The factors influencing nurse graduates use of mobile technology in clinical settings in Perth Western Australia: A mixed method study

Benjamin Hay

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Chapter 2

Review of the Literature

Introduction
This literature review identifies and briefly discusses key concepts associated with mobile technology use by nursing graduates. These concepts will set the background for the proposed study. It will include nursing students and graduates use of mobile technology; mobile technology in learning and teaching; mobile technology use by health professionals; policies and guidelines associated with mobile technology in the clinical setting; and factors influencing the use of mobile technology in healthcare.

A systematic search of the research literature was performed using the universities electronic online databases based on the key concepts highlighted above. The online databases included for example: CINAHL, MEDLINE, PubMed, Cochrane Library, JAMA Network, New England Journal of Medicine, and Science Direct. A broad list of keywords were included in the search which included: mobile technology, personal digital assistants (PDA’s), hand held computers, laptops, notebooks, smartphones, nursing education, information communication technology (ICT), Information technology (IT), nurse education, and elearning. Keywords were then searched in the results which included: barriers, enablers, attitudes and perceptions. Inclusion and exclusion criteria was based on recency of peer-reviewed papers that linked to the key concepts. Information sourced was appraised using the ‘RADAR-test’ framework (Mandalios, 2013).

Nursing students and graduates use of mobile technology
Undergraduate nursing students have found that mobile devices can increase their self-confidence (Goldsworthy, Lawrence & Goodman, 2006; Johansson, Peterson & Nilsson, 2013; & Wu and Lai, 2009) enhance their learning (Farrell & Rose, 2008; George, Davidson, Serapiglia & Barla, 2010; Koeniger-Donohue, 2008; Patillo, Brewer & Smith, 2007; Wu & Lai, 2009; Secco, Jamieson, Profit, Bailey, Brennick,
Whitty-Rodgers, 2010; & Hudson & Buell, 2011) and assist in integrating theory to practice (Wu and Lai, 2009). Recent trials of mobile technology use by student nurses in their clinical practice, have demonstrated successful integration into clinical practice. These trials revealed benefits for clinical practice including access to point of care resources such as: drug references; enhanced learning in the clinical setting; maintenance of patient safety; efficiency of care; and staff satisfaction (Farrell & Rose, 2008; George, Davidson, Serapiglia, Barla, & Thotakura, 2010; Hudson & Buell, 2011; Koeniger-Donohue, 2008; Patillo, Brewer & Smith, 2007; Secco, Jamieson, Profit, Bailey, Brennick, Whitty-Rodgers, 2010; Wu & Lai, 2009).

A United States (US) study of 89 undergraduate nursing students and graduates use of mobile technology, found that 96% of students used their personal digital assistants (PDAs) in the clinical setting, 67% in the classroom and 56% for personal use. Eighty percent of participants used their mobile device as a reference in education, with medication/drug guides being the highest references utilised (97.9%), second to medical dictionaries (83.3%). Seventy one percent of students indicated that their PDA improved their efficiency, with 100% indicating that it was an effective educational tool (George, Davidson, Serapiglia, Barla & Thotakura, 2010). Likewise, in a similar US survey of 3900 registered nurses and students, it was found that 85% had an application version of a drug guide, with 71% using a smartphone at work. Sixty six percent of nursing students used their smartphone in nursing school with 85% of them suggesting they would like the drug application guide (Dolan, 2012).

As medicines are the most common treatment in healthcare, they are also associated with higher incidences of errors and adverse events which can lead to injury and death (Australian Commission on Safety and Quality in Health Care [ACSQHC], 2008). In Australian hospitals, problems associated with medication is one of the highest reported adverse events incidents in which harm to a patient may occur (Australian Institute of Health and Welfare [AIHW], 2017). A recent literature review reviewing the extent of medication errors and adverse drug reactions in Australian hospitals, revealed medication safety continues to be a significant problem. In hospitals in Australia, there are an estimated 230,000 medication related admissions each year with an associated annual cost of $1.2 billion (Roughhead, Semple & Rosenfeld, 2017).
Many solutions have been discussed to assist in preventing medication errors which includes the use of technology at the point of care. The National Safety and Quality Health Service (NSQHS) ten standards were created to assist all health service organisations in Australia to deliver safe and high quality care. From the ten standards, standard four relates to medication safety. Within standard four, recognised solutions for reducing common causes of medication errors can include: improving clinical workforce and clinician-patient communication; using technology to support information recording and transfer; and providing better access to patient information and clinical decision support at the point of care (ACSQHC, 2012).

Responsibility for meeting Standard Four is shared from a range of professionals that includes nurses at varying levels in healthcare settings. The ACSQHC states that systems should be developed considering local circumstances, with consideration of individual roles and resources using information technology, equipment, staff, education and training (ACSQHC, 2012). Personal use of mobile technology at the point of care may assist in meeting standard four for healthcare settings and may assist in reducing medication errors for nurse graduates and students. Further research is required, therefore, to investigate the role of mobile technology at the point of care for improving safety with medication administration, for nurse graduates transitioning from University to clinical settings.

A recent study within the U.S. with first year nursing students, revealed that 90% of students planned to continue using healthcare smartphone apps as a clinical resource, having used them in the University settings and in clinical rotations (George, DeCristofaro, Murphy, & Sims, 2017). The authors suggest, it is important to encourage students to use these resources early within the curriculum (George, DeCristofaro, Murphy, & Sims, 2017). This research implies that mobile technology for learning and as an ongoing clinical resource, is encouraged at an early stage within undergraduate nursing programs.

Previous research with student nurses using mobile technology, supports the notion that students access resources they are familiar with from their University setting (Kuiper, 2008; Williams and Dittmer, 2009). In two studies which involved student nurses using their mobile technology clinically, students found online mobile technology more useful than text-based resources, and were more likely to access
evidence based resources with this method (Kuiper, 2008; Williams and Dittmer, 2009). In another study, confidence was increased for nursing students when they were able to view video files of clinical skills on mobile technology such as an iPod. The clinical skill was performed based on the modelling demoed in the video file through this format (Clay, 2011). Further research is required to investigate if nurse graduates access similar resources from their University training on their mobile devices, as a bridge from University to the clinical setting.

Similarly, research into mobile technology use with third year nursing students from two nursing schools in South Korea, found that 46.2% used them during clinical practice, and the majority of those surveyed (83.7%) had observed nurses using them clinically (Cho & Lee, 2016). The authors argued that educators and faculty of nursing schools should develop policies that encourage intelligent and safe use of mobile technology during clinical rotations (Cho & Lee, 2016).

An important and recent study with nursing students, found that educators can enhance the benefits of mobile technology use in academic and clinical settings (Williamson & Muckle, 2017). Benefits were noted through improved delivery methods, practice methods, and strategies to keep students engaged and prepared (Williamson & Muckle, 2017). It is argued that these initiatives would ensure that nursing students are even more prepared for the transition into the clinical workforce (Williamson & Muckle, 2017). Another study in the U.S. with nursing students using personal digital assistant (PDA’s) in both clinical and classroom settings, identified similar strategies to enhance use of mobile technology clinically. These included having preceptors and nursing staff who were competent in using the resource (Hudson & Buell, 2011).

A critical review of the literature regarding mobile technology use in clinical nursing education, found a lack in the current body of evidence for a clear definition of what mobile technology is, and where its boundaries lie in clinical nursing education (O’Connor & Andrews, 2015). In addition, the authors identified conflicting reports of patient and staff attitudes towards mobile technology use in clinical areas. They suggest further research is required to explore these issues in more detail so nursing education and practice can move into the future (O’Connor & Andrews, 2015). Addressing the many sociotechnical barriers is required when
implementing mobile technology within the clinical areas (O’Connor & Andrews, 2015).

Mobile technology in learning and teaching
Smartphone use and mobile technology has carved a niche in the area of tertiary education. This is associated with: portability of Wi-Fi; cellular networks; apps; and high-resolution screens. These communication technologies have provided learning in and out of the classroom (George, Davidson, Serapiglia & Barla, 2010; Johansson, Petersson, & Nilsson, 2013; & Johnson, Adams & Cumins, 2012). Currently, students use mobile technology to assist their learning needs both on and off campus (Smith, Raine, & Zickuhr, 2011; Tindell & Bohlander, 2012). An Australian project investigating the use of iPods by student nurses studying off campus, found that there were significant benefits. These included an enhanced learning experience for the students and a positive teaching experience for educators. Although challenges arose from: connectivity difficulties; small screen sizes; compatibility of learning resources; and technology literacy levels, both students and educators were innovative and resourceful in managing these problems (Martyn, Larkin, Sander, Yuginovich, & Jamieson-Proctor, 2013).

In contrast however, researchers in the U.S. who studied undergraduate students enrolled in four different degrees, found that increased use of cell phones was associated with decreased academic performance. It was suggested that based on these findings, a review of policies affecting the use of mobile phones should be conducted in academic environments (Lepp, Barkley & Karpinski, 2015). Correspondingly, another U.S. study demonstrated that whilst 95% of students brought their mobile phones to their undergraduate class, 92% used their device to send text messages unrelated to their learning (Tindell & Bohlander, 2012).

It has been recently argued by some authors, that there is no such thing as a digital native who is able to engage and utilise technology information systems due to being simply being born into it (Kirshner & De Bruyckere, 2017). Instead however, it is argued that educators should review the learners: cognitive knowledge and skills, their attitudes and dispositions, and their meta-cognitive knowledge and skills rather than assuming their digital native status (Kirschner, 2015).
beginning stages in school settings when learner’s own mobile devices are encouraged, it is suggested that educators know when to use and when not to use these tools to teach by example (Kirshner & De Bruyckere, 2017).

A Canadian literature review found 52 studies relating to integrating mobile devices into nursing curricula. These consisted of randomised controlled, quasi experiments, qualitative and mixed methods studies. Findings from these studies suggested that there were benefits for nursing students in using mobile devices. Implementing such devices, however, posed challenges such as a lack of administrative support, and time/funding for education of faculty and students (Doyle, Garrett & Currie, 2013).

Correspondingly, the Canadian Association of Schools of Nursing (CASN) has embraced the integration of nursing informatics in curricula and professional practice by developing competencies expected on graduation. The competencies consisted of three domains: information and knowledge management; professional and regulatory accountability; and use of information communication technology (ICT). An overarching competency stated that the RN, as part of their undergraduate education and for entry-to-practice: ‘uses information and communication technologies to support information synthesis in accordance with professional and regulatory standards in the delivery of patient/client care’ (CASN, 2012, p.5). The CASN promoted the development of a culture within nursing education that embraced the integration of nursing informatics in curricula and professional practice. It suggested this be achieved by: dialogue amongst key players for integration of nursing informatics into nursing; increasing the capacity of nurse educators to teach nursing informatics; and to develop nursing informatics outcome based objectives for undergraduate curricula (CASN, 2012).

An U.S. study assessing undergraduate and graduate nurse programs for nursing informatics competencies, found that they were competent in: basic computer knowledge; attitude to clinical informatics; and wireless device skills. In contrast, however, the students perceived themselves as not competent in applied computer skills and in the clinical informatics role (Choi & De Martinis, 2013). These later findings point to the skills needed for future nurses in informatics and the establishment of a baseline of informatics competencies in nursing curricula.
Recommendation from nurse leaders and healthcare stakeholders in the U.S., argue that competencies in informatics are needed to adequately prepare students for evidenced-based practice and safe nursing care, on graduating into professional practice (Hebda & Calderone, 2010).

Findings from an Australian literature review on eLearning and ICT in nursing education, found students needed ongoing support and education with nursing informatics. It was argued that this initiative would enable lifelong learning skills for evidence-based care. To enable this process to take place, it has been suggested that increased time and adaption of education methods would be required by educators to incorporate eLearning into their teaching practice (Button, Harrington & Belan, 2013).

Many nursing programs in the U.S. have integrated informatics into the clinical, classroom and laboratory settings. It has been suggested, however, that more work needs to address constraints on mobile technology in the clinical settings. Concerns have also been raised in relation to cost factors such as; lack of IT support; lack of faculty acceptance; role modelling; and activities encouraging mobile technology (Raman, 2015).

Previous literature suggested nursing students used mobile technology devices in the form of tablet computers, to mentor and educate other nursing students (Bogossian, Kellett, & Mason, 2009). In relation to the influence of others, and role modelling, nursing staff gave positive feedback to students using mobile technology for education and learning, as they viewed its integration in education as progression of the nursing profession (Bogossian et al., 2009). In the same study however, some nursing students were reluctant to use their mobile technology resource due to the potential unprofessional image implications in front of patients (Bogossian et al., 2009).

Research conducted in New Zealand with nurse managers and nursing students in regards to mobile technology use in clinical settings, revealed students preferred its use as an educational referencing tool for clinical decision making (Mcnally, Frey, & Crossan, 2016). Managers in the same study however, perceived its use as unprofessional, and did not trust younger cohorts of student nurses to act ethically when using this technology. The authors recommend that without a change
in the perceptions held by nurse managers, with resolution of the valid safety concerns, the use of mobile technology in clinical areas may remain covert and unregulated (McNally, Frey, & Crossan, 2016).

Mobile technology use by healthcare professionals

Information and computer technology are changing the way that health professionals deliver patient care (Smedley, 2005). This change is associated with the advances in healthcare technologies. Nurses face the challenge of managing quality, safe patient care with an increase in clinical information and technological advances (Doran, Haynes, Kushniruk, Straus, Grimshaw, Hall, Dubrowski, Di Pietro, Newman, Almost, Nguyen, Carryer, & Jedras, 2010). A pilot study aimed at assessing nursing students’ technology skill level and perceived barriers to technology, found that learning new technologies was seen as important for advancement within nursing. Students perceived that although technology skills were not critical to entering the nursing field, they felt these skills were critical to their current position and essential for their promotion. The participants felt that although they valued technology, training and exposure were major barriers to learning new technologies in the workplace (Virgona, 2013).

An Australian survey of 43 health professionals, found that 91% owned a mobile phone, and 87% used their personal mobiles to support their clinical practice. Despite these findings, however, the participants had reservations in using their mobiles in the clinical setting. Concerns related to patient confidentiality; cross-infection; whether apps were permitted at their workplace; and whether patients and colleagues might perceive that the mobile was being used for non-work purposes (Koehler, Vujovic & McMenamin, 2013). Despite these reservations, there continues to be an increase in the number of health professionals using smartphones and other mobile devices in the clinical setting (Mosa, Yoo & Sheets, 2012).

In a survey of 821 nurses, 75% owned a smartphone and 66% had an iPhone or iPad device (Springer Publishing, 2011). According to a survey of 130 hospitals in the US by networking vendor Aruba Networks, about 85% of hospitals allowed employees to bring and use their own mobile devices, including cell phones, smartphones, laptop computers and tablets. Within these hospitals, more than 50%
allowed employees to access the hospital Internet, about a quarter allowed them some access to hospital applications, whilst only 8% allowed full access to the hospital network (Aruba Networks, 2012).

Recent research into personal smartphone use by nurses in acute care settings in the US across six hospitals, revealed whilst most participants (98%) used a smartphone in the acute care setting, participants older than 50 years were less likely to use a smartphone in acute care settings and to agree with the benefits of smartphones (Flynn, Polivka, & Behr, 2017). Based on the results of the study, the authors concluded a critical need exists for acknowledgment that smartphones are used by point-of-care nurses in many ways, and that a need for realistic policies for its use is required. Patient care would then be enhanced and potential distractions for nurses would be minimized (Flynn, Polivka, & Behr, 2017).

A cultural change in regards to the clinical use of mobile technology has been identified in recent literature (Farrell, 2016). Qualitative findings of a recent mixed method study with the use of iPhones by nurses, reported that using mobile technology was integral to the modernization of the workplace (Farrell, 2016). Furthermore, the study reported a degree of evolution and change was occurring in ward culture for mobile technology use (Farrell, 2016). In moving into the future, however, it was suggested in the study that a larger screened device such as an iPad would have benefits in patient education. The iPad might not be as useful for communication, however, as it cannot be put into your pocket like a smartphone (Farrell, 2016).

A systematic review of healthcare apps for smartphones found that they made useful tools in the clinical setting. They were used in providing evidence-based practice at the point of care, for mobile clinical communication, and for remote monitoring of patients. Importantly, smartphones could play a role in patient education and self-management of health (Mosa, Yoo & Sheets, 2012).

An Australian study of nurses’ use of an online website evidence resource at the point-of-care, revealed 58% of nurses had heard of the site, with 70% of the sample using the websites. Senior nurses more than other nurses most frequently used the resource and had a greater awareness of the site. Whilst the resource was used to fill knowledge gaps and for personal education, findings indicated that
managerial and supervisor support was significant in legitimising information seeking (Gosling, Westbrook & Spencer, 2004).

A UK-based, multicentre, cross-sectional survey study, explored the ownership rates and use of smartphones among doctors and nurses in the clinical setting. Across five hospital sites, 98% of doctors and 95% of nurses owned a smartphone, with 92% of doctors and 53% of nurses finding them ‘very useful’ or ‘useful’ in performing their clinical duties. Medical apps were used as part of their clinical practice with 89% of doctors and 67% of nurses accessing these from their smartphones. Staff sent patient related clinical information on these devices, which raised concerns for healthcare organisations to develop policy to support the safe and secure use of these technologies (Mobasher, King, Johnston, Gautama, Purkayastha & Darzi, 2015).

**Policy and guidelines associated with mobile technology use in the clinical setting**

In the clinical setting, nurses, midwives and nursing students are obligated to practice under the guidance of hospital policies, guidelines and standards with direction from nurse managers, nurse educators and nurse executives. For new nurses in the clinical setting, the challenge in using mobile technology for learning, means balancing learning resources with these regulations. There could be a potential gap in the transition of theory to practice when there are discrepancies and inconsistencies with policies and guidelines addressing the use of mobile technology. In a UK study, challenges affecting compliance when distinguishing between essential and irrelevant policies and guidelines within hospitals, was found to affect staff morale. Issues such as: policy and guideline length; complexity; accessibility; volume; and failures to consult with other health professionals; were seen to be part of the challenge. The study recommended rationalisation and the standardisation of policies and guidelines at national and local levels (Carthey, Walker, Deelchand, Vincent & Harrop Griffiths, 2011).

The National Institute for Health and Care Excellence (NICE) launched two apps concerning evidenced-based clinical guidelines. These were freely available for National Health Service (NHS) staff on their mobile devices. This initiative suggested that the message to clinical staff is that it is acceptable to access these
guidelines on mobile devices in clinical settings (Moore, Anderson, & Cox, 2012). Locally in WA, Sir Charles Gairdner Hospital (SCGH) nursing staff are encouraged to access professional development and educational opportunities using a scanned quick response (QR) code on posters located around the hospital. This code is a two dimensional (2-D) matrix that is often referred to as a barcode (Denso, 2011). It can be scanned by mobile device apps that enables an Internet link to access the information contained in the poster. Staff are encouraged to scan the QR code for a ‘registration form’, or for a ‘smartphone form’. It is assumed that staff can use their mobile devices, but there are no accompanying guidelines for their use in clinical settings.

Within the clinical setting, many hospitals originally banned phones due to anecdotal evidence and fear that they might interfere with clinical monitoring of patients and pacemakers. The Australian Mobile Telecommunications Association (AMTA) reported however, that neither the American Medical Association (AMA) nor the UK Medicines and Healthcare products Regulatory Agency (MHRA) condone blanket bans on using mobile phones in hospitals. Alternatively, both these organisations encourage hospitals to develop local guidelines to minimise the risk of interference, by taking into account local circumstances, including the location of sensitive medical equipment (Australian Mobile Telecommunications Association [AMTA], 2015). The risk from interference, however, appears to be low. The Mayo Clinic in the U.S. conducted 510 tests of 16 different medical devices with 6 cellular phones. Only 1% of the tests performed, demonstrated clinically important interference. The researchers suggested that if no clinically important adverse effects occur as a result of using cellular telephones in the hospital, then it seems that the advantages that this technology brings to the institution and patients would be well received (Tri, Severson, Firl, Hayes & Abenstein, 2005). Although there remains a low risk for interference, most organisations and critical care areas are advised to keep mobile phones one metre away from the bedspace (Lieshout, Veer, Hensbroek, Korevaar, Vroom & Schultz, 2007). This is consistent with evidence of discrepancies within the clinical settings, where (as previously highlighted) a memo to clinical ICU staff indicated medical staff can use mobile devices at least 1 meter from equipment, but nurses are instructed to turn off these devices.
A study reporting the perceptions of administrators, staff and project leaders about factors influencing implementation of nursing best practice guidelines, found that individual, organisational and environmental issues influenced guideline implementation. The study recommended that best practice guidelines could be better implemented, by tailoring them to specific groups of stakeholders and to the individual practitioner (Ploeg, Davies, Edwards, Gifford & Miller, 2007). Role modelling evidence-based practice, was found to be an important factor in the transition from novice to expert practitioner with nurse leaders providing pivotal support (Buonocore, 2004; Byram, 2000).

Correspondingly, the authors of a recent important discussion paper regarding benefits and barriers of mobile technology use at the point of care for nursing in Australia, highlight the need for appropriate governance in healthcare environments. The authors argue, due to the rapid uptake of mobile technology use, a paradox exists in clinical settings. Although mobile technology use is recognised to enhance nursing practice, and for ongoing learning and development, nurses are limited by unclear guidance. Within Australia, the Australian Nursing and Midwifery Accreditation Council (ANMAC) states that nursing programs require the inclusion of nursing informatics and technology (Australian Nursing and Midwifery Accreditation Council [ANMAC], (2012); & Australian Nursing and Midwifery Accreditation Council [ANMAC], (2014)). Reform is required in clinical settings however, to enable implementation at the point of care (Mather, Gale, & Cummings, 2017). In Australia, the rapid uptake and use of mobile technology has outpaced its governance within healthcare settings (Mather, Gale, & Cummings 2017). The authors argue that although mobile technology use is recognised to enhance nursing practice, and for ongoing learning and development, nurses are limited by unclear guidance from governing bodies (Mather, Gale, & Cummings, 2017).

Furthermore, an Australian study revealed that for undergraduate nurses, personal and professional use of information technology has outpaced the development of policy, or codes of practice for guiding its use in the workplace (Mather, Cummings & Allen, 2014). The study revealed that undergraduate nurses limit their access to non-work or non-patient centred information when undertaking work integrated learning, but expect easy mobile access to ensure safe and competent care (Mather, Cummings & Allen, 2014).
An integrative review of nurse’s attitudes toward meaningful use technologies like mobile technology, revealed that nurses’ perceptions of meaningful use technologies are most influenced by peer support and the overall effect of the technology on existing processes and workflow (Scott, 2017). These meaningful use technologies intend to improve healthcare quality, safety, and care coordination (Scott, 2017). The author suggested that proactively engaging nurses as full stakeholders in implementing and improving these technologies can increase acceptance and positive perceptions of its use, to ensure improvements in patient care (Scott, 2017).

A recent study focused on the perceptions and experiences of nurse managers in British Columbia in the Bring Your Own Device (BYOD) phenomenon within nursing practice. The study suggested specific policy was required about how personal mobile technology should be used in clinical settings, and this included boundaries and expectations of use (Martinez, Borycki, & Courtney, 2017). A recent study of nurse leaders in the U.S. into the clinical use of personal mobile technology with staff, suggested more concerns than benefits. The study, however, suggested caution for the implications of the findings, suggesting clinical nurses at the point of care who were not included in the study may find significant benefits (Brandt, Katsma, Crayton, & Pingenot, 2016). More research is required, therefore, to investigate both nurses and nurse leader’s perspectives into the factors that may influence clinical mobile technology use.

A recent Australian mixed method study reported qualitative findings on the use of iPhones by nurses in an acute setting revealed benefits at the point of care with patients including enhanced communication. Negatives included small screen sizes when educating patients, and the perception of unprofessional use with patients and family (Farrell, 2016). An important conclusion to the study, recommended that nursing leaders and managers in education and clinical settings to develop policy to ensure the potential benefits can be woven into the everyday practice of nursing (Farrell, 2016). The author states that more research is needed to realize the potential of these technologies and the impact on patient outcomes (Farrell, 2016). The study suggests a significant theme emerged that mobile technology was so well embraced, that it would become such a necessary clinical tool such as the stethoscope for clinical areas (Farrell, 2016).
A qualitative, descriptive study of student’s experiences in clinical settings when using mobile technology, identified that students felt ‘stuck in the middle’ due to a lack of clarity around mobile technology use. In some cases it was supportive, and in others, it was non-supportive (Beauregard, Arnaert, & Ponzoni, 2017). Due to challenges associated with contextual clarity, inconsistent expectations from preceptors, and the concern of professional image when using mobile technology clinically, students formed adaptations to its use. Adaptations included strategies demonstrating they could be trusted in use of the device, such as continuous disclosure explaining what the device is being used for. As identified by the author, having to constantly adapt, ultimately, may discourage students using mobile technology as a valuable point of care resource (Beauregard, Arnaert, & Ponzoni, 2017).

Another study reviewing nursing students perceptions of using mobile technology at the point of care, found more time was actually spent with patients, by looking up information to improve quality of care with enhanced safety (Grabowsky, 2015). Opportunities for patient education may be missed if there are no clear guidelines or policies informing professional, clinical use of mobile technology.

Furthermore, a U.S. study reviewing what information patients and family was provided for an Intensive Care Unit (ICU) admission, was examined across four different hospitals (Schnock, Ravindran, Fladger, Leone, Williams, Dwyer, Vu, Thornton & Gazarian, 2017). Results revealed that despite a need for clear information, patients and family had no central or easily accessible standard source of educational content (Schnock et al, 2017). Furthermore, it was recommended that a web based digital learning centre be built around different stages of the ICU admission, as this would leverage easily accessible technology to access the content on demand (Schnock et al, 2017).

Canada and the U.S. seem to be leading innovations, however, in guiding professional mobile technology use in clinical settings. One of these innovations involves eLearning courses promoting mobile technology in healthcare settings and in health education. These are available free online for nurses to undertake (Registered Nurses Association of Ontario [RNAO], 2017) Detailed hospital information sheets and posters from nurses to patients, advise of mobile technology
use by staff and for patient education is another initiative that guides professional use (Registered Nurses Association of Ontario [RNAO], 2017).

When there are inconsistencies and discrepancies with clear guidelines or policies available across clinical settings, students and graduate nurses may use their personal mobile technology in a covert manner. Previous research with nursing students, identified that were covert and discreet with their clinical mobile use, as the culture of the unit or ward, impacted their use of mobile technology clinically (Doyle et al. 2014; Strandell-Laine, Stolt, Leino-Kilpi, Saarikoski, 2015; Pimmer, Brysiewicz, Linxen, Walters, Chipps, & Gröhbiel, 2014).

Additionally, previous research with nurses in acute settings found that even when policy that restricted clinical use of mobile technology, nurses perceived the benefits outweighed the risks of being caught out by nurse leaders (Bautista & Lin, 2016). The study conducted from in-depth interviews with nurses across thirteen hospitals in the Philippines, reviewed sociotechnical components on nurses’ use of mobile technology at work (Bautista & Lin, 2016). The study found that mobile technology use was instrumental for the nurse’s role. Although its use was prohibited by most hospitals, however, nurses justified their covert use for clinical purposes and for the benefit of their patients (Bautista & Lin, 2016). Other findings within the same study included that nurses used their own devices as there were no hospital provided devices for use, and that senior nurses and managers also influenced their use (Bautista & Lin, 2016). The research suggested that hospitals should consider revisiting their policies regarding nurses’ use of personal mobile phones at work as the devices can improve work productivity. Clear and constructive guidelines were recommended for its use considering the work related benefits (Bautista & Lin, 2016).

When nurses felt their organisation had high levels of facilitating conditions of both physical and technical infrastructures supporting the use of the technology, high levels of technology acceptance was noted (Aggelidis & Chatzoglou, 2009; Asua, Orruno, Reviriego, & Gagnon, 2012). The authors of a study involving both nurses and medical staff, noted these facilitating conditions included: support and technical help when the technology was implemented, available equipment, and importantly end-user involvement in the decision making process (Asua, Orruno,
Reviriego, & Gagnon, 2012). Further research is required, therefore, to investigate the levels of support available in hospital settings in the clinical use of mobile technology for graduate nurses.

Factors influencing the use of mobile technology in healthcare

An Australian study of nurses found a number of principle barriers to the use of information and computer technology (ICT) in the clinical setting. These included: current work demands; access to computers; and a lack of support. The study identified that these barriers, must be addressed by local administrators and managers at a state and national level (Eley, Fallon, Soar, Buikstra & Hegney, 2008). The study focused on ICT as a ward based computer system or application for patient data entry, with no specific mention of mobile technologies. Also considerable developments in mobile technology and learning for healthcare applications have occurred since the study was published. A need therefore, is to investigate the factors that may influence a new nurse graduate’s use of technologies such as mobile devices.

Technology acceptance models for individuals and organisations have analysed the impact of social influences and cognitive instrumental processes on the acceptance of mobile technology (Venkatesh & Davis, 2000). Cognitive instrumental processes included whether the technology was seen as having job relevance; having a high output quality; and a demonstrable result within the clinical setting (Venkatesh & Davis, 2000).

From the social influence perspective, a meta-analysis of technology acceptance found the influence of others, was related to the perceived usefulness of the technology and the intention to use it in the workplace. These people of influence were those perceived as important in the organisation, and may or may not have given directions for its use. The matter of compliance could be associated with the intention to use the technology. The other social influence was the internalisation effect of interpreting information from important others, as evidence of reality leading to perceived usefulness (Schepers & Wetzens, 2006).

A study within a tertiary education setting, found that peers strongly influenced undergraduate students. It was noted that students were more technology
ready and sensitive to trends. They were also influenced by technology
characteristics than non-students or older users (Schepers & Wetzels, 2006). The
findings from the study have implications for nursing, nurse managers and nurse
educators when considering mobile technology for the clinical settings. It also points
to the need to conduct a further study to identify and explore potential factors to the
use of mobile technology from the graduate’s perspective.

Mobile technology is changing the way in which nurses intervene, access
health information, and communicate. This enhances health promotion, and the
prevention, diagnosis, and treatment of illness (Doswell, Braxter, DeVito Dabbs,
Nilsen, & Klem, 2013). The rapid introduction of mobile technologies and mHealth
into nursing practice, dictates that educators must train our current and future nurses
to be prepared to deliver these new strategies of care (Doswell, Braxter, DeVito
Dabbs, Nilsen, & Klem, 2013).

In summary, evidence suggests that nursing students and nurses are keen to
continue to learn with resources they utilise on their mobile devices, but evidence on
potential factors to using these when transitioning to clinical settings is limited. The
research proposed will seek to identify these potential factors.

The Technology Acceptance Model (TAM) theoretical framework
The Technology Acceptance Model (TAM) first originated in the 1980’s to
investigate individual users acceptance and behaviour to technology and systems
(Davis, 1989). The TAM model suggests that users evaluate a technology and/or
system based on its Perceived Ease Of Use and Perceived Usefulness (PU). If the
technology and/or system is perceived as easy to use and useful, then the user has a
positive attitude to the system, leading to the decision and Intention To Use (ITU)
the system leading to its actual use (Davis, Bagozzi & Warshaw, 1989; Holden &
Karsh, 2010). The TAM has had strong empirical findings and has been replicated in
many information technology studies (Chen, Yang, tang, Huang & Yu, 2008; Putzer
& Park, 2010; Shoham & Gonen, 2008; Zhang, Cocosila & Archer, 2010). For
example, a study in the US using the TAM found that community hospital nurses,
were influenced by several factors in their use of smartphones. These factors
included: observing others using a smartphone; the perceived compatibility of the
smartphone to other technology in the work setting; and the internal environment of the work setting. The environment included such factors as the size of resources and support from management (Putzer & Park, 2010).

Similarly, recent mixed methods research used the TAM model to evaluate student nurses perceptions of usefulness and ease of use of technology within an undergraduate nursing program. Both quantitative and qualitative results and findings suggested that overall, students perceive technology as useful and easy to use (Williamson & Muckle, 2017). The term ‘technology’, however, was broadly defined as: e-books; clinical reference software on handheld devices; polling software; interactive whiteboard systems; learning management systems; and medium/high-fidelity simulation devices (Williamson & Muckle, 2017).

The TAM model consistently explained a substantial proportion of the variance in usage intentions and behaviour of technology acceptance. It compared and was adapted from well-known alternative models, such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) (Venkatesh & Davis, 2000). The TPB postulates that a person’s intentions/behaviour was based on three main determinants including: a personal component which reflects the individual’s attitude to the behaviour; a social influence or social pressure to perform or not perform the behaviour also titled subjective norm; and finally, a sense of efficacy or ability to perform the behaviour, termed perceived behavioural control (Ajzen, 2005). The TPB was an extension of TRA, which included the additional determinant of perceived control over the performance of the behaviour (Montano & Kasprzyk, 2015).

Findings from a literature review of the TAM in healthcare settings, demonstrated that TAM can predict a substantial portion of the use or acceptance of health information technology (Holden & Karsh, 2010). Following the study it was found that for important future directions, the TAM could benefit from several additions and modifications specifically to the health care context (Holden & Karsh, 2010). The TAM, and variations of the model such as TAM2, however, have been criticised by some scholars due to its self-reporting structure, versus an objectively measured approach (Legris, Ingham and Collerette, 2003; Yousafzai, Foxall and Pallister, 2007; Venkatesh & Davis, 2000).
A key weakness and limitation of TAM, was that the causes and explanations of the variables such as usefulness and ease of use were not identified. Some scholars within the literature, however, have criticized TAM research for adding variables unsystematically, raising the risk of a less coherent TAM theory (Benbasat & Barki, 2007).

Despite the criticisms, the TAM it was extended to the TAM2. This extension included key social influences and cognitive variables that were considered as assisting in determining the barriers and facilitators in the acceptance of technology (Holden & Karsh, 2010; Legris, Ingham, & Collerette, 2003; Venkatesh & Davis, 2000). An integrative literature review demonstrated that the TAM2 could provide a better explanation of nurses’ acceptance of healthcare technology (Strudwick, 2015).

The TAM2, whilst appearing to fit this study, is not without potential limitations and weaknesses. The original authors noted in their important study, that their sample sizes were less than 50 for each of their four longitudinal samples (Venkatesh & Davis, 2000). The smaller sample sizes, risked reducing the power of the significance of the tests. Most of the findings across all four studies, however, were significant and the small sample sizes provided assurance that levels of significance observed, indicated meaningful effect sizes (Venkatesh & Davis, 2000).

Another problem identified with TAM2, was that four of the variables were measured with only two questions or items. The original authors noted within their study, however, reliability or validity concerns were not warranted, as adequate reliability was measured with high Cronbach alpha scores along with strong factorial validity (Venkatesh & Davis, 2000).

As this study will use nurse graduates voluntary use of mobile technology, a foreseeable weakness in using the TAM 2 for this study was its focus on mandatory usage of technology in industry with only two sites classified as voluntary (Venkatesh & Davis, 2000). Furthermore, the study found that social influences for voluntary usage of technology, was non-significant (Venkatesh & Davis, 2000). Despite this finding, however, it is argued that the TAM2 model may demonstrate a significance of these variables, since complex social relationships and cognitive forces may influence graduates in the clinical setting. Additionally, incorporating the
TAM2 framework will assist in answering the research questions. It includes the following variables (see Figure 1):

- Subjective Norm (SN) (expressing the influence of colleagues, supervisors, and patients);
- Image (expressing the status of the individual in the organization);
- Job Relevance (JR) (showing the importance of the technology for the job);
- Output Quality (OQ) (reflecting the perceived system’s output); and
- Results Demonstrability (RD) (expressing the ability of the individual to share with others the results of using the technology (Venkatesh & Davis, 2000))

Figure 1. The Technological Acceptance Model 2 (TAM2) (Adapted from Venkatesh & Davis, 2000)

**TAM2 Variables**

The TAM2 model incorporates the variables of social influence processes of Subjective Norm (SN), and Image. Social influences impacting behavioural intention to use technology in the clinical setting was found to be significant (Holden, Brown, Scanlon, & Karsh, 2012). In one study evaluating bar coded medication administration technology within the clinical area, found that social influence...
predicted behavioural intention as nurses were influenced by peers, patients, medical staff and administrators (Holden, Brown, Scanlon, & Karsh, 2012). A similar finding demonstrated that when nurses used technology such as hospital information systems, the social influence of others predicted their behavioural intentions (Aggelidis & Chatzoglou, 2009). There are minimal studies, however, that have investigated the impact of the TAM2 variables of social influence on graduate nurses use of mobile technology in clinical settings.

An extensive literature review across a number of domains including health, revealed gender played a significant role in determining the intention to accept technology (Goswami & Dutta, 2016). Previous research, by one of the original TAM2 authors, revealed that women used technology or systems when there was less effort required, with a lower Perceived Ease Of Use (PEOU) due to higher levels of technology anxiety (Venkatesh & Morris, 2000). Such a finding was unsurprising when conducted on mandatory usage in industry, and could be different now that most people in the community commonly use technology.

In addition, previous research linked a stronger social influence effect, when females were seen to be more sensitive to the suggestions of their peers. This influence was stronger when they formed an Intention To Use (ITU) the technology (Venkatesh, Morris, Davis, & Davis, 2003). The same study also revealed that females were more anxious than men in using technology. This resulted in a reduction in their self-effectiveness, leading to increased perceptions of the effort required to use the technology (Venkatesh et al, 2003). It is argued that given these findings from TAM2 studies, both the social and cognitive influences of graduate’s intentions to use or not to use mobile technology in clinical settings needs to be explored.

Cognitive instrumental processes related to how the individual formed a perceived usefulness (PU) judgement, by comparing the technologies capabilities with what needed to be done in their job or role. Perceived Usefulness (PU) suggests that if the nurse believes the technology is useful they are more likely to accept it in the clinical setting. Other studies have suggested that was considered useful as it enhanced patient safety; improved care quality; and/or increased efficiencies (Strudwick, 2015). The cognitive variables include: Job Relevance (JR); Output
Quality (OQ); Result Demonstrability (RD); and Perceived Ease Of Use (PEOU) (Venkatesh & Davis, 2000).

Previous research with nurses and hospital staff for computer based technology within a hospital setting, revealed Job Relevance (JR) as a significant independent predictor of technology acceptance (Ketikidis et al., 2012). In a different setting, home care nurses found that the use of PDA’s was not of Job Relevance (JR) and was not a significant predictor of technology acceptance (Zhang, Cocosila & Archer, 2010). It could be suggested from these findings that the significance of the TAM2 variable of Job Relevance (JR), may be mainly associated within hospital settings. Further research could expand on potential differences between specialities and clinical settings.

An integrative literature review, concerning nurses’ use of healthcare technology using the TAM model and TAM2 found that TAM has been applied to nursing populations since the year 2000 but only twenty included nurses. Sixteen were noted that used extended versions of TAM such as TAM2 (Strudwick, 2015). This shortage of evidence suggests that although research is continuing, it is still in its infancy and needs more to explore factors that may affect nurse’s use of technology in healthcare.

Conclusion
This brief literature review uncovered limited studies on nurse graduates clinical use of mobile technology. It did, however, suggest that student nurses are familiar with its use and are taught and encouraged to use it in the University setting. This finding was deemed important, as the perspectives of student nurses may have an influence on their use of mobile technology when practicing in the clinical area on graduation. This study investigates these factors in seeking answers to the research questions.