Nursing students' preparedness for the digitalised clinical environment in Australia: An integrative review

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A B S T R A C T

Aim: The aim of this integtrative review is to examine the literature on nursing students preparedness for the digitalised clinical setting.
Background: Digital literacy skills ensure nursing students can provide quality and safe care to patients in a digitalised clinical setting.
Design: Integrative review of the literature.
Methods: The integrative review of the literature incorporated Whittemore and Knafl's (2005) framework and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2021 statement. A review of the literature comprised of a search of the following databases: ERIC, Scopus, CINAHL, Medline, Cochrane Library and Google Scholar from 2010–2022. Data were critically appraised using the Critical Appraisal Skills Programme (CASP), the Mixed Method Tool (MMAT) and Joanna Biggs Institute (JBI).
Results: The literature reported on nine studies from 2010 to 2022. The four themes identified using Braun and Clarke's thematic analysis were curriculum design, education and training, digital literacy level and professional digital literacy competency standard framework. Major findings include the need for the development and integration of a professional digital literacy competency standard framework embedded into nursing curricula to equip nursing students with appropriate digital literacy skills to navigate digitalised healthcare settings.
Conclusion: Current registered nurses and preregistration nurses are required to be upskilled with the understanding and knowledge of health informatics and its role in the clinical setting. This will enable future registered nurses to keep up with the rapidly evolving technological clinical environment.

1. Introduction

Due to the fast paced evolving world of digital technology all nurses need to be equipped with appropriate digital literacy and information communication technology (ICT) skills to provide efficient and safe nursing care (Brown et al., 2020; Kuek et al., 2020; Sharma et al., 2019). Digital literacy involves the capacity to locate, analytically use and disseminate data using digital devices (Roche, 2017). Universities are obliged to prepare nursing students to work in a digitalised clinical environment. However, an upsurge in student enrolments and diversity in student cohorts globally has constrained academics' ability to address nursing students' varying levels of digital literacy skills at university (Bednarz et al., 2010; Roche, 2017).

2. Background

Worldwide, informatics is being embedded into nursing curricula in countries such as the United States of America (USA), Canada and the United Kingdom (UK) (Sorensen and Campbell, 2016; Gonen et al., 2016; Baillie et al., 2013). In Australia in 2020, a National Nursing and

Midwifery Digital Health Capabilities Framework was implemented which acknowledges the ongoing changes in digital technology that occur in the healthcare sector (HISA, 2020). In July 2018, the Australian Digital Health Agency (ADHA) developed a strategy, "Framework for Action", that supports how Australian health information systems will share data to improve patient care and safety (Australian Digital Health Agency 2018b). This requirement is reflected in the Australian Nursing and Midwifery Accreditation Committee (ANMAC) standard 3.4 which states that teaching and learning needs to reflect contemporary practices in nursing, health and education. This includes responding to emerging trends such as advances in technology (ANMAC, 2019). The National Nursing and Midwifery Digital Health Capability Framework (2020) recommends that digital literacy is embedded across nursing and other health disciplines with the 5 domains: Digital Professionalism, Leadership and Advocacy, Data and Information Quality, Information Enabled Care and Technology. This will ensure our future health professionals provides safe quality and connected person centred care (Australian Digital Health Agency, 2020).

Several states in Australia currently support and encourage public hospitals to implement electronic medical record (EMR) systems (New South Wales (N.S.W) Government, 2014; Victoria State Government, 2017–2019). In today's healthcare system, nurses are expected to have information communication technology (ICT) skills which are referred to as e-health literacy that is a term used in some of the literature (Tubaishat and Habiballah, 2016). However, traditional nursing curriculum are less focused on the development of ICT skills (Mather and Cummings, 2016). This raises the question of whether nursing students are prepared and equipped with adequate digital literacy skills to cope with the rapid change in technology in universities. At present nursing students are taught basic digital literacy skills and provided with free internet connection, the use of computers in libraries and technical assistance required for the university environment. However, the skills needed to work effectively in the clinical environment are not adequately addressed in many nursing educational departments. This review will highlight the educational needs of student nurses so that they are satisfactorily prepared for the digitalised workforce.

2.1. Aim

The specific aims of this integrative review is to examine the literature on nursing students preparedness for the digitalised clinical setting. The below questions outline the foundations of this review

1. What evidence exists about nursing students preparedness for the digital healthcare environment?
2. What are the factors that contribute to gaps in nursing students' digital literacy competency?

The objective is to conduct a review of the literature and examine the current landscape of research findings around nursing students' digital literacy levels gaps in Australia and critically analyse the data.

3. Methods

3.1. Design

An integrative review of the literature incorporating Whittemore and Knafl's framework (2005) was chosen as it includes research of both experimental and non-experimental studies. This framework consisted of five steps: problem identification; literature search; data evaluation; data analysis and presentation (Whittemore and Knafl, 2005). The literature search explored nursing students' levels of digital literacy skills, university curricula (such as nursing and computer informatics) and nursing education preparation for a digitalised clinical setting. The PRISMA flow chart illustrates the number of records identified and clarifies the selection process of studies (inclusion/exclusion criteria).

The critical appraisal of the articles included in the review was conducted using the appropriate critical appraisal tool for each article. The stages of the appraisal tool/s for the review included a search of the literature, appraisal of included articles, reading and extracting data from the articles, amalgamating the data into a summary table and identifying major themes which configured the recommendations.

3.2. Problem identification

In the current clinical healthcare settings, patient information is entered and stored in digital health platforms. To date educational providers only teach nursing students how to enter patient data using the traditional paper-based format. Currently, in Australia and worldwide there is limited knowledge about nursing students' experience and skill level in the use of digital health technology in the clinical environment. Therefore, this review aims to examine the research related to nursing students' digital literacy skills competency and their preparedness for the digitalised clinical environment in Australia.

3.3. Literature search

A review of the literature comprised of a search of the following databases: ERIC, Scopus, CINAHL, Medline, Cochrane Library and Google Scholar from 2010 to 2022 and limited to the English language. The research focused on the following keywords: student nurse, registered nurse, undergraduate nursing students, digital technology, digital literacy, computer informatics, nursing/health informatics, electronic medical record, nursing education. information communication technology, knowledge, experience preparedness and Australia (Table 1).

3.4. Inclusion criteria

The review considered any qualitative, quantitative, mixed methods or literature review articles relevant in Australia that investigated nurses and nursing students' digital literacy skills, experience, educational institution's hindrances, curriculum gaps, assistance with nursing student knowledge and preparedness for the digitalised clinical environment between 2010 and 2022 in the English language. All articles included in the selection criteria were synthesised and a thematic analysis (Braun and Clarke, 2006) was formed and discussed in the discussion and findings (Fig. 1).

3.5. Exclusion criteria

Studies conducted and published in other counties and not in the English language prior to 2010. Any studies that involved medical and postgraduate students as they have prior tertiary qualifications.

3.6. Critical appraisal

The nine studies were each assessed using the appropriate appraisal tool. The Critical Appraisal Skills Programme (CASP) checklist was used for the five (5) quantitative research papers and one (1) qualitative study (CASP, 2021). The two (2) mixed method studies were reviewed using the Mixed Method Tool (MMAT) (Hong et al., 2018) and one (1) scoping review paper Joanna Briggs Institute (JBI) for Systematic Review (JBI, 2020) critical appraisal tool was used (Aromataris et al., 2015). A score was allocated by researcher (AS) to each study according to the methodological quality. The rating is as follows: The CASP checklist reported for each criterion as yes, no, clear or unclear. The MMAT tool scored yes or no for each criterion and the JBI tool recorded yes, no unclear of not applicable (NA) for each criterion (Table 3).

3.7. Data evaluation and extraction

Data were extracted from studies that used a purpose-designed data

Table 2

Summary table.

Author	Theme/s	How the theme/s was developed
Mather and Cummings (2016)	Curriculum	Mobile health technology for learning needs to be implemented into the curriculum
Cummings et al. (2016)	Curriculum Education Competencies	Embed nursing informatics into Australian universities undergraduate curriculum. Nursing Informatics educational preparation of graduate nurses Workforce entry level of NI competencies
Roche (2017)	Digital literacy Curriculum	Students need to be digitally literate to engage in learning through online technologies Curriculum design need to make sure they equip students with digital literacy skills.
Morgan (2018)	Digital literacy Curriculum	Student diversity result in variable levels of digital literacy. Underprepared with basic software skills. Digital literacy to be included in the curriculum
Kuek and Hakkennes (2020)	Digital literacy	70–80% respondents reported high digital literacy levels, expressing confidence in using digital technology. Anxiety was reported by one-fifth of respondents using information systems.
Mollart et al. (2020)	Education Curriculum	Educational need for simulation training of the EMR system in preparing undergraduate nursing students for clinical practice. Implementation of EMR program into undergraduate nursing curricula will better prepare and enhance nursing students' confidence level.
Brown et al. (2020)	Digital literacy Competencies	Basic computer knowledge and skills Able to use the internet to locate and download (97.6%) at least confident. Applied computer skills Only (55%) of participants considered their applied skills to be at least competent. (27.7%) rated as at least proficient. (21%) rated as not confident
Harerimana et al. (2022)	Education Competencies Digital Literacy	Barriers in nursing education relate to disparities of informatic content. Lack of guidelines and frameworks Poor digital literacy skills
Lokmic-Tomkins et al. (2022)	Digital literacy Education Curriculum	Nursing students have baseline digital literacy skills Digital literacy educational interventions are required to enhance nursing students' digital literacy skills. Scaffold across nursing programs to ensure smooth transition into the digitalised workforce.

Table 1

Search strategy.

Search	Keywords
1	Undergraduate nursing student
2	Undergraduate nursing student OR nursing student
3	Undergraduate nursing student OR registered nurse
4	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology
5	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy
6	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy OR computer informatics
7	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy OR computer informatics AND nursing informatics
8	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy OR computer informatics OR nursing informatics AND information communication technology
9	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy OR computer informatics OR nursing informatics OR information communication technology AND nursing education
10	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy OR computer informatics OR nursing informatics OR information communication technology OR nursing education AND preparedness
11	Undergraduate nursing student OR nursing student OR registered nurse AND digital technology OR digital literacy OR computer informatics OR nursing informatics OR information communication technology OR nursing education OR preparedness AND Australia

3.8. Data analysis

The data analysis consisted of detecting recurring themes of nursing students and/or nurses digital literacy skills needed for the digitalised clinical environment and whether these findings assisted higher educational institutions in preparing new graduate nurses for the digitalised clinical setting (Braun and Clarke, 2006). The nine (9) selected articles were read to ascertain how they answered the research question. This was accomplished by reading and re-reading the articles and distinguishing how common themes arose. The following steps were applied in analysing the articles: Similarities in each article were highlighted

(1) The articles were re-read to validate recurring similarities and to identify limitations
(2) The similarities were grouped into themes
(3) Data obtained from the articles were allotted into a summary table (Table 2).
(4) Potential bias was eliminated by following the appropriate critical appraisal checklist and Braun and Clarke's (2006) six- step approach to thematic analysis.

4. Presentation of results

The overall search of the literature revealed 22 studies that were limited to Australia. A further review identified nine (9) articles that aligned with the title and inclusion criteria. Out of the nine (9) articles comprised in this integrative review, five (5) were quantitative studies,

extraction form independently reviewed by two authors (AS and RO) with a third author (AG) resolving any discrepancies through discussion and consensus. To remove the possibility of bias the data evaluation was further discussed by several members of the research team who came from different disciplines including nursing, computer science and education. The final data extraction was developed by consensus. Fields extracted included author, setting, study aim, sample population, sample size, study methodology (including randomisation techniques and allocation concealment), intervention/s, outcome measures and study findings. This method aligned with the aims of the study to capture data-rich information.
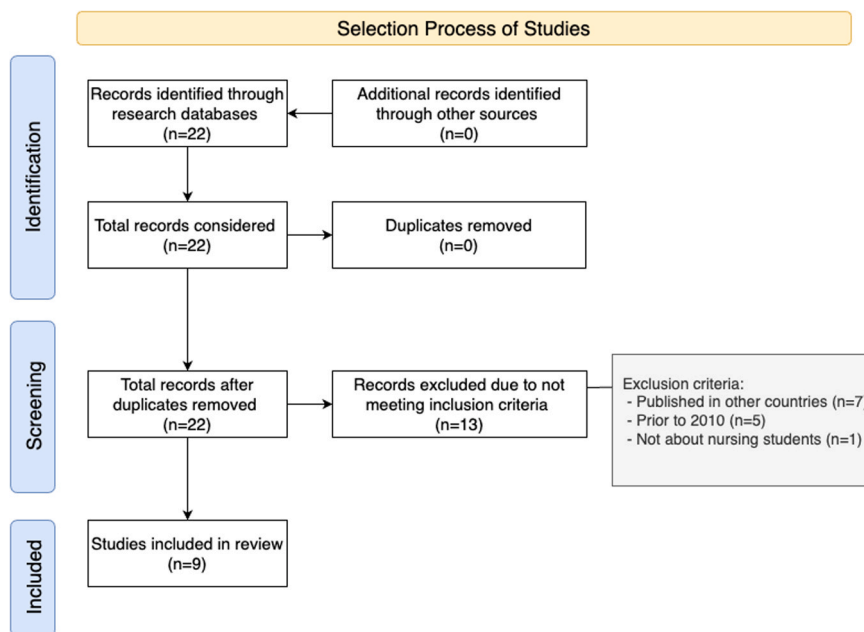
Fig. 1. PRISMA 2020 flow diagram.

Table 3.2
Critical appraisal quantitative studies.

CASP Critical Appraisal Criteria	Did the study address a clearly focussed issue?	Was the cohort recruited in an acceptable way?	Was the outcome accurately measured to minimise bias?	What are the results of the study? (clear)	How precise are the results of the study? (clear)	Do you believe the results?	Can the results be applied to the local population?	Do the results of the study fit with other available evidence?	What are the implications of this study for practice?	Total
Morgan (2018)	Yes	Yes	No	Clear	Clear	Yes	Yes	Yes	Clear	8
Kuek and Hakkennes (2020)	Yes	Yes	No	Clear	Clear	Yes	Yes	No	Clear	7
Lokmic-Tomkins et al. (2022)	Yes	Yes	No	Clear	Clear	Yes	Yes	Yes	Clear	8
Brown et al. (2020)	Yes	Yes	No	Clear	Clear	Yes	Yes	No	Clear	7
Mather and Cummings (2016)	Yes	Yes	No	Clear	Clear	Yes	Yes	Yes	unclear	6

Table 3.3
JBI Appraisal Tool – Systematic Review.

JBI Critical Appraisal Checklist	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?
Harerimana et al. (2022)	Yes	Yes	Yes	Yes	NA	NA	Yes	Yes

one (1) qualitative, two (2) mixed-method investigations and one (1) scoping review of published literature. Three of the five (5) quantitative methods contained surveys looking at student perceptions, experience and attitude (Morgan, 2018; Kuek and Hakkennes, 2020; Lokmic-Tomkins et al., 2022). One (1) observational study outlined a cross-sectional descriptive approach which explored nursing students' perceived digital literacy skills (Brown et al., 2020). Whereas one (1) quantitative study consisted of a descriptive cross-sectional survey on students' perceptions and barriers relating to the use of mobile devices in the digitalised clinical setting (Mather and Cummings, 2016). The two (2) mixed-methods studies comprised of questionnaires, telephone and focus group interviews (Roche, 2017, Mollart et al., 2021). The (1)

scoping review was retained in the study because it reported on literature that has been published on nursing informatics (NI) in nursing education and had not been critically reviewed by the other studies (Harerimana et al., 2021). The results of the above articles were synthesised into a thematic analysis where four themes emerged,. These include *curriculum design, education and training, digital literacy level* and, *professional digital literacy competency standard* framework (Table 4). The results table lists the study type, intervention and key findings.

4.1. Curriculum design

Due to the blended learning model being implemented in several

Table 3.4
MMAT Appraisal Tool.

	CRITERIA	Mollart et al. (2020) YES	Mollart et al. (2020) NO	Roche (2017) YES	Roche (2017) NO
S.1	Are there clear research questions?	Yes		Yes	
S.2	Do the collected data allow to address the research question?	Yes		Yes	
1.1	Is the qualitative approach appropriate to answer the research questions?	Yes		Yes	
1.2	Are the qualitative data collection methods adequate to address the research question?	Yes		Yes	
1.3	Are the finding adequately derived from the data?	Yes		Yes	
1.4	Is the interpretation of results sufficiently substantiated by data?	Yes			No
1.5	Is there coherence between qualitative data sources, collection, analysis & interpretation?	Yes			No
2.1	Is randomisation appropriately performed?		No		No
2.2	Are the groups comparable at baseline?	Yes			No
2.3	Are there complete outcome data?	Yes		Yes	
2.4	Are outcome assessors blinded to the intervention provided?	Yes		Yes	
2.5	Did the participants adhere to the assigned intervention?	Yes		Yes	
3.1	Are the participants representative of the target population?	Yes		Yes	
3.2	Are measurement appropriate regarding both the outcome and intervention?	Yes		Yes	
3.3	Are there complete outcome data?	Yes		Yes	
3.4	Are the confounders accounted for in the design and analysis?	Yes		Yes	
3.5	During the study period, is the intervention as intended?	Yes		Yes	
4.1	Is the sampling strategy relevant to address the research question?	Yes		Yes	
4.2	Is the sample representative of the target population?	Yes			No
4.3	Are measurement appropriate?	Yes		Yes	
4.4	Is the risk of nonresponse bias low?	Yes		Yes	
4.5	Is the statistical analysis appropriate to answer the research question?	Yes		Yes	
5.1	Is there an adequate rationale for using a mixed method design to address the research question?	Yes		Yes	
5.2	Are the different components of the study effectively integrated to answer the research question?	Yes		Yes	

Table 3.4 (*continued*)

	CRITERIA	Mollart et al. (2020) YES	Mollart et al. (2020) NO	Roche (2017) YES	Roche (2017) NO
5.3	Are the outputs of the integration of qualitative and quantitative components adequately integrated?		No		No
5.4	Are the divergences and inconsistencies between quantitative and qualitative results adequately addressed		No		No
5.5	Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Yes		Yes	

higher degree courses, students need to be digitally literate to engage in learning. Blended learning is a method of teaching that integrates technology online and offers traditional face to face teaching (Chen, et al., 2014). Today, larger cohorts of international students from diverse backgrounds are enrolling into contemporary university courses (Roche, 2017). Roche reported universities need to consider English for Academic Purposes (EAP) curriculum design in preparing students with the appropriate digital literacy skills for academic and workforce success (Roche, 2017). Some university enabling and pathway programs in Australia are already supporting students from culturally linguistically diverse (CALD) and low social-economic (LSE) backgrounds to network with technology for learning (Morgan, 2018). Since 2019, the English language proficiency level requirement in Australia for entry into a pre-registration nursing program requires an IELTS (International English Language Testing System) of seven and therefore EAP is not an accepted pathway of entry into nursing programs. Mather and Cummings (2016) believe to mirror the sophistication of health technology and informatics in the clinical setting, construction of a new curriculum is necessary for future graduate nurses to access health technology in Australia. A recent observational study conducted in Australia suggest that by scaffolding theoretical and practical content into nursing curriculum the gaps in nursing students' digital literacy skills may be filled (Brown et al., 2020). A current cross-sectional descriptive study that was also conducted in Australia revealed the nessarity of implementation of an EMR program into undergraduate nursing curricula would better prepare and enhance nursing students' confidence level for the use of digitalised clinical platforms in the clinical setting (Mollart et al., 2021). To be competent with the use of digitalised clinical systems the integration of nursing informatics subjects into undergraduate nursing curricula is essential (Harerimana et al., 2021). Authors Lokmic-Tomkins et al. (2022) point out that there is still a delay by educational providers to embed digital health technology interventions such as EMR education into curricula.

4.2. Education and training

Future nursing students rely on faculty, academic, education and training to equip them with the required graduate attributes that will appropriately prepare them for the workforce. In Australia, a recent scoping review conducted by Harerimana et al. (2022) found one of the main barriers that affect nursing student levels of digital literacy is a lack of education in nursing informatics. Interestingly, a cross sectional descriptive study conducted in Australia highlighted the educational need for simulation training of the EMR system in preparing undergraduate nursing students for clinical practice (Mollart et al., 2021). More recently, in a study conducted in Australia found that 97% of students from a cohort of 181 stated that they are not prepared and feel

Table 3.1

Critical appraisal qualitative study.

CASP Critical Appraisal Criteria	Clear statement of research aims	Is qualitative methodology appropriate?	Was the research design appropriate to address the aims	Was the recruitment Statement appropriate in the aims of the research	Was the data Collected in a way that addressed the research?	Has the relationship between the researcher and the participants been considered?	Have ethical issues been taken into consideration?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?	How valuable is the research?	Total
Cummings et al. (2016)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	unclear	8

anxious using an EMR system whilst on clinical placement without prior training (Lokmic-Tomkins, 2022). A study conducted several years ago by Cummings et al. (2016) at one unnamed university in Australia revealed that nurses' digital literacy skills are inconsistent and they are not prepared for the ever-changing technologies in the clinical setting. The findings of a literature review indicated that nursing students' decision making and clinical reasoning skills increase when ICT skills are included in nursing education (Cummings et al., 2016).

Finally, a study in Australia stipulates that patient safety and quality of care is compromised if inadequate education and training are not targeted towards healthcare workers who have poor engagement with information systems (Kuek and Hakkennes, 2020). In Australia, it has been identified that educational institutions need to equip nursing educationalists with the appropriate digital literacy skills by providing education and training to prepare nursing students for the digitalised clinical environment.

4.3. Digital literacy level

Digital literacy not only requires nursing students to be digitally literate, but it also requires them to be able to analyse, solve and make decisions about the accuracy of the data available (Roche, 2017). In Australia, students' technological knowledge is varied for there is greater diversity in students' experience, especially in first-year. Morgan's (2018) study found that many students in Australia lacked the digital literacy/competency skills required for university which would have a direct impact on their preparedness for the digitalised clinical setting. A current scoping review of published Australian studies on the topic of nursing informatics in nursing education revealed there is an assumption that domestic students who enter university from high school are tech savvy; however, overseas students from developing countries may not be equipped with the required digital literacy skills to facilitate their learning (Harerimana et al., 2022). A recent study conducted in Australia that attracted 407 healthcare workers, one fifth reported feeling anxious using an information system such as EMR due to low digital literacy levels and confidence (Kuek and Hakkennes, 2020).

An observational study conducted in Australia found that 55% of nursing students surveyed out of 84 were competent with using applications for diagnostic coding and extracting information from clinical data sets, but, lacked the skills to apply this into practice in the workplace (Brown et al., 2020). An up- to-date study in 2022 of 205 pre-registration nursing students in Australia revealed that masters nursing students' digital literacy level of confidence was slightly higher than bachelor of nursing students (Lokmic-Tomkins, 2022).

According to Roche (2017) Australian nursing students fail to critically gauge information online and this has resulted in increasing recognition of poor ICT skills. Morgan (2018) conveys that many nursing students in Australia feel underprepared and have a deficit in knowledge of basic software and are not prepared to use technology. To add, several studies conducted in Australia highlight that nurses and nursing students' have a deficiency in ICT skills and this has an impact on the use of technological devices in the clinical arena (Cumming & Mather, 2016;

Morgan, 2018; Roche, 2017).

4.4. Professional digital literacy competency standard framework

To ensure all graduating nursing students are prepared for the digitalised clinical setting, a Professional Digital Literacy Competency Standard Framework has been developed in 2020. However, according to Harerimana et al., (2022) in Australia this framework has not embedded into nursing courses. The results of a study conducted recently in Australia (Brown et al., 2020) highlighted nursing students lack of competence and low attitude rating of NI and reinforces the importance of the implementation of Professional Digital Literacy Competency Standard Framework. Before 2020, authors Cummings et al. (2016) stated the main focus of nursing informatics competencies involves knowledge of basic computer skills. The study looked at educational scaffolding and modular development used to build skills in support of the development of competencies (Cummings et al., 2016).

5. Discussion

The four main themes, curriculum design, education and training, digital literacy level and professional digital literacy competency standard framework were found to be pivotal in nursing students' preparedness for the digitalised clinical setting in Australia. These themes identified the need for the development and integration of a professional digital literacy competency standard framework to be embedded into nursing curricula to equip nursing students with appropriate digital literacy skills to navigate digitalised healthcare settings. These findings will be discussed in more detail and compared with global research findings in the literature.

Current curriculum is designed to offer students more flexibility in learning. As there is larger number of students from diverse background applying to enter into higher degree courses, some of these students may lack the required skills in English language proficiency which generally has an impact on their digital literacy level. Students who do not receive an ILETS score of 7 for direct entry into university may receive an offer to complete EAP course which could potentially enhance their digital literacy level in preparing them for their studies (Terraschke and Wihid, 2011).

A study conducted in South Africa which consisted of 45 nursing students recommended the integration of digital literacy courses into curriculum due to students' lack of computer skills and knowledge of digital health (Nkosi et al., 2011). In the UK a survey of 215 nursing students' and midwives' experiences of learning to use the electronic health records system revealed there is a need for formalised training to be competent with the use of electronic health record (EHR) system in the clinical environment (Baillie et al., 2013). The EHR and EMR both store patient data but the main difference is that the patient data in the EMR system is not shared between organisation whereas patient data in the EHR system can be accessed from multiple healthcare organisations. Similarly, back in 2010, Heba and Calderone's (2010) findings suggested that there were major gaps in nursing students' ability to use

Table 4
Results Table.

AUTHORS	SAMPLE	COUNTRY	DATA COLLECTION	STUDY TYPE	INTERVENTION	KEY RESULTS
Morgan (2018)	Survey Survey 1 417 students Survey 2 150 students	Australia	Commencing students in 2016 survey 1 (T1) in week 1 Survey 2(T2) in week 11	Quantitative surveys	Demographic information, device use and ownership, technology and students' university experience, preferences and experiences of learning environment and dispositions towards technology	T1 and T2 91% students reported having internet access. 43% students had a positive outlook towards technology 66% students felt that they learned better in a blended learning environment. 45% students felt underprepared with basic knowledge of software Increasing student diversity result in variable levels of digital literacy.
Kuek and Hakkennes (2020)	Survey 407 clinical (51.45) and non-clinical staff (48.4%)	Australia	Online and paper copies	Quantitative 13 survey questions	Survey questions related to user's confidence levels, frequency of use hardware/software devices, 5-point Likert scale to measure digital literacy level using technology acceptance model (TAM) and unified theory of acceptance and use of technology (UTAUT) model to assess attitudes to information systems	70–80% respondents reported high digital literacy levels, expressing confidence in using digital technology. Anxiety was reported by one-fifth of respondents using information systems.
Lokmic-Tomkins et al. (2022)	Survey 205 nursing students	Australia	Online survey 27 items	Quantitative Likert type scale Forced –choice items & open ended questions	Demographic characteristics. Use of technology for learning. Perceived digital literacy. Barriers and enablers in using technology for learning. Engagement with EMR.	49.75% using technology device before the age of 10. Highest use of technology to search the internet 92%. Online social networking 68.3%. Watching video 67%. Least confident different types of storage devices 24.1%. Confidence in using EMR 24.7%
Mather and Cummings (2016)	undergraduate nursing students (Number of students not mentioned)	Australia	Online survey 22 items	Quantitative Online survey 22 items	Online survey administered while undergraduate nurses were undertaking work integrated learning which captured students self-reported access to internet or device-based resources using a mobile device at the workplace	Owned a mobile device (n=47) Barriers to using mobile devices: Access to resources for clinical and educational purposes and professionalism issues. Educational preparation for appropriate use of mobile learning is necessary. Health technology needs to be implemented into the curriculum.
Brown et al., (2020)	84 nursing students	Australia	Purposive sampling Self-Assessment Nursing Informatics Competencies Scale 30 -item 5-point likert scale	Observational study used a descriptive cross-sectional design	Demographic data 5 factors measured 1. Clinical information role 2. Basic computer knowledge and skills 3. Applied computing skills 4. Clinical informatics attitude 5. Wireless devices skills	Demographic data Commencing students (39.3%) Midway (32.1%) Graduating (28.6%) Female (89.3%) 20–45yes (98.8%) Used EMR (65.5%) on clinical placement Used EMR (46.4) paid employment. 1.Clinical information role At least confident (58.3%) Reduced by 30% when participants rated themselves as at least proficient. Average (13.5%) rated themselves as not competent 2. Basic computer knowledge and skills Able to use the internet to locate and download (97.6%) at least confident. 3. Applied computer skills Only (55%) of participants considered their applied skills to be at least competent. (27.7%) rated as at least proficient. (21%) rated as not confident

Table 4 (*continued*)

AUTHORS	SAMPLE	COUNTRY	DATA COLLECTION	STUDY TYPE	INTERVENTION	KEY RESULTS
						4. Clinical Informatics attitude (91%) rated as at least competent (4.2%) rated not competent 5. Wireless device skills (90.6%) rated as at least competent
Cummins et al. (2016)	Worldwide	Australia	Literature search key words Undergraduate nursing, curriculum, nursing informatics, education, curriculum development and competency	Qualitative/ Descriptive Constructivist approach	The principles of educational scaffolding and modular development were used to build skills in support of the development of NI competencies.	The key findings were: Nursing Informatics needs to be taught at an undergraduate and post graduate level A nursing Informatics education package is required for all staff There must be educational preparation of graduate nurses to be who are confident with Nursing Informatics Workforce entry level Nursing Informatics competencies need to be developed
Mollart et al. (2020)	70 third year nursing students	Australia	Survey, demographic details, Likert style and open-ended questions	Mixed methods	Questionnaire using descriptive and inferential comparative analysis. Open ended questions thematic approach SPSS, Witney U test	Ages ranged from 2 to 55ys (medium 23) Training as assistant in nursing (56.5%) Not Confidence first clinical placement using patient EMR (31.9%). What they perceived of only using paper-based documentation in university for student preparedness to use EMR in their first clinical placement. Four themes Paper based learning gave me a foundation for using EMR in clinical practice. Feeling unprepared to use EMR Need to learn both paper -based and EMR Paper based system is outdated
Roche (2017)	125 first year nursing students	Australia	Survey, 39 items five responses, key Likert-scale questionnaire (7 dimensions of learning) Open ended response Question 47	Mixed methods	English as an additional language (EAL) and digital literacy in higher education topics Understanding academic integrity roles Using online plagiarism detection tools Understanding course rules Using online learning management systems Assessing online course material Building social networks Using academic integrity practices	Cronbach alpha score Understanding of: Academic literacy tools (0.92) Academic integrity (0.91) Online technology (0.98) Descriptive Statistics EAP pathway (n=69) No EAP pathway (n=48) t-Tests Academic literacy tools No EAP M=3.64, SD=1.36 EAP M=1.47, SD=0.52 Academic integrity No EAP (n=48) Poor understanding M=3.63, SD=1.31 EAP (n=69) M=1.5, SD=0.56 Online technology No EAP M=2.38, SD=0.98 EAP M=4.04, SD=0.67 Open ended responses Using digital academic tools is new to them. Difficulty of navigating different learning management systems (LMS) No EAP difficulties with a number of online LMS systems
Harerimana et al. (2022)	Australia	Australia	Literature search key words nursing, informatics, nursing education curriculum and undergraduate	Scoping review using Levac, Colquhoun, and O'Brien framework	PRISMA flowchart 26 articles identified. Descriptive analysis and inductive thematic synthesis	Only 2 studies described the process of developing curricula that contain nursing informatic competencies

e-health databases in the US due to the limited integration of informatics units in the nursing curriculum. However, a recent cross-sectional study in India conducted by Sharma et al. (2019) which investigated 152 nursing students concluded that 65.1% had self-reported moderate levels of digital literacy skills.

Nursing Informatics combines nursing practice with information communication technology skills in providing safe evidenced-based patient care. Nursing informatics competencies are evolving and need to be scaffolded into courses starting from a basic level to ensure all nursing students from diverse backgrounds with varying digital literacy levels and knowledge are consistent (Flood et al., 2010). A study conducted in Canadian nursing schools revealed that only 33% of nursing students and academics have adequate nursing informatics competencies skills (Jones and Donelle, 2011). Another study led in the US in regard to informatics projection disclosed that 60% of states had no requisite for informatics content (Meyer et al., 2014). However, a study in Israel with 59 s-year nursing students showed that students favoured the introduction of nursing informatics competencies into curriculum (Gonen et al., 2016).

Moreover, a systematic review carried out in Canada revealed that there was a lack of faculty knowledge, skills and motivation to integrate informatics competencies into the curriculum (Kleib et al., 2013). Fulton et al. (2014) also discovered that decreased faculty understanding of informatics curricular guidelines is associated with discrepancies in how informatics courses are implemented into nursing programs. Favourably, a study conducted in the US by Sorenson and Campbell (2013) in regard to the integration of an academic electronic record software into the curricula pathway, attracted positive feedback from students. It can be said, preparing future nurses for the digitalised clinical environment, education providers need to review their current curricula and embed a digital literacy framework that tests students' knowledge and level of digital literacy. Globally, nursing students are in favour of the integration of NI education and training competencies to be embedded into nursing curricula.

Education and training that promotes and improves nursing students digital literacy level will prepare them to be work ready. A recent study in Norway highlighted technological literacy promotes nursing students' critical thinking skills to become more efficient and confident in the delivery of a digitalised point of care (Nes et al., 2021). In comparison, Chen et al. (2014) highlighted that nursing education in Singapore does not fundamentally prepare students for the advanced technological clinical environment for the 21st century. Another study from Jordan mentioned that nursing students have low digital literacy levels due to a lack of experience, training and education (Akhu-Zaheya and Khater 2011). Additionally it has been found in the US, that due to a lack of education and training, there is a shortage in the use of technologolical approaches which impacts skills required to manage eHealth systems (Talcott et al., 2013). A study from Riyadh and Jeddah hospitals in Saudi Arabia revealed that better education and training programs for all nurses are required for the successful use of an EMR system in e-health (Almutairi and McCrindlel 2016). A recent study conducted in the Netherlands revealed that educational preparation is central for graduate nurses to be competent in NI and using e-health applications in a digitalised clinical setting (Holt et al., 2020).

According to Holt et al. (2020) there is limited knowledge around what influences nursing students' health literacy and digital literacy levels. Worldwide it has been revealed that nursing students' lack of experience, education and training has resulted in varying digital literacy levels. Therefore, it is imperative that academics are upskilled and trained in educating nursing students and equipping them with the required knowledge and digital literacy skills to function in the digitalised clinical setting.

Digital literacy level determines nursing students readiness to work efficiently in digitalised work setting. A cross-sectional study of 310 undergraduate nursing students' in Greece (Deltsidou et al., 2010) back in 2010 showed that two thirds of students were not skilful with internet

use and experienced anxiety with the introduction of computers into the clinical setting. However, Alasmary et al. (2014) study in Saudi Arabia discovered that EMR users with high computer/digital literacy skills were more satisfied in using the EMR system than users with low computer/digital literacy skills. Likewise, a descriptive study in Canada (Wahoush and Banfield, 2014) concluded that there is limited knowledge of nursing students' informatics/digital literacy skills. A pilot study conducted in Korea (Park and Lee, 2015) with 176 nursing students discovered that only a few students were equipped with adequate skills to differentiate between low and high quality health resources on the Internet. Similarly, Tubaishat and Habiballah's (2016) cross-sectional study of 541 undergraduate nursing students in Jordan found that most students did not have appropriate ICT skills to evaluate e-health resources. A recent review of technological literacy mentioned the significance of equipping nursing students with ICT skills for the 21st century and the digitalised future of nuring (Nes et al., 2021). Whereas, a previous study conducted in South Korea established that nursing students' attitudes lack of ICT experience, education, competence and had an impact on their confidence level towards ICT (Lee and Clarke, 2015). The integration of professional digital literacy competency standard framework will not only improve nursing students digital literacy level but will ensure they are work ready for the digitalised clinical setting.

It has been established that professional digital literacy competency standard framework is essential not only in Australia but globally in preparing nursing student to be work ready. In 2006, Canadian nurses developed the eNursing strategy which resulted in several projects. These projects were funded by Canada Health Infoway which involved the development of ICT initiatives that were required to be implemented into nursing programs as Health Information Technologies competencies (Jones and Donelle, 2011). The results of a study conducted in Australia over 13 years ago (Eley et al., 2008) reinforced the necessity of the development and implementation of a professional digital literacy competency framework into all nursing education curricula. In 2008, the National Health System (NHS) in the UK identified core ICT competencies standards that health professional requires (Dowding, 2013).

Similarly, in the USA, the HITECH Act of 2009 outlined that all healthcare professionals need to have the knowledge and skills to become efficient users of health information technology which is one (1) of the five (5) core competencies developed by the *Institute of Medicine and the American Association of Colleges of Nursing*. The *College of Nursing* also worked collaboratively with the *Quality and Safety for Nursing Education* to incorporate informatics competencies into nursing programs (Skiba et al., 2014). The *American Medical Informatics Association* (AMIA) established the *Technology Informatics Guiding Education Reform* (TIGER) initiative that developed core international informatics competencies.

Another study in Asia illustrated that nursing informatics units in entry to practice nursing education vary significantly and that most Asian countries are currently in the process of developing and standardising nursing informatics competencies (Wu et al., 2017). Whereas, in the UK the Scottish Government's e-health strategy invested in health information technology infrastructure. The Knowledge and Skills Framework (KSF) was introduced by the National Health Service (NHS) where several references were made in regard to technology and how clinical staff use the information to manage patient care (Dowding, 2013). Eley et al. (2008) further noted that most nurses would welcome an introduction to a national digital competency standard.

The findings of this study reveal the importance of the development and implementation of a national professional digital literacy competency framework into nursing curricula that would consist of contemporary learning and teaching approaches in closing the gap in nursing students digital literacy skills. To enable nursing students to establish decision-making skills when working with an EMR system, a health informatics program needs to be embedded into nursing curricula to prepare new graduates for the digitalised workforce (Stephens-Lee et al., 2013). Therefore, it is crucial that educational providers prepare new

graduate nurses for the fast-paced digitalised environment by supporting nuring students to become competent in nursing informatics (Cummings et al., 2016). Due to an ever-changing digitalised clinical environment, nursing students' need the required ICT knowledge and skills to practice safely, which has made a change in curriculum structure a priority (Mollart el at., 2021). The findings along with workforce implications, organisational efficiencies and patient safety have been discussed above and compared globally in this discussion.

6. Limitations

This review has been limited to Australia but has compared worldwide research findings that conclude nursing students graduating from educational institutions with low levels of digital literacy competency are a global concern for the healthcare industry. The National Nursing and Midwifery Digital Health Capabilities Framework (2020) has accentuated the necessity of the implementation of structured health informatics subjects into the nursing curricula. Further research needs to be conducted in regard to the development, implementation and evaluation of a national digital literacy and health informatics competency standard framework effectiveness in equipping nursing students with appropriate levels of digital literacy skills required to work effectively in the clinical environment.

7. Conclusion

The conclusion this review indicated that Australian nursing students lack the required digital literacy and ICT skills to cope with the ever-changing innovative trends in technology. In Australia, there is no research or existing data that evaluate or measures the effectiveness of a national competency framework in improving nursing students' digital literacy skills and how this ultimately prepares them for the digitalised clinical environment (Cummings et al., 2016). Educational institutions need to consider designing and implementing a curriculum that includes digital literacy competencies to equip nursing students with the necessary ICT skills in preparation for the e-health environment.

Finally, it can be concluded that NI in undergraduate nursing programs provides and equips nursing students with the required digital literacy and ICT skills to successfully use an e-health system. Due to large cohorts of students from diverse backgrounds with varying digital literacy experience and levels, there needs to be a national competency framework that sets a standard that tests nursing student competency levels in digital literacy. Nursing schools need to review their existing programs and update to a curriculum that includes NI to keep up with the ever-changing technological workplace. For future nurses to function in a rapidly evolving technological clinical environment, nursing academics also require further education in NI and its role in the clinical setting.

CRediT authorship contribution statement

Heaton Leeanne: Supervision, Writing – review & editing. **Sanagavarapu Prathyusha:** Supervision, Writing – review & editing. **Ginige Anupama:** Formal analysis, Methodology, Supervision, Writing – review & editing. **O'Reilly Rebecca:** Supervision, Writing – review & editing, Formal analysis, Methodology. **Jefferies Diana:** Methodology, Supervision, Writing – review & editing. **Stunden Annette:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

There are no financial interests/personal relationships which may be considered as potential competing interests.

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