Review

Mobile technology in nursing education: where do we go from here? A review of the literature

Janet Raman *

Adelphi University, College of Nursing and Public Health, One South Avenue, Garden City, NY 11530, United States

ABSTRACT

Background: The International Council of Nurses (ICN), Sigma Theta Tau International Honor Society of Nursing (STTI), and many National Nurses Associations (NNAs), have called for the integration of information technology into nursing curriculums to prepare nursing students for the current practice environment which requires access to large amounts of information to provide evidence-based patient care. Nurse educators have begun to address the integration of technology in nursing curriculum, but are the available tools, in particular, mobile devices loaded with informational applications, being maximized?
Literature Review Aims
The aims of this literature review are to 1) explore the literature written on the use of mobile technology in nursing education; 2) methodically discuss the benefits and concerns involved in using mobile technology in nursing education; and 3) consider strategies for enhancing the use of mobile technology in nursing education.
Review Methods
A search was conducted on the use of mobile technology in nursing programs in Academic Search Complete, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Medline with Full Text, and Medline Journals. Seventeen studies, published within the last five years in peer-reviewed journals regarding the mobile technology in nursing programs were identified.
Findings
Although many nursing programs have implemented the use of mobile technology in the clinical, classroom, and laboratory settings, more work needs to be done to overcome the concerns related to: cost, lack of IT support, lack of faculty acceptance and role-modeling, lack of structured assignments and/or activities designed to encourage the implementation of mobile devices; and constraints on their use in clinical settings.
Conclusion: While much has been done to incorporate the use of mobile technology in nursing curriculum, nurse educators are encouraged to develop strategies to overcome the concerns noted. Possible strategies to overcome the concerns are discussed herein.

Introduction

The use of mobile technology, both in personal and professional activities, is here to stay. The need for nursing students to become proficient in the use of information technology (American Association of Colleges of Nursing, 1999; Canadian Nurses Association, 2006; Cronenwett et al., 2007; International Council of Nurses, 1997, National League for Nursing, 2008; Nursing Council of New Zealand, 2010; Sigma Theta Tau International Honor Society of Nursing, 2006) has been identified for some time now. Therefore, studies on the implementation of mobile technology in nursing education are most welcome. This literature review will examine the findings of recent research, including the value of this technology and the concerns related to its usage.

Implications for nursing programs, including actions that might be taken to overcome some of the concerns, as well as recommendations for future research, will also be explored.

Background

Mobile technology entered the general educational environment around two decades ago, and more recently in nursing programs (Swan et al., 2013, p. 192). Su and Liu (2012) mention that "mobile devices are increasingly being used to extend the human mind's limited capacity to recall and process large numbers of relevant variables to support information management, general administration, and clinical practice" (p. 1139) in the nursing environment. Because of the need to access evidence-based information swiftly in health care, personal digital assistants "(PDAs) and other handheld computing devices are becoming a valued addition to the toolbox of information technology

* Tel.: +1 917 653–2137; fax: +1 516 877 4558.
E-mail address: raman@adelphi.edu.

(IT) resources used by nurse educators" (George, Davidson, Serapilgia, Barla, & Thotakura, 2010, p. 374). Mobile technology in nursing programs has been implemented in the clinical setting (Beard, Greenfield, & Morote, 2011; Brubaker et al., 2009; Chioh et al., 2013; Cibulka & Crane-Wider, 2011; George et al., 2010; Hudson & Buell, 2011; Johansson et al., 2012; Kuiper, 2010; Secco et al., 2013; Swan et al., 2013; Williams & Dittmer, 2009; Wittmann-Price et al., 2012; Wu & Lai, 2009; Wyatt et al., 2010), in the classroom setting (Beard et al., 2011, Brubaker et al., 2009, Chioh et al., 2013; Cibulka & Crane-Wider, 2011; De Marcos Ortega et al., 2010; George et al., 2010; Hudson & Buell, 2011; Martyn et al., 2014; Swan et al., 2013; Wyatt et al., 2010), and in the laboratory/simulation setting (Schlairet, 2012; Swan et al., 2013). Since many studies discuss the high cost of mobile technology, as well as other concerns (Beard et al., 2011; Cibulka & Crane-Wider, 2011; George et al., 2010), it becomes vital for nurse educators to ensure that use of this technology is maximized.

Aims

The aims of this literature review are to 1) explore the literature written on the use of mobile technology in nursing education, 2) - methodically discuss the benefits and concerns involved in using mobile technology in nursing education, and 3) consider strategies for enhancing the use of mobile technology in nursing education.

Review Methods

A search of the literature was conducted on Academic Search Complete, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Medline with Full Text, and Medline Journals, selected. Three hundred and seventeen journal articles meeting the high-level search criteria were found. Key search phrases and database results are cited in Table 1.

Key terms included "nurses," "nursing students," "personal digital assistants," "mobile technology," and "handheld devices." After eliminating studies more than five years old, duplicates, articles related to non-nursing health care professionals, opinion pieces, published studies involving only practicing nurses and not students, dissertations, and articles on social media, seventeen published studies involving the use of mobile devices in nursing educational settings met the criteria for inclusion (Table 2).

Findings

Benefits

Kuiper (2010) found that implementing technology in nursing programs would facilitate the students' success in current "technology-rich" (p. 13) practice, and that it will increase nursing students' "confidence in computer ability, computer self-efficacy" (p. 11), both of which will help graduate nurses prepare for employment in the present practice environment. Many of the studies in this literature review found that nursing students liked the accessibility to data that mobile devices, loaded with informational applications, afforded them

(Beard et al., 2011; Brubaker et al., 2009; Cibulka & Crane-Wider, 2011; Johansson et al., 2012; Wittmann-Price et al., 2012).

Further, it was discovered that the use of mobile technology improved nursing students' learning and performance in the clinical setting (Beard et al. 2011; Brubaker et al., 2009; Chioh et al., 2013; Cibulka & Crane-Wider, 2011; George et al., 2010; Hudson & Buell, 2011; Johansson et al., 2012; Kuiper, 2010; Secco et al., 2013; Williams & Dittmer, 2009; Wittmann-Price et al., 2012; Wu & Lai, 2009; Wyatt et al., 2010) by providing them with easily accessible, current evidence-based facts. Mobile devices were also shown to facilitate classroom learning (Beard et al., 2011; Brubaker et al., 2009; Chioh et al., 2013; Cibulka & Crane-Wider, 2011; George et al., 2010; Swan et al., 2013; Wyatt et al., 2010) by helping nursing students stay "organized" (Chioh et al., 2013, p. 41) and by providing a way to simply reference information (Beard et al., 2011; Cibulka & Crane-Wider, 2011). Wyatt et al. (2010) found that the students utilized their mobile devices to supplement reading assignments (p. 112), and that the interactions between the teachers and students were improved, which enhanced their learning (p. 112). Schlairet (2012) and Swan et al. (2013) found that mobile devices enabled learning in the simulation laboratory as well. All of these factors have been shown to enhance nursing student success and contribute to competent nursing practice.

Concerns

The considerable cost of mobile devices was seen as a disadvantage (Beard et al., 2011; Cibulka & Crane-Wider, 2011; George et al., 2010; Wittman-Price et al., 2012) to their utility in nursing education. This is particularly troublesome since many nursing students may have limited funding available for their education.

Although information technology (IT) support was implemented to facilitate the use of the mobile technologies as in most of the studies reviewed, some of the studies' participants still spoke of not having enough (Brubaker et al., 2009; Cibulka & Crane-Wider, 2011; De Marcos Ortega et al., 2010; George et al., 2010; Martyn et al., 2014; Swan et al., 2013; Wu & Lai, 2009). Brubaker et al. (2009), George et al. (2010), and Swan et al. (2013) reported that it took faculty and nursing students too long to learn the technology. Small screen size (Martyn et al., 2014) and declining battery life of the devices (Cibulka & Crane-Wider, 2011; Wittman-Price et al., 2012) were also seen as shortcomings.

Beard et al. (2011), Cibulka and Crane-Wider (2011), and Secco et al. (2013) mentioned that lack of faculty development, faculty's resistance to change, and lack of role-modeling by faculty were detriments to nursing students' success in using mobile technology. Swan et al. (2013) discovered that resistance to the use of mobile devices and lack of role-modeling seen in practicing clinicians was also problematic. Swan et al. (2013) additionally noted that the nursing faculty needed more guidance in integrating "the technology into lesson plans, classroom activities, simulations and clinicals" (p. 192). Undoubtedly, nursing faculty must become proficient in, and actively utilize, informational applications on their mobile tools. Nurse educators must also develop specific assignments and/or activities that can be implemented to increase nursing students' proficiency.

Table 1
Search terms and databases used.

Search terms:	"and"	Database:	Number of articles found:
Nursing students	Personal Digital Assistants, mobile technology, handheld devices	Academic Search Complete	24
		CINAHL	22
		Medline with full text	15
		Medline, Journals selected	4
Nurses	Personal Digital Assistants, mobile technology, handheld devices	Academic Search Complete	164
		CINAHL	48
		Medline with full text	40

Some clinical sites have, or are creating, policies prohibiting using mobile devices in the hospital clinical areas as patient confidentiality can be compromised if nursing students use non-approved applications during care (Swan et al., 2013; Wittmann-Price et al., 2012). And, since many sites only grant computer access to employees (Wu & Lai, 2009, p. 191), it is necessary to address this issue for the nursing students.

Discussion

A review of the literature regarding the use of mobile technology in nursing education revealed that mobile technology has been widely implemented in the clinical setting, and to a lesser extent in the classroom and laboratory settings. But how successful has this application been in light of the many concerns noted? The problems found regarding the use of mobile technology must to be addressed.

Many of the studies were able to provide mobile devices to the nursing students through grant funding but this is not always the case. In many situations, nursing students are required to purchase their own mobile devices and/or the necessary informational applications. Perhaps nursing education faculty and institutional information technology services can explore options that will produce needed financial support (Zurmehly, 2010). They should also encourage distributors of applications that can be used on the students' mobile devices to permit purchasing of the applications in bulk to reduce cost as well. Nurse educators may wish to examine what are the total required purchases and/or fees incurred by their students, in addition to tuition, to determine if any of the mandatory resources are being duplicated and thus can be removed (Zurmehly, 2010). For example, must the nursing students purchase a medical dictionary when one is provided in a needed application?

Increased IT support can be sought to improve the faculty and students' proficiency in using their mobile devices. The distributors of the required applications can be encouraged to provide greater IT support, along with improved support from university-based IT departments. Additionally, introducing mobile technology early in the curriculum, for example in Informatics courses, and then integrating it throughout the curriculum, may increase the nursing students', and faculty's, competency (Zurmehly, 2010).

Small screen size is necessary in some instances, especially in the clinical setting, so that nursing students can have devices that easily fit into their pockets. However, the use of tablets is becoming more common and may solve this issue (Swan et al., 2013). Shortened battery life can be addressed with battery charger cases on mobile devices.

Additional training for the nursing faculty is needed to enhance faculty's familiarity with mobile technology. As noted above, more training can be implemented by the providers of the applications and further supported by the universities' IT and/or faculty development departments. Time must be allowed for training (George et al., 2010; Swan et al., 2013; Zurmehly, 2010). Certain members of the faculty can be identified as "super-users" to support their colleagues in becoming more comfortable and proficient with these tools. With more training, nurse educators will more likely to buy-in to working with mobile technology and will more readily role-model the use of these products.

Developing specific assignments and/or activities involving the use of mobile technology, that can be implemented by the nursing faculty will also be most helpful. Specific assignments and/or activities to encourage the use of mobile devices were not explicitly addressed in the literature, for the most part. Cibulka and Crane-Wider (2011), however, did mention that clinical questions were asked of the students, who then looked up solutions on their PDAs (p. 116). Cibulka and Crane-Wider (2011) further permitted some students to use PDAs during exams (p. 116). K. Williamson (personal communication, January 6th, 2015), a nurse educator in the U.S.A. has developed a "Clinical Preparation Tool," which consists of case studies followed by questions that are answered using an informational application on a mobile device, and a "Scavenger Hunt," which directs nursing students to look up

information as well. This author has developed Case Study Exams that require the use of reference applications on mobile devices for implementation in pharmacology courses, and students have been asked to reference items from their applications in Health Assessment Lab at this author's university (D. Ambrosio, personal communication, January 4th, 2015). Information technology could also be added to other classroom activities, such as in flipped classrooms, "group projects" (Zurmehly, 2010, p. 180), and in other ways that have not yet been created and/or published as of this current time.

The literature revealed that use of mobile technology during clinical rotations has been quite successful. However, the use of these devices has been and may become further curtailed by the facilities that are utilized for nursing students' clinical experiences due to institutional concerns over patient privacy. Since clinical facilities are becoming increasingly reluctant to grant nursing students permission to use their mobile devices in the clinical setting (Swan et al., 2013) more conversations can be held with the clinical organizations to resolve this problem, especially as nurse educators are preparing future nurses to join the work force. Clinical organizations, at the very least, need to be encouraged to permit nursing student access to their institutional information technology. Perhaps, nursing programs can partner with the local clinical organizations to share institutional information technology with the students, and to share the required nursing program applications with the nursing staff in the institutions. This will encourage role modeling by the staff as well. Health care institutions and nursing programs have begun to develop policies regarding communication devices and the use of Internet and/or social media in clinical agencies that may serve to assuage these fears.

Additionally, due to the current clinical restrictions, nursing education may wish to explore additional ways to implement the use of mobile technology in the classroom and laboratory settings to comply with the ICN's Position Statement of 1997 (International Council of Nurses, 1997) by developing new assignments and/or activities as discussed above.

Limitations of Literature Review

While the search for literature about mobile devices was comprehensive, articles that are not yet in print, dissertations (which are not peer reviewed), or missed studies may have added more insight to the review. However, this review can be considered adequate as the themes and concerns resounded throughout the literature.

Conclusion and Recommendations

Although it is clear that progress has been made since the ICN Position Statement (International Council of Nurses, 1997), work is necessary to make mobile devices more easily accessible to students and to encourage and enhance the practice of working with mobile technology in nursing education. Although the incorporation of mobile technology in nursing curriculum has been studied in many different countries, little literature exists regarding what can be done to address the concerns discovered. More assignments and/or activities involving the use of mobile technology need be developed and integrated into the curriculum for use in classroom and laboratory settings and research regarding the success of these assignments and/or activities should be reported. Additionally, more reflection is needed regarding the various concerns about the use of mobile technology, especially in an environment with increasing clinical facility constraints.

The question then, is posed—where do we go from here? Some of the possible solutions have been presented herein but nurse educators need to continue to advance towards the goals of the original ICN Position Statement (International Council of Nurses, 1997) by meeting these challenges and sharing the discovered solutions.

Table 2
Summary of literature findings MD = mobile device.

Author(s)/year/country	Research question(s)	Sample	Procedure	Research design/methods	Data analysis	Key findings
Beard et al. (2011) USA	Program evaluation	Sample: n = 95 (convenience sample). Students were in a traditional baccalaureate program. Sample: 90.4% female; between the ages of 18–30 years; Caucasian: 54.7%; African American: 15.8%; Asian: 13.7%; Hispanic: 1.1%; English as their first language: 75%.	Nursing based software package (drug guide, laboratory and diagnostic test reference, nursing care plan guide, medical dictionary, disease and disorder guide) installed on multiple platforms was required by students at beginning of junior year.	Mixed methods: Descriptive exploratory study. Instruments: 17 item survey (faculty-developed) containing five questions related to demographics, and 9 Likert-style questions and ranking order questions.	-Descriptive statistics.	Ninety-six point seven percent used mobile device in clinical. Sixteen point two percent stated it helped prevent clinical errors. Fifty-eight point seven percent used the software package while studying for class. Forty-six point seven percent used the software package during class. Fifty-six percent liked the accessibility to (and large amount of) information, including the medication content. It was also reported that many of the students did not like the cost of the program, the lack of information, experienced technical problems, and reported difficulty using the software. Limitations: not discussed.
Brubaker et al. (2009) USA	1) How does the availability of Personal Digital Assistant (PDA) technology influence the information-seeking behaviors of nursing student in the clinical setting? 2) Which PDA references/applications do students find most useful? 3) Which PDA references/applications do students regard as nonessential? 4) What challenges arise when using PDAs in the clinical setting?	Sample: n = 7 (convenience sample). Sample: senior nursing students.	Students received a PDA with reference software installed and classroom instruction for its use.	Pilot study: qualitative, descriptive design. Instruments: clinical logs. The students then provided a written summary addressing the research questions.	-Data analyzed using NUD*IST Vivo (NVivo) software for emerging themes.	Themes: Related to information-seeking behaviors: 1) Convenience 2) Time Management 3) Nursing Theory 4) Up-to-date information. 4) Usefulness of references/applications. 5) Challenges 6) Technology Limitations: not discussed.
Chioh et al. (2013) Singapore	1) What was the usability of the Personal Digital Assistant (PDA) in the classroom and clinical setting for first year nursing students? 2) What were the students' perceptions on the use of PDA in enhancing their learning in the classroom and clinical setting?	Sample: n = 456 (convenience sample). First year diploma nursing students.	The Hewlett Packard Pocket Personal Computer and PDA classic were required and used by Year One nursing students. The students had a two week workshop to familiarize themselves to the use of the PDA operating systems and the various applications.	Quantitative: Prospective longitudinal one group pre-post-test design. A questionnaire was developed by the researchers containing 65 Likert-scale items.	-Descriptive statistics using percentages were used. Pearson's Chi-square was used to investigate the pre-post responses, with significance taken at $p < 0.01$.	Eighty-one point nine percent and 79% of the students surveyed found that the PDA was useful for clinical practice and the classroom setting, although the students' perception after the use of the PDA was less positive than their perceptions in the pre-survey Limitations: surveys were anonymous, unable to determine how the students' perceptions had changed after using the PDA. Another limitation was that the study lacked generalizability.

Cibulka and Crane-Wider (2011) USA	1) What factors should be considered when selecting a Personal Digital Assistant (PDA)? 2) How does the use of PDAs affect students' information-seeking behavior in both the classroom and clinical setting? 3) What components of a PDA program do students most readily adopt? 4) What are common barriers to PDA adoption?	Sample: $n = 95$ (convenience sample). Sample: Nurse practitioner (NP) students: $n = 22$, 91.6% female; between the ages of 30–40; Caucasian: 87.5%. Baccalaureate nursing students $n = 73$, 91.6% female; aged in their early 20s; Caucasian: 100%.	NP students purchased a software package that included clinical consult guide, a prescribing reference, differential diagnosis tool which was introduced to the NP students in their Adult Health Course and Baccalaureate nursing students purchased a software package that included a drug reference guide, a medical and nursing dictionary, diagnostic and laboratory reference guide and a nursing diagnosis handbook which was introduced to the baccalaureate students in their Pharmacology course.	Quantitative: Instruments: Online survey, which obtained the students' information seeking behaviors, use of their devices, barriers to using a PDA and degree of satisfaction with their PDAs in an academic setting.	-Descriptive statistics.	Seventy-three percent of the NP students used device in clinical. Ninety-five percent of the NP students felt device helped them in the clinical and the classroom setting. Ninety percent of the undergraduate students used the device. Approximately 24% of the undergraduate students used the device in other courses besides clinical. The undergraduate nursing students also indicated that the high cost of the program, keeping their devices charged and insufficient technical support were barriers to the use of the program. Limitations: not discussed.
De Marcos Ortega et al. (2010) Spain	The aim was to test the degree to which mobile self-assessment improves the achievement of nursing students.	Sample: $n = 28$ (purposive sample). Sample: Third year-nursing students aged between 20 and 21 years in experimental group. $N = 28$ in control group.	A Web-based system was designed and built to support mobile self-assessment in traditional class-based learning and uploaded by the experimental group. Teachers uploaded and configured tests. The system was designed to reinforce previously acquired knowledge, not to gain new knowledge.	Experimental design. Instruments: Students in experimental group took self-assessments and an attitudinal survey on their mobile device. Cronbach alpha was .86.	-Descriptive Statistics.	The students' achievements showed no difference in the mean scores between the experimental and control group. The results of the "attitudinal survey" were fairly positive. The researchers further noted that the younger students had higher levels of improvement in achievement. Limitations: not discussed.
George et al. (2010) USA	1) How are students enrolled in nursing programs using Personal Digital Assistants (PDAs)? 2) What are the facilitators and barriers to use of PDAs by students in nursing programs?	Sample: $n = 48$ (convenience sample). Sample: Graduate students: $n = 5$. Undergraduate students: $n = 42$. No academic level indicated: $n = 1$. The age distribution was: 54.2% range 18–24 years of age, 18.8% were between 25 and 34 years of age, 22.9% were 35–44 years of age, and 4.2% were over 45 years. 45 females; 3 males.	PDAs were distributed to graduate and undergraduate nursing students with programs containing: Davis Drug guide®, laboratory and diagnostic manual®, RN Diseases and Disorders®, Taber's Cyclopedic Medical Dictionary® and Nursing Diagnosis Handbook® prior to their first clinical experiences.	Quantitative: Instrument: A questionnaire.	-Descriptive statistics.	Fifty percent of the students used program daily. Ninety-six percent of the students used it in clinical. Fifty-six percent of the students used it in the classroom. Eighty percent of the students used it for educational purposes as reference devices in the classroom and clinical environment. Seventy-one percent of the students said it improved their efficiency. One hundred percent of the students found it to be an effective educational tool. Barriers to the use of PDAs included: cost, extra time needed for teaching and learning how to use new devices, and perceived lack of technical support and discomfort with technology. Limitations: Small sample size of 48 respondents, sample self-selected, male and graduate students were underrepresented.

Table 2 (*continued*)

Author(s)/year/country	Research question(s)	Sample	Procedure	Research design/methods	Data analysis	Key findings
Hudson and Buell (2011) USA	What were the characteristics of Personal Digital Assistant (PDA) uptake and use in both clinical and classroom work for baccalaureate student nurses (BSN).	Sample: $n = 105$ completed the pretest (purposive sample), During the first pretest the age range was 19–43 (mean age 23 years); female 89 (85%), male 15 (14%); Caucasian 82 (78%), Black 15 (14%), Hispanic 4 (4%), Other 2 (2%), unanswered 2 (2%). Sample: baccalaureate student nurses.	The nursing students purchased the PDAs as part of the nursing course requirements. The software included pharmacology, laboratory information, medical dictionary, patient teaching, health assessment, nursing procedures, pathophysiology, calculations, foreign language interpretation and North American Nursing Diagnosis Association nursing diagnoses. Technical support was available from the software company by telephone. A 45-minute educational session was also implemented during the general nursing orientation.	Quantitative: Single-Group pretest/posttest design. A PDA assessment tool was developed using Delphi methods.	-Descriptive statistics.	At the end of the senior year, the remaining students ($n = 75$) that were using the PDAs was 30 (40%) and 51 (87%) of them disagreed or strongly disagreed that they were having difficulty understanding the technical aspects of the program. Ten (13%) of those students agreed that they felt that they would lose some reasoning skills and become dependent on the device. Forty-two students (56%) of the students stated that they had not used the PDA in clinical. They reported that the PDA did not enhance their classroom learning at all, eight (11%) felt that it "somewhat" enhanced their classroom learning, and one (1%) felt that the use of the PDA "very enhanced [sic]" their classroom learning. Limitations: not discussed.
Johansson et al. (2012) Sweden	An exploration of nursing students' experience of using a Personal Digital Assistant (PDA) in clinical practice.	Sample: $n = 67$ (random sample). Sample: From three final semesters of three consecutive undergraduate nursing degree programs, Average age: 27.3 (range 21–50); Gender: 78% female; 22% male.	Nursing Students were supplied with PDAs (contained pharmaceutical and medical resources and a medical calculator, guidelines/techniques for treatment, and acts and regulations for nursing) during clinical practice in the three final semesters of three consecutive undergraduate nursing degree programs.	Mixed methods: Interventional study. Nursing students answered a pre- and post-questionnaires and focus groups.	-Descriptive statistics and content analysis. The data from the focus group was coded and "emerging categories" were identified.	Post-questionnaire showed that the majority of students partly agreed or totally agreed that the PDA was useful in their clinical practice, gave them a higher degree of confidence in their clinical practice, might be useful in increasing the quality of care, patient safety and saving time. The nursing students noted that immediate access to information was helpful especially where access to computers was limited. Limitations: not discussed.
Kuiper (2010) United States	1) Do people use computers if they perceive benefits from that use? 2) Are behavioral intentions to use computers influenced by attitudes towards using technology?	Sample: $n = 26$ (convenience sample). Sample: Baccalaureate nursing students. Mean age: 23.42 years, range (20–33). Eighty-eight percent female; and 11% male. Caucasian: 100%. Unmarried: 73%.	Nursing students used a personal digital assistant (PDA) during a clinical experience.	Mixed methods: A revised Computer User Perceptions Questionnaire (at week one). Computer Self-Efficacy Measure (at weeks 2 and 8) and journal prompts as the students completed weekly journals. A "PDA clinical log" was also utilized.	-Content analysis. Repeated measures design was used to describe metacognitive strategies, computer perceptions, computer self-efficacy of students who used PDA for eight weeks in clinical. Computer User Perceptions Questionnaire: Cronbach's alpha > .80, factors loading > 0.7. Cross-tabs and chi-square tests were used to compare pre- and post tests on Computer Self-Efficacy Measure. Computer Self-Efficacy Measure: Internal consistency reliability >	The students reported that data was more readily available and easier to find, "better than carrying around textbooks." "When using the PDA I feel confident." The results indicated a significant improvement of confidence when using a PDA, that the PDA was frequently used in clinical setting, and that the students were confident it would increase work output ($r = -.60.\ p < .05$), improve clinical performance and work effectiveness ($r = -.51, p < .05$).

	0.80, factors loading > 0.7.	Limitations: small sample size, voluntary participation, and selection from a singular area of the Southeastern USA. Prior use of self-regulated learning strategies for journals and prior use of PDA's might also have been limitations.

Martyn et al. (2014) Australia	1) How does the introduction of the iPod Touch affect distance learners' interactions with course content? 2) How does the introduction of the iPod Touch affect distance learners' patterns of communication with instructors and peers? 3) Which capabilities of the mobile devices are valued by distance learners and for what purpose? 4) What constraints are evident in the use of the mobile devices to support distance learning? 5) What modifications to university study resources are necessary or desirable to optimize their use on the iPod Touch or similar mobile devices?	Sample: $n = 40$ (purposive sample). Sample: Twenty nursing students from across two academic semesters in two courses at two universities.	The nursing students were provided with iPods by the researchers.	Mixed methods: Online survey tool pre- and post the two semesters in which they used the iPods. Archival discussion posts and instructors' and students' journals were maintained and analyzed to reveal common themes and information obtained in focus groups was also analyzed.	-Quantitative data was analyzed using SPSS19 to determine frequencies and relationships between demographic variables and mean scores on the pre- and post- surveys with chi-square and paired sample t-tests. The qualitative data was analyzed using Leximancer to determine themes.	Emerging themes: Connectivity Technology Literacy Level Compatibility of Resources Screen Size Limitations: not discussed.
Schlairet (2012) USA	1) Are nursing students' knowledge and attitude scores following a Personal Digital Assistant (PDA)-assisted Simulated Clinical Experiences (SCE) equivalent to textbook-assisted scores?	Sample: $n = 44$ (convenience sample). Sample: first semester baccalaureate nursing students. Sample: 89% female, mean age of 22 years (range 20–47), Nontraditional (older than 25 years or second degree): 7%, Non-Caucasian: 25%.	Pilot study during simulation Assigned PDA (drug lab, lab manual, clinical diagnosis tool, dynamic medical information channels and other information) vs textbook resources. Students developed/implemented/evaluated nursing plans of care using either PDAs (intervention) or traditional text-based resources (control), and took a multiple-choice knowledge test to measure basic nursing knowledge with content taken from an NCLEX-RN® preparation test. First without the use of PDAs or textbooks, and then two days later using PDAs or textbooks.	Mixed methods: Questionnaire Q-CN Form I was used to collect data on students' attitudes towards computers, consisting of Likert-type items. The knowledge test results were compared by t-tests. Intervention group completed a modified format of the Impact Assessment Scale (IAS) modified with two open ended questions	-Q-CN Form I: Cronbach's alpha 0.91 and 0.92. 20-item multiple-choice knowledge test measuring basic nursing knowledge with reliability coefficient of 0.73.	The mean scores for the knowledge tests between the intervention and control group when students used PDAs or textbooks were not statistically significant, therefore equivalence was established. Attitudes between the intervention and control group were not statistically significant. The intervention group through use of the IAS reported: Positive impact on nursing practice, Improvement in practice, learning/recall, information confirmation. Limitations: Small sample size and associated power issues. The students' brief exposure to PDAs and short duration of the intervention phase were also mentioned to be limitations.

Table 2 (continued)

Author(s)/year/country	Research question(s)	Sample	Procedure	Research design/methods	Data analysis	Key findings
Secco et al. (2013) Canada	Evaluation of the students' perspectives who used Nursing Central®(NC) in a clinical practice rotation.	Pilot Study. Sample: $n = 31$ (convenience sample).Third and fourth year students from a baccalaureate nursing program. Sample: The average age was 25.86 years, ages ranged from 20 to 43 years.	The students were provided with the Nursing Central® software which was donated by the parent company Unbound Medicine. This software program contained Taber's Medical Dictionary®, Davis's Drug Guide for Nurses®, Davis's Comprehensive Handbook of Laboratory and Diagnostic Tests®, Davis's Diseases and Disorders®, Handbook of Nursing Diagnosis®, as well has Medline® search capability. The fourth-year students were oriented to NC in the classroom, and the third-year students were oriented in the clinical setting before using in the clinical rotation.	Mixed methods study. Online survey consisting of 25 Likert items and three textboxes.	-Not described.	High rating of NC as having overall helpfulness as a resource during the clinical rotation ($M = 4.69$). One student found it hard to navigate, also found negative attitudes among older nurses. Study noted that Nursing Central® as a tool supports clinical learning. Limitations: not discussed.
Swan et al. (2013) USA	1) How does tablet technology affect student and faculty teaching-learning processes? 2) What are the outcomes in an accelerated, pre-licensure baccalaureate program?	$N = 17$ students (convenience sample) and $n = 9$ faculty. Sample nursing students were in an accelerated pre-licensure baccalaureate program.	Tablets were integrated into classroom teaching, simulation/laboratory sessions, and clinical experiences. Faculty and students received technical and instructional design support.	Qualitative descriptive design. Focus groups were held to elicit data from students and faculty.	-Not described.	Faculty noted that they needed more time and instruction on how to incorporate the technology into lesson plans, classroom activities, simulations, and clinicals, although they felt that the tablets supported the integration of different teaching strategies with classroom content. Students felt that there was a disconnect between the faculty's syllabi and what was talked about in class and available on their tablets. The students also noted that the faculty had varying levels of ability to work with the tablets. In clinical, the use of the tablets was met with resistance by the clinicians. The students also liked the ease of having textbooks electronically. Limitations: not discussed.
Williams and Dittmer (2009) USA	1) What are students' current information retrieval practices? 2) Do their practices change when given handheld devices with e-books? 3) What are students' perceptions of the role of handheld e-books with clinical nursing courses? 4) How do students use	Sample: $N = 63$ (random sample). Sample: BSN students in their sophomore, junior, and senior clinical courses.	Students were either selected to work with a Personal Digital Assistant (PDA) which was provided to them or were placed in control groups. The experimental groups received handheld devices loaded with a bundled e-book package consisting of RNDiseases®, RNLabs®, and Davis Drug Guide® to use during their clinical rotation. The experimental group received training in the use	Multiphase, quasi-experimental design with control groups and experimental groups. Pretest posttest design.	-The data was analyzed in SPSS: versions 11.0 and 14.0. Posttest data was analyzed using one-way ANOVAs ($p < .01$) to reveal differences between the means of perceived helpfulness of the different resources.	Students in the control and experimental groups both (64%) perceived that they had expanded their use of information resources and retrieval skills. The mean of the perceived helpfulness of the different resources was statistically significant at $p = <.01$. Fifty-six percent of the students felt that they prepared for clinical more efficiently and were more effective in clinical

Study	Research questions	Sample	Intervention	Methods	Analysis	Results
	handheld e-books while delivering nursing care? 5) What is the role of the library with this technology?		of the PDA. Both the experimental and the control groups used standard preparation and care methods.			when using the handheld device. The students subjectively perceived that their use had saved time. Limitations: not discussed.
Wittmann-Price et al. (2012) USA	1) What is the frequency of smart phone use during a semester-long (10 week) clinical rotation? 2) What are senior nursing students' perceptions about smartphone use during a semester-long clinical rotation? 3) What are staff nurses' perceptions of student smartphone use?	Sample: n = 13 (convenience sample). Sample: Second-semester senior nursing students: n = 8, average age: 25 years, staff nurses: n = 5.	The students, and their clinical instructor, were provided with an electronic reference package which was purchased for them with grant money. The electronic package was used in a clinical setting.	Mixed methods: Pilot study. Data was obtained via survey, students' logs, and a focus group.	-Descriptive statistics, frequency distributions and content analysis. Themes were identified from the open-ended questions on the survey.	Students' perceptions of the electronic reference package included comments such as: The electronic device made patient care "so much easier", "so much faster" and increased the students' confidence. The themes that emerged were resource, confidence, and safety. The staff nurses surveyed did note the students using their handheld devices and noted that the handheld device had a positive influence on patient care. Limitations: Varied recording of data due to lack of instructions for the logs, two students did not use the package, one who didn't have a handheld device, and one who lacked technical skills.
Wu and Lai (2009) Taiwan	1) What were students' feedback on the features of the Personal Digital Assistant (PDA)-based environment in terms of advantages and disadvantages? 2) What were the benefits of the PDA-supported clinical practicum as compared to the previous ones? 3) What issues might occur when implementing such a PDA-based practicum session?	Sample: n = 6 female nursing students (convenience sample).	Constructed a wireless handheld learning environment for the nursing students containing resources for patient assessment, nursing dictionary, discussion forum and concept map programs.	Qualitative study. Implemented reflective journaling, open-ended questionnaires for the students, instructor, four nurses working on the same ward, and interviews of the students and instructor, and field observation journals in a clinical practicum session.	-The researchers examined the collected data and identified content. Themes were then identified.	Most students felt that they had benefitted from the PDA and saved time. The students found that the PDA made learning more efficient. The students reported that it supported learning in the clinical site. Limitations: There was a limited capacity of the PDAs and internet resources. Students' preconceptions about using PCs were also viewed as a limitation.
Wyatt et al. (2010) USA	1) Do cooperative and interactive mobile technology for learning (m-learning) techniques enhance classroom and clinical nursing education at multiple locations? 2) Is there a relationship between m-learning and students' learning styles?	Sample: n = 22 (convenience sample). Sample: Nurse Practitioner students from two difference programs. Sample: Female: 22, Caucasian: 95%; African-American: 1, Less than 40 years of age: 64%; over 40 years of age: 36%.	Students and faculty were registered on a SharePoint® collaborative m-learning website and introduced gradually to the Personal Digital Assistants (PDAs) by tutorials with access to technical support. The applications for the PDAs included: ePocrates®, Shots 2006®, ClassInHand®, and Skype®, among others. In Phase 1, students initially used their PDAs in clinical, and then in the classroom setting. In Phases 2 & 3, students had assignments that promoted cooperative learning.	Mixed methods: Pre-test, post-test design. Students also participated in a focus groups.	-The principal investigators recorded extensive field notes. Content analysis used to identify themes. The data from the pretest and posttest questionnaires were analyzed by SPSS 15.0. Nonparametric McNemar test was computed. The level of significance was set at .05.	Results showed that students significantly increased their use of their PDAs as reference tools. Using interactive m-learning activities with the PDA facilitated both classroom and clinical learning. Students used their PDAs to supplement reading assignments in classroom and clinical settings, found PDAs helpful with classroom case studies. Limitations: not discussed.

References

American Association of Colleges of Nursing, 1999. The essential clinical resources for nursing's academic mission. (Retrieved). http://www.elsevier.com/nedt.

Beard, K.V., Greenfield, S., Morote, E., 2011. Mobile technology lessons learned along the way. Nurse Educ. 36 (3), 103–106. http://dx.doi.org/10.1097/NNE.0b013e382161016.

Brubaker, C.L., Ruthman, J., Walloch, J., 390–391, 2009. The usefulness of Personal Digital Assistants (PDAs) to nursing students in the clinical setting: A pilot study. Nurs. Educ. Perspect. 30 (6), 390–391 (Retrieved from http://www.nln.org/nlnjournal/).

Canadian Nurses Association, 2006. Nursing information and knowledge management. (Retrieved from). http://www.elsevier.com/nedt.

Chioh, M.S., Yan, C.C., Tang, K.L., Mustaffa, S.M., Koh, M.G., Sim, T.W., Chan, Y.H., 2013. The use of the personal digital assistant by nursing students in the classroom and clinical practice: a questionnaire survey. Singap. Nurs. J. 40 (20), 38–44.

Cibulka, N.J., Crane-Wider, L., 2011. Introducing Personal Digital Assistants to enhance nursing education in undergraduate and graduate nursing programs. J. Nurs. Educ. 50 (2), 115–118. http://dx.doi.org/10.3928/01484834-20101230-07.

Cronenwett, L., Sherwood, G., Dlsch, J., Johnson, J., Mitchell, P., Warren, J., 2007. Quality and safety education for nurses. Nurs. Outlook 55 (3), 122–131. http://dx.doi.org/10.1016/j.outlook.2007.02.006.

De Marcos Ortega, L., Barchino Plata, R., Jiménez Rodríguez, M.L., Hilera González, J.R., Martínez Herráiz, J.J., Gutiérrez De Mesa, J.A., Otón Tortosa, S., 2010. Using M-learning on nursing courses to improve learning. Comput. Inform. Nurs. 29 (5), 311–317. http://dx.doi.org/10.1097/NCN/.0b013e3181fcbddb.

George, L.E., Davidson, L.J., Serapiglia, C.P., Barla, S., Thotakura, A., 2010. Technology in nursing education: a study of PDA use by students. J. Prof. Nurs. 26 (6), 371–376. http://dx.doi.org/10.016/j.profnurs.2010.08.00.

Hudson, K., Buell, V., 2011. Empowering a safer practice: PDAs are integral tools for nursing and health care. J. Nurs. Manag. 19, 400–406. http://dx.doi.org/10.111/j.1365-2834.2011.01251.x.

International Council of Nurses, 1997. Career development in nursing. (Retrieved from). http://www.elsevier.com/nedt.

Johansson, P.E., Petersson, G.I., Nilsson, G.C., 2012. Nursing students' experience of using a personal digital assistant (PDA) in clinical practice—an intervention study. Nurse Educ. Today 33, 1246–1251. http://dx.doi.org/10.1016/j.nedt.2012.08.019.

Kuiper, R., 2010. Metacognitive factors that impact student nurse use of point of care technology in clinical settings. Int. J. Nurs. Educ. Scholarsh. 7 (1), 1–6. http://dx.doi.org/10.2202/1548- 923X.1866.

Martyn, J., Larkin, K., Sander, T., Yuginovic, T., Jamieson-Proctor, R., 2014. Distance and devices—potential barriers to use of wireless handheld devices. Nurse Educ. Today 33, 457–461. http://dx.doi.org/10.1016/j.nedt.2013.04.021.

National League for Nursing, 2008. Position statement: innovation in nursing education: a call to reform. (Retrieved from). http://www.elsevier.com/nedt.

Nursing Council of New Zealand, 2010. Education programme standards for the registered nurse scope of practice. (Retrieved from). http://www.elsevier.com/nedt.

Schlairet, M.C., 2012. PDA-assisted simulated clinical experiences in undergraduate nursing education: a pilot study. Nurs. Educ. Perspect. 33 (6), 391–398 (Retrieved from http://www.nln.org/nlnjournal/).

Secco, M.L., Dorion-Maillet, N., Amirault, D., Furlong, K., 2013. Evaluation of Nursing Central as an information tool, part I: student learning. Nurs. Educ. Perspect. 34 (6), 416–418 (Retrieved from http://www.nln.org/nlnjournal/).

Sigma Theta Tau International Honor Society of Nursing, 2006. TIGER summit: Evidence and informatics transforming nursing. (Retrieved from). http://www.elsevier.com/nedt.

Su, K., Liu, C., 2012. A mobile nursing information system based on human–computer interaction design for improving quality of nursing. J. Med. Syst. 36, 1139–1153. http://dx.doi.org/10.1007/s10916-010-9576-y.

Swan, B.A., Smith, K.A., Frisby, A., Shaffer, K., Hanson-Zalot, M., Becker, J., 2013. Evaluating tablet technology in an undergraduate nursing program. Nurs. Educ. Perspect. 34 (3), 192–193 Retrieved from http://www.nln.org/nlnjournal/.

Williams, M.G., Dittmer, A., 2009. Textbooks on tap: using electronic books housed in handheld devices in nursing clinical courses. Nurs. Educ. Perspect. 30 (4), 220–225 (Retrieved from http://www.nln.org/nlnjournal/).

Wittmann-Price, R.A., Kennedy, L.D., Godwin, C., 2012. Use of personal phones by senior nursing students to access health care information during clinical education: staff nurses' and students' perceptions. J. Nurs. Educ. 51 (11), 642–646. http://dx.doi.org/10.3928/01484834-20120914-04.

Wu, C., Lai, C., 2009. Wireless handhelds to support clinical nursing practicum. Educ. Technol. & Soc. 12 (2), 190–204 (Retrieved from http://www.ifets.info/).

Wyatt, T.H., Krauskopf, P.B., Gaylord, N.M., Ward, A., Huffstutler-Hawkings, S., Goodwin, L., 2010. Cooperative m-learning with nurse practitioner students. Nurs. Educ. Perspect. 31 (2), 109–113 (Retrieved from http://www.nln.org/nlnjournal/).

Zurmehly, J., 2010. Personal digital assistants (PDAs): review and evaluation. Nurs. Educ. Perspect. 31 (3), 179–182 (Retrieved from http://www.nln.org/nlnjournal/).