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Using Curriculum Mapping to Develop Undergraduate Nursing Informatics: A New Zealand Study

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Abstract **-** ***Aim:*** *The purpose of this research was to determine the range and scope of nursing informatics skills required by undergraduates.* ***Methods:*** *Curriculum mapping was used to assess the nursing informatics content of nursing curricula from three Schools of Nursing.* ***Results:*** *The mapping process showed where information communication technology skills were explicitly taught, those that students already knew, and identified gaps in student informatics learning and teaching delivery in the three undergraduate nursing programmes studied.* ***Conclusion:*** *These results make an important contribution to the nursing profession's knowledge and understanding of nursing informatics teaching to undergraduate nursing students. Nurse educators need to be assured that the nursing informatics skills developed by students over the course of their undergraduate education will stand them in good stead for their future work as registered nurses.*

Keywords: ***Curriculum mapping, nursing informatics, information communication technology skills, nursing degree programmes.***

1. Introduction

This paper explains how curriculum mapping was used to evaluate the nursing informatics content in three nursing programmes at bachelor's degree level. 'Nursing Informatics' is a term used to integrate the science and practice of nursing; it is a combination of computer science, information science, and nursing science designed to assist in the management and processing of nursing data, information and knowledge to support the practice of nursing and the delivery of nursing care (Graves & Corcoran, 1989; Pope, 2017). Curriculum mapping results identified the scope of computer and information technology literacy and management skills required by undergraduate nurses including areas for development. The paper concludes with a number of recommendations for nurse educators interested in curriculum development in nursing informatics.

Background

Today's medical professionals work in increasingly diverse and challenging technological environments prompting nurse educators to examine how to best prepare students to competently use health information systems and new digital technology (Pearce, 2017; Pope, 2017). Students entering a degree programme are expected to possess basic computer literacy skills (word processing, internet searching, data file management) and to be able to navigate their way around a Learning Management System (LMS) such as *Blackboard* or *Moodle*. During the degree programme, given the appropriate training and instruction, students' technology skills should progress from using a range of simple equipment (e.g. a hand-held glucometer) to mastering more complex technologies (e.g., organisational patient management systems) and participating in scenarios caring for simulated 'patients', i.e. high fidelity computer operated manikins. By graduation, employers and the nursing profession expect nurses to be highly skilled practitioners with sufficient computer skills and nursing informatics knowledge to use new and emerging medical technologies. However, it is difficult to know exactly what information and communication technologies (ICT) skills are required, and how, when and where these are being taught (and practiced) in the nursing curriculum. In order to begin to answer these questions, the researchers mapped three nursing curricula against the Australia Nursing and Midwifery Federation (ANMF) Australian National Informatics Standards for Nurse and Midwives (ANMF, 2015), to determine what was currently occurring.

Curriculum mapping

Curriculum mapping is a tool used in teaching and learning environments to examine course content, programme alignment, pedagogy and assessment (Harden, 2001). Mapping also provides transparency to curriculum

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content (MacNeil & Hand, 2014) and is a tool for programme development (Holycross, 2006). Most often used in teaching and education settings, curriculum mapping has been utilised by allied health professionals to assess course content in chiropractic programmes (Gorrell, Beirman & Vemulpad, 2015) and by nurse educators to align bachelors and associate degree programmes (Landry, Marshall, Orsolini-Hain, Boyle, Privé, et al., 2011).

The mapping activity is concerned with 'what', 'how', and 'when content is taught' and the measures used to determine whether or not the student has achieved the expected learning outcomes (Harden, 2001). It is a technique where elements of a curriculum are pulled apart, examined, collated and entered into a document or spreadsheet. When completed regularly, mapping identifies gaps, redundant and duplicated curriculum content (Uchiyama & Radin, 2009). It also provides an opportunity for staff and students to work collaboratively to develop curricula or examine a topic or area of interest, such as nursing informatics.

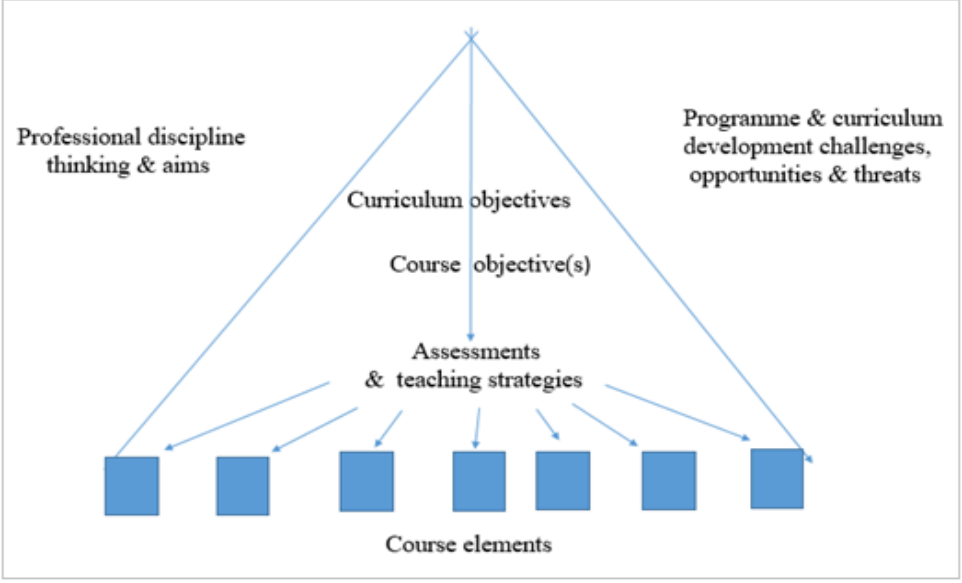

Figure 1: Overview of curriculum mapping process

There are various ways in which to map curricula. Methods range from simple manual charting or entering data into a table or spreadsheet, to sophisticated electronic methods such as horizontal data aggregation (Uchiyama & Radin, 2009) and bi-axial mapping of multiple indicators and attributes (Sumsion & Goodfellow, 2004). Harden (2001), writing about curriculum mapping in medical education suggests that the following 10 elements should be included in any analysis. These are; the expected learning outcomes, areas to be covered, and assessments, learning opportunities, location, resources, timetable, staff, curriculum management and students. Regardless of the chosen analytical tool however, the goal of the mapping exercise is to determine curriculum content, provide clarity, and identify strengths, gaps and overlaps (Veltri, Webb, Matveev & Zapatero, 2011).

2. Research purpose and context

The purpose of this research was to determine current informatics teaching and practice in nursing curricula in three Schools of Nursing. The ANMF Australian National Informatics Standards for Nurses (ANMF, 2015) were used as a template to map undergraduate nursing curricula from three NZ Schools of Nursing; two in Auckland and one in Dunedin. The ANMF document specifies informatics standards for registered nurses (RNs), i.e. graduates of degree programmes who have passed their RN state final examinations. It contains three areas; the 'domain' or area of competency, the 'standard(s)' or measure to be achieved, and 'cues' which are the behavioural and practice indicators used to assess whether or not the standard has been met. Given that Australia and NZ offer reciprocal registration for RNs, and that there is no equivalent NZ nursing informatics guidelines, the ANFM standards were an appropriate framework for this curriculum mapping exercise.

Research method

The following coding system and columns were used to map ICT skills found among curriculum documents from three Schools of Nursing. Data were tabulated in an excel spreadsheet.

- **Columns 1-3** were the ANMF domains, 'standards' and 'cues' format shown in tables, 2-4 (ANMF, 2015).
- **Column 4;** 'demonstrated in which paper', identified the BN paper that included the relevant standard and 'cue'.
- **Column 5;** 'concepts taught', recorded whether or not concepts were explicitly taught and if so, how they were taught.

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- **Column 6;** 'Technology skills (to support ICT skill development)' recorded whether or not it was assumed that the student had the skills necessary to engage with this concept.
- **Column 7;** 'formally assessed/not assessed' recorded if the 'standard' and 'cue' was formally assessed.

3. Results

This mapping exercise showed where skills were explicitly taught, those that students already knew, and identified gaps in student informatics learning and teaching delivery in the nursing programmes. Results are reported according to the three competency domains stated in the Australian informatics guidelines. Three categories were used to indicate the applicable skills.

✓ Required
➢ Needing refinement
N/A Not applicable

Computer literacy skills

The first area or domain "Computer Literacy" has one standard, "Demonstrates knowledge & skills in computer basics (ANMF, 2015, p. 13). Corresponding 'cues' or indicators that this standard has been met are shown in Table 1.

Table 1: Computer literacy skills for nurses

1.1 Understands concepts of information and communication technologies (ICT)	✓
1.2 Understands the basic concepts of computers, electronic devices, operating systems, intranets, hardware, software and peripheral devices	✓
1.3 Knows how to use & manage ICT relevant to practice, effectively and efficiently, such as: • Computer(s) or electronic device(s) • The World Wide Web • Electronic communication • Electronic file management • Word processing • Spreadsheets • Databases • Presentation software	✓
1.4 Considers ergonomics and workstation safety	N/A

Table 1 shows the range of computer literacy skills and abilities required of the nursing workforce. While educators may assume that most new entrants have these skills upon entry, particularly knowledge of computer(s) or electronic device(s), the World Wide Web, etc., some of these skills (e.g., spreadsheets and presentation software) are not explicitly taught within the nursing degree programme. It is also assumed that these skills will be strengthened by use during the programme.

Information literacy

Domain 2 "Information literacy" includes three ANMF standards: 2) Effectively and efficiently identifies and finds information to support evidence-based practice, 3) Critically evaluates information gathered and 4) Manages information collected or generated (ANMF, 2015, p. 13). Corresponding 'cues' or indicators are listed in Table 2.

Table 2: Information literacy skills

2.1 Uses basic on-line searching options and internet terminology, for example: website, HTML, home page, hypertext link, bookmark, URL address	✓
2.2 Constructs and implements effective on-line literature and resources search strategies which include scholarly literature and websites	✓
2.3 Uses appropriate services to retrieve information needed, for example; library resources, professional associations, community resources, relevant experts and practitioners	✓
2.4 Keeps up to date with information sources, information technologies, tools for accessing information and investigative methods	➢
3.1 Defines and applies criteria for evaluating information • Examines and compares information from various sources to critically evaluate reliability, currency ,validity, accuracy, authority, timeliness, and point of view or bias • Recognises the cultural, physical or other context within which the information was created and understands the impact of context on interpreting the information	✓
4.1 Records and organises information and its courses using information management tools	✓
4.2 Demonstrates an understanding of intellectual property, copyright and fair use of copyrighted material	✓
4.3 Considers cultural, ethical and socioeconomic issues related to access to, and use of, information	✓
4.4 Manages information legally and respectfully	✓

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This domain covers information literacy and is clearly a skill that develops through the programme. Students are taught how to identify, locate, assess and evaluate information in the first year in all three study locations. These skills are also reinforced throughout each degree programme. However, one area requiring development is cue 2.4 (keeping up to date with information sources, information technologies, tools for accessing information and investigative methods). Also while the importance of evidence-based research to guide nursing practice is evident, keeping up to date with the latest sources, technology and tools is not made explicit. The implication of this being that students may possibly overlook the importance of continual learning.

Information management skills

Domain three, "information management" is more complex and has the following standards and the corresponding cues listed in table 3.

- "Demonstrates collection, use and management of data and information to support decision making in practice.
- Demonstrates understanding of the purpose, basic structures, use and storage of electronic health records and personally controlled health records.
- Understands the concepts, scope and practice of a variety of information and communication technologies that support health and aged care
- Complies with the legal and regulatory requirements, and ethical principles, for all uses of information and communication technologies used in nursing and midwifery practice
- Demonstrates the ability to use information communication technologies to promote safe effective use of information to support nursing and midwifery practice.
- Demonstrates the ability to include research, evidence-based practice and quality improvement in supporting the use of information and computer technology" (ANMF, 2015, p. 13)

Table 3: Information management skills

5.1 Understands the concept of information management	✓
5.2 Recognises the difference between data and information and how both can be used to support practice	✓
5.3 Identifies purposes, benefits and potential risks of aggregating clinical data	➢
5.4 Demonstrates ability to manage access to electronic health data and information	✓
5.5 Demonstrates ability to communicate electronically with other health care professionals using networks, intranets and internet.	➢
5.6 Understands importance of data and information to support and to advance nursing and midwifery practice	✓
5.7 Understands decision support systems and their application to practice	✓
5.8. Understands that measuring the relationship between nursing and midwifery care and health outcomes has the ability to influence health policy, health budgets, practice, research and education.	✓
5.9 Advocates for use of innovative information and communication technologies to support nursing and midwifery practice and quality health outcomes	N/A
6.1 Understands data storage methods including formats and movement of data and information	N/A
6.2 Understands the impact of information management on clinical workloads	✓
6.3 Understands the basis and application of coding systems, classifications, terminologies and languages that support the use of information and communication systems in nursing and midwifery practice	N/A
6.4 Complies with national standards for the use of information and communication technologies in health and nursing and midwifery systems	✓
6.5 Understands the importance of data quality, analysis and presentation to quality control and validation of information	✓
6.6 Communicates and collaborates with key stakeholders relating to the collection, use and management of electronic health data and information	✓
7.1 Understands basic informatics terminology such as data, information, knowledge, hardware, software, computer, networks, information systems, and information systems management	✓
7.2 Understands the importance of interoperability of systems and communication	➢
7.3 Understands the importance of data analytics and the impact on care delivery	✓
7.4 Promotes awareness and education on collection, use and management of heath data, information sharing and information access	✓
7.5 Demonstrates use of a variety of information and communication technologies that support safe, quality nursing and midwifery practice.	✓
8.1 Understands the legal and regulatory requirements, and ethical issues, related to the use of electronic data and	✓

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health/aged care information	
8.2 Uses electronic health data and information legally and ethically	✓
9.1 Integrates and uses electronic communication competently	✓
9.2 Presents data and information clearly and accurately	✓
9.3 Adheres to requirements for documentation	✓
9.4 Demonstrates ability to create reports	➢
9.5 Demonstrates ability to use information and communication technologies for the provision of education and information	✓
9.6 Understands strengths and weaknesses of information and communication technologies	✓
9.7 Ensures usage of information and communication technologies supports practice	✓
10.1 Undertakes regular literature searches to inform nursing and midwifery practice	✓
10.2 Advocates for innovation, quality improvement, research and evidence based practice using information and communication technologies to support practice	➢
10.3 Uses research to guide practice in the use of information and communication technologies that support nursing and midwifery practice	✓
10.4 Promotes involvement of nurses and midwives in design, implementation and evaluation of information and communication technologies that support nursing and midwifery practice	➢

This domain covers a broad range of information management skills covering essential areas including legal and ethical use of information and ICT systems within clinical practice, using patient portals and electronic health records. Standard 6 relates to understanding electronic health records and is an area that is currently being developed as part of the government's health strategy (New Zealand Health Strategy, 2016). Undergraduates' information management skills clearly develop during the three years of study, improve with application in the clinical setting and wherever possible with practice in a simulated environment.

4. Discussion

This research is important because nursing informatics is a rapidly growing discipline presenting clinical nurses, educators and researchers with opportunities to deliver evidence-based care that leads to better patient outcomes (Pearce, 2017). Digital technologies have a wide range of applications, for example virtual reality headsets and guided imagery can be used as an alternative non-pharmacological pain management technique, and medication is now usually administered by nurses using computer controlled medication protocol and systems (Pope, 2017). Electronic health records and patient management systems are also used by nurses, medical and ancillary staff to collect, collate, track and record patient information (Saba & McCormick, 2015). It is therefore essential that nurses know how to input data and correctly use electronic information management systems.

Curriculum mapping

Curriculum mapping is a valuable tool that provides educators, students, the institution, external agencies and professional bodies with a blueprint of the existing curricula. The mapping process allows reviewers and stakeholders to view the curriculum as a whole, identifying overlaps, non-essential elements and gaps (Harden, 2001; MacNeil & Hand, 2014). For educators this information helps to refine existing curricula and assists programme managers to judiciously remove redundant content before adding new content.

This mapping exercise highlighted the importance of clinical practice placements to strengthen and consolidate nursing informatics concepts. Clinical practice exposes students to up to date and relevant ICT in practice and therefore enables them to meet higher level nursing informatics competencies, e.g., 6.4 'Complies with national standards for the use of information and communication technologies in health and nursing and midwifery systems', and 9.3 'Adheres to requirements for documentation'. It is therefore essential for educators and clinical practice nurses to have close working relationships to ensure all students have access to host organisation's Patient Management and electronic health systems. Preferably, when students are more senior (second or third year), they should have their own access, rather than just having access under the jurisdiction of their supervising RN.

The Australian Nursing informatics standards

The Australian standards provide a comprehensive guide for assessing the range and scope of nursing informatics skills required by graduates (ANMF, 2015). It is an essential guide for educators wishing to evaluate the nursing informatics content of their curricula. However, it is suggested that reducing the number of standards and cues would make the document more accessible. All of the Domain 8 standards, for example, "Complies with the legal and regulatory requirements, and ethical principles, for all uses of information and communication technologies used in nursing and midwifery practice" applied to the NZ context. Only four cues (e.g., "1.4: Considers ergonomics and

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workstation safety", and 5.9, 61, 6.3) did not directly apply or were beyond the scope of a student nurses and four more (2.4, 5.3, 5.5 and 7.2) were identified as needing refinement.

Implications for nurse educators

Nurse educators generally assume that today's, mainly 'i-gen' entrants to a nursing degree are competent in ICT skills. However, to guarantee student learning success it is important that all undergraduate's ICT skills be assessed upon entry to the programme, particularly to identify students who don't have the required skills or knowledge, who can then be directed to institutional IT support services. Educators can be reassured however, that multiple learning opportunities are provided in curricula reviewed in this study. For example, students using presentation software such as PowerPoint to do group presentations fulfil the requirements of Domain 1, 1.3 'knows how to use and manage ICT relevant to practice, effectively and efficiently, such as presentation software". Nonetheless, in group work, it is possible that not all students develop ICT skills, especially if responsibilities are delegated to a group leader selected because of technological proficiency. In these situations, rather than being concerned that students have equal abilities, it is suggested that equal opportunities to participate, help students to learn and develop communication and presentation skills. Finally, it may also be worthwhile for students to evaluate their own nursing informatics competencies at the end of the degree programme, using a self-report tool such as one developed by Fetter (2009) in North America. Sharing self-reported data could also assist educators to evaluate their nursing informatics teaching and assist graduates to identify areas for ongoing education and professional development opportunities.

5. Recommendations

Nursing curricula need to reflect nursing informatics competencies and provide opportunities for students to develop the requisite knowledge, skills and attitudes to be a RN. Six recommendations for nurse educators are proposed.

1. Assess student's ICT skills at the beginning of nursing programme and ensure that they know how to access the available support services.
2. Provide adequate teaching and learning opportunities to enable students to meet the nursing informatics competencies and demonstrate that they are work ready.
3. Build opportunities for students to engage with real time Patient Management Systems and other appropriate electronic health systems. This could include but is not limited to discussions with clinical partners.
4. Evaluate student's nursing informatics competencies at the end of their programme, perhaps using a self-report tool such as described by Fetter (2009).
5. Discuss how to use and interpret data and organise information etc. with students in an ICT context as well as in a research context. Often they go hand-in-hand as we educate the students about evidence based practice, however more emphasis needs to be given on how data, information and knowledge influences practice.
6. Adjust and refine nursing curricula regularly to take account of the rapidly changing technological environment.

6. Conclusion

This curriculum mapping exercise provided insights about current informatics practice and teaching in nursing curricula in three NZ Schools of Nursing. The study lays the foundation for the next phase of this research, i.e. developing a comparable set of undergraduate nursing informatics standards. Educators can be reassured that the nursing informatics skills developed by students over the course of their undergraduate education will stand them in good stead for their future work as a RN. Many of these skills learnt in the education environment are transferrable to professional nursing life. Ongoing monitoring of changes occurring within the health sector with supporting financial and human resourcing to do so, is needed, along with flexibility in the curriculum to ensure that teaching and learning keeps abreast of changes as they, or before they occur.

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