students found it difficult to adapt to the Australian educational system. Some students joined the program in the second year as a direct entry and missed the orientation provided in the first year. The programs such as Professional Communication Academic Literacy (PCAL) and Support and Peer Assisted Study Sessions (PASS) were beneficial to their learning. In the clinical placements, students put into practice the acquired knowledge. Clinical placement was an opportunity to improve oral communication skills for international students and to experience cultural differences and expectations.
Meedya, Moroney, Nielsen, and Najafi Bokar (2019), Australia	"To explore nursing students' experience in learning science concepts through a formative assessment task which was based on making a digital explanation."	Blended learning, Digital formative assessment	Mixed methods, sequential explanatory	Undergraduate nursing students (n = 428)	Creation of digital explanations through digital media such as podcast, slowmation, video, digital story or blended media	Students had first hand experiences of completing digital tasks through podcasts, videos, slowmation and digital stories. Searching for information assisted students to learn more about science. Deep learning by linking knowledge and nursing practice during the simulation and clinical experience. Issues included: Lack of feedback and grades to the undertaken tasks and challenges to use technology.
Oprescu, McAllister, Duncan, and Jones (2017), Australia	"To explore the needs in the professional development of Queensland based nurse educators."	Educators' technology experiences	Quantitative, cross-sectional	Nurse educators (n = 138)	n/a	The majority of participants indicated that the roles of nurse educators include: Communicator (96%), supporter (91%) and role model (91%). The desired areas for professional development were ICT research and publication skills. Nurse educators had challenges to teach in virtual classes, design learning and assessment activities, develop IT-supported activities and use the flipped classroom techniques.

(continued on next page)

Authors, year, country	Aim	Topic focus	Research design	Population/ sample	Intervention	Key findings
Phillips et al. (2013), Australia	"To identify students' perceptions of the Virtual Maternity Clinic; learning about the impact of the Virtual Maternity Clinic on the students' experience of its use and access, and learning about the level of student satisfaction of the Virtual Maternity Clinic."	Clinical simulation	Mixed methods, pre and post evaluations	Undergraduate students (n = 112); and postgraduate students (n = 28)	Virtual Maternity Clinic (VMC) interventions	Virtual Maternity Clinic (VMC) allowed students to learn about different cases of pregnant women. The characters used in VMC were realistic. VMC was useful to model the workplace practices. VMC enhanced students' knowledge and skills. VMC facilitated self-directed learning due to its online access and learning nature.
Raymond, Jacob, Jacob, and Lyons (2016), Australia	"To examine students' opinions of the experience of peer group online learning."	Blended learning, Online/Virtual learning	Qualitative, descriptive	Undergraduate nursing students (n = 35)	n/a	Online learning facilitated the communication between students and the faculty. Online learning was convenient, flexible. Online learning facilitated independent learning, group assignments and access to people's answers and/ or comments. The online discussion was preferred by students as a learning method. Online learning allowed students to balance life issues of work, studies and family. Face to face and blended approach was the most preferred for peer group learning. Issues included: Poor ICT skills, mark allocation and group dynamics.
Reid-Searl, Happell, and Vieth (2012), Australia	"To explore nursing students' perceptions of the use of high-fidelity silicone simulation, developed by one university academic to overcome these limitations."	Clinical simulation	Qualitative, exploratory	Undergraduate nursing students (n = 19)	High fidelity patient silicone simulation	High fidelity silicone simulation assisted in developing practical skills. Simulation prepared students for different clinical scenarios similar to those found in the clinical environment. The simulation allowed students to reflect on their own practices. Simulation helped students to deal with their fears, and development of confidence. The simulation allowed students to be actively involved in their learning. Nurse educators stated that new graduates had good computer operating skills.
Shin, Cummings, and Ford (2018), Australia	"To identify graduates' nursing informatics needs on entering the workplace in acute care settings from the perspectives of clinical nurse educators."	NI readiness	Qualitative, descriptive	Clinical nurse educator (CNEs) (n = 6)	n/a	Students get familiar with the computer through assignments and online learning. New graduates use informatics tools to access information. Experienced nurses assist new graduates on the use of technology. NI education at the orientation was provided by the organisation. Issues included: Insufficient information literacy, long process to obtain permission to access hospital systems and perform online tasks.
Smadi, Parker, Gillham, and Muller (2019), Australia	"What is the awareness and knowledge of Australian nursing educators about the Col framework?" "What is the participants' attitudes on the applicability of the Col framework to online nurse education courses?"	Blended learning, Col framework, Online/Virtual learning, Technology experiences	Mixed methods, cross-sectional	Nurse educators (n = 138)	n/a	The majority of nurse educators had extensive experience (> 6 years) in nursing education (84%) and curriculum design (48%). The majority of nurse educators (90%) perceived the importance of using the instructional designs and frameworks to build online courses. Most (90%) nurse educators indicated that blended learning was the most suitable teaching mode. Institutional support was essential in online course development. Nurse educators stated that the community of inquiry (COI) framework was applicable to nursing education. COI framework guided the teachers to initiate online discussions, provide direct instruction, and give technical support.
Stanley and Latimer (2011), Australia	"To evaluate the effectiveness and suitability of 'The Ward' as a simulation game to promote and support students' understanding of decision making, critical thinking and teamwork in clinical practice situations."	Clinical simulation	Mixed methods	Undergraduate nursing students (n = 96)	The Ward simulation game	The majority of students (83%) found simulation games relevant to practice. Simulation promoted the development of skills such as teamwork, critical thinking, decision making, delegation and conflict management. Students requested improvement in selecting better environment for simulation, practical scenarios and adequate scoring system.
Stupans, Baverstock, and Jackson (2019), Australia	"To gain an understanding of students' experiences of a newly designed assessment task which focused on the determinants of health: a photo-essay."	Digital assessment	Mixed-methods	Undergraduate nursing students (n = 30)	Photo-essay	Photo-essay enhanced students' critical reflection and deep learning. Photo-essay allowed students to connect health determinants to their local context.
Terry, Moloney, Bowtell, and Terry (2016), Australia	"To implement the online IVPE and evaluate student learning outcomes and perceptions of device use."	Blended learning, Clinical simulation, Online/Virtual learning	Mixed-methods	First-year nursing students (n = 179)	Implementation of online Intravenous Pump Emulator (IVPE)	Nursing students found that IVPE simulation was realistic and promoted authentic learning. Easy access and use of IVPE irrespective of the time and location. Most students stated that instructions and resources were helpful. Students were confident to use IVPE.

Table 1 (continued)

Authors, year, country	Aim	Topic focus	Research design	Population/ sample	Intervention	Key findings
Terry, Terry, Moloney, and Bowtell (2018), Australia	“To compare the retention of competence in using an IV infusion pump among nursing students trained in its use using three different protocols.”	Blended learning, Clinical simulation, Online/Virtual learning	Quantitative, descriptive, quasi-experimental	First-year undergraduate nursing students (n = 102)	Intravenous infusion pump simulation	The performance of students significantly improved when combining online and on-campus simulation (ONL+ONC). Students who used only on-campus simulation (ONC) performed the worst. More students completed their activities when using a combination of ONL+ONC simulations than ONC or ONL simulations as standalone.
Todhunter, Hallawell, and Pittaway (2013), Australia and UK	“To discuss the design and initial progress made with a virtual learning environment to help student nurses develop an understanding of cultural awareness and globalisation.”	Digital assessment, Online/Virtual learning	Qualitative, descriptive	Undergraduate nursing students (n = 24)	Implementation of a virtual exchange project	Students provided pictures and photographs representing cultural artefacts. Students uploaded the pictures into the repository. Socratic line of inquiry guided learning exchanges. Photographs prompt reflection and discussion about health disparities, rural health and lifestyle, environmental influence on the wellbeing and resource provision. The health systems and laws impacting on care delivery in Queensland and Nottingham were different.
Turnbull, Royal, and Purnell (2011), Australia	“To develop nursing students’ information literacy skills through interdisciplinary partnership.”	Digital literacy	Mixed methods, evaluation study	Undergraduate nursing students (n = 174)	Implementation of a collaborative embedding process to develop students’ information literacy	The knowledge to use library resources improved after the intervention, and students were confident. The implementation of virtual classes required a collaborative approach (academic learning support facilitator, unit coordinator, team coordinator and librarian). Six modules developed were developed to improve information literacy of students. A virtual classroom facilitated teaching external students and the librarians provided technological support through Learnline or “drop in” library sessions.
Warland, Smith, and Smith (2012), Australia	“To discuss the design and implementation of an online e-role play for a large class of undergraduate nursing and midwifery students.”	Online/ Virtual learning	Mixed methods	Undergraduate nursing and midwifery students (n = 143); Nursing faculty (n = 13)	Design and implementation of e-role play for a large class	Students were motivated by teachers to participate in online activities. Students indicated that e-role promoted active learning and collaborative learning. E-role helped students understand their roles as registered nurses and registered midwives. E-role provided an enriched educational experience through Moodle. E-role modelled the real-world environment. Issues included: Much time spent to accomplish the task and distant geographical students.

ity of them being under 25 years of age. There were variations in the sample of nurse educators, and in one study, more than 48% had extended experience in curriculum development of more than 6 years.

The selected 26 studies covered a wide range of technology usage in nursing education, and some of them covered multiple aspects simultaneously (Table 1). Few topics focused on the concept NI ($n = 1$), readiness to use NI ($n = 1$), the process for embedding technology in the undergraduate curricula ($n = 2$). The majority of selected studies focused on informatics tools to support learning and teaching, which included clinical simulation ($n = 9$), online or virtual learning ($n = 11$), blended learning ($n = 7$), digital assessment—photographs/photo essays ($n = 2$), e-role play ($n = 1$), and digital formative assessment ($n = 1$). Few studies focused on educators' experiences ($n = 2$) and students' digital skills ($n = 1$).

Four main themes arose from the summary of the data, some of which included subthemes. Themes and subthemes are discussed in turn with supporting evidence from relevant studies. These themes are (i) Expectations for integrating NI in undergraduate nursing education, (ii) NI in undergraduate nursing programs, (iii) Facilitating factors, and (iv) Inhibiting factors.

4.1. Expectations for integrating nursing informatics in nursing education

Embedding nursing informatics in undergraduate nursing education is expected to impact nursing education and practice positively. NI is used to enhance teaching and learning in the classroom, clinical simulations, and clinical placements (Andrew, Maslin-Prothero, & Ewens, 2015; Brown & McCrorie, 2015; Klein et al., 2019; Terry, Terry, Moloney, & Bowtell, 2018).

The use of technology in nursing education prepares nursing students to provide quality care in a technology-mediated environment and better understand their roles as registered nurses [RNs] in disease prevention and containment (Warland, Smith, & Smith, 2012). In understanding their roles, students are able to link theory to practice and model workplace practices (Meedya, Moroney, Nielsen, & Najafi Bokhat, 2019; Phillips et al., 2013; Reid-Searl, Hapell, & Vieth, 2012; Stanley & Latimer, 2011).

ICT in undergraduate nursing education allowed students to be actively involved in their learning and develop skills in various clinical situations (Carlson et al., 2019; Ferguson et al., 2016; Reid-Searl et al., 2012; Warland et al., 2012). Furthermore, when students interacted with informatics tools, it enhanced their digital health literacy, and increased their confidence to use technology to support their studies and later in nursing practice (Andrew et al., 2015; Carlson et al., 2019; Ferguson et al., 2016; McNally, Azopardi, Hatcher, O'Reilly, & Keedle, 2019; Reid-Searl et al., 2012; Terry, Moloney, Bowtell, & Terry, 2016).

4.2. Nursing informatics in the undergraduate nursing program

4.2.1. Structure of undergraduate nursing programs

Exploring how NI is integrated into nursing education goes hand in hand with understanding the structure of undergraduate nursing programs. In Australia, the undergraduate nursing program is subdivided into two program types: bachelors of nursing (BN) and double degrees (nursing and either midwifery, paramedicine, or early childhood education, for example). One study indicated that nursing program duration ranges from six semesters for single degrees and eight semesters for double degrees (Bogossian et al., 2018). Furthermore, Bogossian et al. (2018) reported that the majority of nursing programs are offered in an on-campus mode in either face to face or blended delivery. A BN degree's total hours ranged from 1484 to 7600 hours, with theoretical instructions covering 355 to 3600, clinical experience from 760 to 1600, and simu-

lated clinical experiences from 0 to 296. Conversely, the total hours for a double degree program ranges from 1492 to 3280, with theoretical hours covering 509 to 1260 hours, clinical experience from 800 to 1600 hours and simulated clinical experience from 103 to 320 hours (Bogossian et al., 2018).

4.2.2. Nursing informatics in undergraduate nursing curricula

The integration of NI into undergraduate nursing education is recommended by the ANMAC; however, the process differs across educational institutions (Cummings et al., 2016; Smadi, Parker, Gillham, & Muller, 2019; Turnbull, Royal, & Purnell, 2011). The majority of the studies in this review focused on the integration of informatics tools in nursing education to support teaching and learning in classroom and simulation sessions through face-to-face, online or blended learning. Two studies highlighted the process followed to integrate technology into undergraduate nursing curricula (Cummings et al., 2016; Smadi et al., 2019), and one study focused explicitly on embedding NI into the curricula (Cummings et al., 2016). The educational scaffolding and modular development framework guided the inclusion of NI into the curriculum (Cummings et al., 2016). Cummings et al. (2016) reported that NI was overtly found in 21 of 25 units of the entire program in a 3-year degree. The inclusion of NI in the nursing curriculum was guided by TIGER and the Canadian Association of Schools of Nursing entry-level competencies (Cummings et al., 2016). In another study, a Community of Inquiry framework (COI) was used to investigate its applicability in online and blended courses in nursing schools in Australia (Smadi et al., 2019). The COI framework addresses the nexus of pedagogy, technology and learner's needs (Smadi et al., 2019).

4.2.3. Digital devices usage in nursing education

Nursing students used digital devices such as computers, laptops, iPads, iPods and Smartphones to communicate, access educational applications and learning materials in the face to face classes, virtual classes and clinical laboratories (Brown & McCrorie, 2015; Ferguson et al., 2016; Mawson, 2014). Furthermore, these devices enabled students to communicate and collaborate with their peers and the faculty through social media platforms such as Facebook, Skype, Twitter and YouTube (Bogossian et al., 2018; Ferguson et al., 2016; Mather, Douglas, & Jane, 2017). Social media facilitated safe collaboration, independent learning, access to resources and collaboration during group work and assignments (Ferguson et al., 2016; Mather et al., 2017). Students used social media, journals, television and radio as sources of information (Mather et al., 2017).

4.2.4. Digital literacy of nursing students and teaching faculty

Nursing graduates are expected to be digitally literate, and improving their NI-related skills is important at the educational level (Shin, Cummings, & Ford, 2018). Nursing students are assumed to be technologically savvy, and they acquire knowledge from high school, which later they use to support their learning; however, international students from less-resourced countries may not have the knowledge and skills to use digital tools (McNally et al., 2019; Terry et al., 2018). Digital literacy includes computer literacy and information literacy (Shin et al., 2018). Computer literacy is concerned with operating mechanical components of the computers and using computer programs and applications (Shin et al., 2018); whereas, information literacy determines when the information is required and where to locate it. Information literacy supports the integration of evidence-based practice into clinical settings (Shin et al., 2018). Shin et al. (2018) indicated that nursing graduates acquired NI skills during orientation programs and their 6-month transition into the ward. Delayed access to hospital computer systems was a barrier to NI's implementation in

practice (Shin et al., 2018). Developing nursing students' information literacy required multidisciplinary approaches and concerted effort (Turnbull et al., 2011). The presence of an information literacy module, and student facilitation, both face to face and on-line, were essential for technological support (Turnbull et al., 2011). Preparing students for study and clinical placement was reported by McNally et al. (2019). This preparedness is achieved through orientation for both class and clinical teaching, and Professional Communication Academic Literacy (PCAL), Support and Peer Assisted Study Sessions (PASS) were reported beneficial (McNally et al., 2019).

Nurse educators' digital and pedagogical competencies were essential for implementing online and blended learning programs (Oprescu, McAllister, Duncan, & Jones, 2017; Smadi et al., 2019). However, the teaching faculty reported insufficient digital literacy, lack of skills to teach in a virtual environment, and to design learning and assessment activities (Oprescu et al., 2017).

4.2.5. Mode of delivery of instructions

In nursing education, the mode of delivery of instructions included online learning and blended learning. Technology-supported teaching strategies are essential to develop nursing students' competencies (Andrew et al., 2015; Klein et al., 2019; Raymond, Jacob, Jacob, & Lyons, 2016; Turnbull et al., 2011). On-line or virtual delivery of instructions facilitated teaching students remotely and access to library resources and recordings irrespective of location and time (Andrew et al., 2015; Raymond et al., 2016). Furthermore, virtual learning facilitated students' academic and social engagement by asking questions, sharing their opinions, getting instant feedback, and collaborating with peers and teachers (Andrew, Maslin-Prothero, & Ewens, 2015; Koch, Andrew, Salamonson, Everett, & Davidson, 2010; Raymond, Jacob, Jacob, & Lyons, 2016). The access to the web-based application was either synchronously in real-time or asynchronously with a time delay (Andrew et al., 2015; Todhunter, Hallawell, & Pittaway, 2013; Warland et al., 2012).

Blended learning combined online and face-to-face learning and teaching (Andrew et al., 2015; McNally et al., 2019; Smadi et al., 2019; Terry et al., 2016; Terry et al., 2018). A study by Terry et al. (2018) observed blended learning improved students' performance significantly more than face to face (on-campus) or online as standalone.

Online and blended teaching and learning were positively perceived; however, teaching and assessment in virtual classes were more challenging (Oprescu et al., 2017; Warland et al., 2012). Other challenges to online and blended learning were time constraints, poor digital literacy, lack of expertise and guidelines to teach in virtual classes and simulation laboratories (Bogossian et al., 2018; Raymond et al., 2016; Warland et al., 2012).

4.2.6. Learning activities and assessment

Numerous online platforms and computer-assisted learning programs (CAL) supported teaching and learning activities, and assessment (Bogossian et al., 2018; Kable, Arthur, Levett-Jones, & Reid-Searl, 2013; Klein et al., 2019; Mawson, 2014; McNally et al., 2019; Meedy et al., 2019; Phillips et al., 2013; Reid-Searl et al., 2012; Stanley & Latimer, 2011; Stupans, Baverstock, & Jackson, 2019; Todhunter et al., 2013). Online platforms included LMS, Podcasts, Webinars, and Zoom® while computer-assisted learning programs (CAL) were Thieme®, An@tomedia Online®, and AnatomyTV® (Klein et al., 2019).

Technology-enabled clinical simulations were used as teaching and learning strategies in undergraduate nursing education. Clinical simulations included Virtual Maternity Clinic (VMC), high-fidelity manikin (Laerdal SimMan 3G), actor simulation with a Mask-Ed, mental health simulations with professional actors, e-role

play, intravenous pump emulator (IVPE), and commercial scenarios and MASK-EDTM Technology (Bogossian et al., 2018; Brown et al., 2012; Kable et al., 2013; Mawson, 2014; Phillips et al., 2013; Reid-Searl et al., 2012; Stanley & Latimer, 2011; Terry et al., 2016; Terry et al., 2018). The importance of technology-enabled simulations was recognised before or as a substitute for clinical placement (Bogossian et al., 2018). Students observed their peers performing simulations in the same room, adjacent room or via video streaming (Bogossian et al., 2018). Simulation using high fidelity patient silicone and simulation games were realistic and relevant to practice (Reid-Searl et al., 2012; Stanley & Latimer, 2011; Terry et al., 2016). Technology-enabled simulations helped students to develop confidence and feel more comfortable when performing tasks in the clinical environment (Reid-Searl et al., 2012).

Technology-enhanced assessment was reported in four studies (Meedy et al., 2019; Stupans et al., 2019; Todhunter et al., 2013; Warland et al., 2012). Two studies (Stupans et al., 2019; Todhunter et al., 2013) reported using photo essays/ photographs, which were innovative assessment strategies to enhance student reflection, deepen learning, and prompt discussions about health determinants and disparities. In one study (Warland et al., 2012), teachers used e-role play to motivate students to participate in online activities. This type of assessment allowed students to collaborate on learning tasks (Warland et al., 2012). Meedy et al. (2019) used digital formative assessment tasks in a science subject where students had to develop digital media, such as podcast video, digital story or blended media. Digital assessment enhanced their understanding of the subject by linking knowledge to practice (Meedy et al., 2019).

4.3. Facilitating factors

Enabling factors such as collaborative partnership, institutional support, and readiness to embrace technology favour the integration of NI into undergraduate nursing curricula (Cummings et al., 2016; Ferguson et al., 2016; Fox, Flynn, Clauson, Seaton, & Breen, 2017; Terry et al., 2016; Terry et al., 2018). Multidisciplinary collaboration and partnership were observed among people involved in curriculum development such as faculty members with expertise in curriculum development and course content, specialists in NI, and a writing team (Cummings et al., 2016). Two studies (Cummings et al., 2016; Turnbull et al., 2011) identified people involved in integrating technology in undergraduate curricula, including academic learning support facilitators, unit coordinators, team coordinators, and librarians.

Institutional support to both students and faculty was also reported to be instrumental in implementing NI (Ferguson et al., 2016; Smadi et al., 2019; Turnbull et al., 2011). Support was offered through ICT platforms such as Learnline, LMS, and social media (Ferguson et al., 2016; Turnbull et al., 2011). Student support was also provided through face-to-face interactions or "drop-in" sessions (Turnbull et al., 2011).

Staff readiness to embrace technology was reported to be a cornerstone to the success of NI. The presence of specialists in NI and experts in online course development helped the faculty develop adequate course content (Cummings et al., 2016); and the availability of educators' training packages were reported to improve their digital literacy and competencies to teach NI to the students (Cummings et al., 2016).

4.4. Inhibiting factors

The studies in this review revealed challenges that hindered the incorporation of NI into undergraduate nursing curricula. These included disparities of the content of NI in Australia (Cummings et al., 2016), along with a lack of nurse educators'

skills in NI, particularly in the use of informatics tools in education and simulation (Bogossian et al., 2018; Cummings et al., 2016; Oprescu et al., 2017). For instance, clinical simulations were hindered by a lack of: time, technical support, academic support, appropriate and sufficient equipment, simulation experiences, and access to a dedicated simulation environment (Bogossian et al., 2018).

Another inhibiting factor was the lack of guidelines and/or frameworks to develop NI and guide the integration of technology in the curriculum (Andrew et al., 2015; Smadi et al., 2019) and in designing learning activities and assessing achievement of skills (Meedya et al., 2019; Oprescu et al., 2017). Students' poor ICT literacy and limited access to ICT tools and applications were also reported to be a challenge (Brown & McCrorie, 2015; Raymond et al., 2016). Evidence shows that there is limited exposure to NI due to a lack of opportunity to interact with NI during the clinical placement, mainly caused by ethical issues to access patient data in health systems in hospitals (Shin et al., 2018).

Although there is evidence of the integration of NI in undergraduate nursing education, few studies described the process of developing a curriculum that integrates the NI competencies expected among nursing students (Cummings et al., 2016; Smadi et al., 2019; Turnbull et al., 2011).

5. Discussion

With the rapid advancement of technology and rapid transformation of the health sector, health/nursing informatics policies, standards and frameworks have been developed for registered nurses and other healthcare professionals (ACN, 2017; ADHA, 2017, 2020; Australian Health Informatics Education Council, AHIEC, 2011; ANMF, 2015, 2018). Nursing education institutions, Nursing and Midwifery Board of Australia (NMBBA), and other organisations in Australia have made efforts to integrate NI into undergraduate nursing education (ACN, 2017; ADHA, 2020; AHIEC, 2011; ANMAC, 2018; ANMF, 2015, 2018). NI is applied to all nursing sectors, including nursing education, nursing services, research and administration (Faustorilla, 2020). To reiterate, this scoping review aimed to provide an overview of the published literature on the integration of NI in undergraduate nursing education in Australia before COVID-19.

This scoping review revealed that before COVID-19, the concept of NI in undergraduate nursing programs was scarce in the empirical literature, and much of the focus was on the use of informatics tools to support teaching and learning in nursing education. Developing students' NI competencies was done through online learning, blended learning and technology-enabled simulations (Bogossian et al., 2018; Meedya et al., 2019; Smadi et al., 2019; Terry et al., 2016; Terry et al., 2018). Informatics tools enhanced the active involvement of the students in their studies and increased their confidence to interact with digital tools (Brown et al., 2012; Carlson et al., 2019; Klein et al., 2019; McNally et al., 2019; Terry et al., 2018). Technology advancements can support transformational outcomes of high quality and evidence-based care and education (Braithwaite et al., 2020; Sheikh et al., 2021; World Health Organisation (WHO), 2016). Technology is increasingly used in nursing practice to support the nursing process, quality care, and electronic nursing documentation (Jouparinejad, Foroughameri, Khajouei, & Farokhzadian, 2020; Laitinen, Koivu, Nykänen, & Kimaro, 2020; Smaradottir, 2018).

In this scoping review, a few studies explored the actual concept of NI, competencies in NI, and the process for developing and implementing the NI curriculum. NI is fundamental in all healthcare systems levels (Australian Digital Health Community, ADHC, 2017). Nursing students' preparation to carry out NI tasks requires their capacity building in computer literacy and infor-

mation literacy (Shin et al., 2018). O'Connor & LaRue (2021, p. 3) explained that core informatics competencies for students to achieve included six domains: health service literacy, information and communication technology literacy, information management, information system management, and patient/health literacy. The capacity building in nursing informatics should be done during students' orientation, both on campus and in clinical settings, and the role of the experienced staff in NI are pivotal to graduates' informatics practice (Shin et al., 2018). Furthermore, it is crucial to state "the core competencies students will gain each year, and they spiral upwards towards achieving the overall knowledge of becoming a nursing practitioner competent in the knowledge and practice of digital health" (O'Connor & LaRue, 2021, p. 3).

In Australia, nursing organisations and experts in nursing informatics have described the NI competencies and digital capabilities for nurses and midwives (ADHA, 2020; AHIEC, 2011; Cummings et al., 2016). Embedding NI into undergraduate nursing curricula should consider national and international initiatives in health/ nursing informatics (Cummings et al., 2016). The ADHA (2020) developed a framework that depicts the domains and capability levels to support individuals' and organisations' digital health development. This framework could be used as a tool to guide nursing education institutions to devise strategies to integrate digital health into their curricula. Integrating informatics competencies into undergraduate curricula will ensure that students are equipped with the necessary skills to work in a digital health environment (ADHA, 2017, 2020).

Adequate integration of NI into the undergraduate nursing curriculum was hindered by numerous factors such as the disparity of NI content in Australia (Cummings et al., 2016), lack of skills to teach NI (Bogossian et al., 2018; Cummings et al., 2016; Oprescu et al., 2017), and a lack of standardised guidelines and frameworks to help develop NI content and guide the integration of technology in the curriculum (Andrew et al., 2015; Cummings et al., 2016; Smadi et al., 2019). Furthermore, challenges included students' poor computer literacy and limited access to ICT tools during students' clinical placements (Brown & McCrorie, 2015; Raymond et al., 2016; Shin et al., 2018). Restrictions and rules hindered students' use of informatics tools in the clinical environment to access hospitals' health systems. Having clearly articulated NI competencies, policies and guidelines may address the lack of skills and awareness of NI among the workforce (Harerimana et al., 2020; Honey & Procter, 2017).

This scoping review provides a baseline for how NI was embedded and integrated into nursing education in Australia before COVID-19 compelled universities to adopt an extensive reliance on ICT to deliver their education. Hence, a follow-up study is recommended to explore the impact of these unprecedented times on the rapid and forced integration of ICT and informatics on nursing education.

6. Limitations

In this scoping review, selected articles were limited to peer-reviewed studies published in English, ranging from 1 January 2010 to 31 January 2019. Although this review described the protocol that guided the scoping review process, some studies might have been missed. Additionally, this scoping review considered only empirical research; thus, it may not capture fully or provide an accurate reflection of the work that nursing programs had done to incorporate NI into their curricula before COVID-19.

7. Conclusion

In recent years, NI has been identified as a subject that could be taught to nurses. The current scoping review revealed that be-

fore COVID-19, most empirical studies in Australia focused on how technology was integrated into undergraduate nursing education to facilitate learning and teaching in classroom simulation laboratories and clinical environments. A small number of empirical papers explored the concepts of NI and how it was embedded into the curriculum. Embedding NI into nursing education was hindered by numerous challenges such as disparities of the NI content, poor digital literacy, lack of guidelines and/ or frameworks to guide the integration of NI in the nursing curriculum, and the paucity of the NI empirical studies around the actual integration process. With an increasing digitalised health sector, nursing schools are expected to produce digitally competent nursing graduates. Successful integration of NI would require the availability of evidence-based NI standards, frameworks and technology readiness to advance nursing education and practice at the same pace of technology advancements. Embedding NI in the undergraduate program is fundamental to ensuring optimal nursing education and quality healthcare delivery in a technology-led environment.

Authorship contribution statement

Alexis Harerimana: Study design, data collection, data analysis, manuscript writing, critical revisions for important intellectual content, **Kristin Wicking:** Study design, data analysis, study supervision, manuscript writing, critical revisions for important intellectual content, **Narelle Biedermann:** Study design, data analysis, study supervision, manuscript writing, critical revisions for important intellectual content, **Karen Yates:** Study design, data analysis, study supervision, manuscript writing, critical revisions for important intellectual content.

Ethical statement

Authors affirm that no ethical approval was needed for this scoping review because the data were obtained from published studies where primary investigators adhered to the ethical requirements.

Conflict of interest

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Supplementary materials

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