Résumé

La situation de l'intégration de l'informatique au programme de baccalauréat en sciences infirmières : une étude systématique

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L'objectif de la présente étude était de dresser un portrait des résultats des recherches et autres projets concernant l'intégration de l'informatique dans les programmes de formation pour l'obtention du baccalauréat en sciences infirmières (B.Sc.Inf.), et de mettre en évidence les répercussions de cette intégration sur la formation et la recherche. L'examen systématique de la littérature sur la question mené par les auteures couvre la période de 1990 à 2011 et exclut les articles portant sur les étudiantes et les étudiants d'un niveau autre que le baccalauréat et sur les infirmières et les infirmiers déjà en exercice. Sur un total de 440 articles repérés, 53 ont été jugés comme répondant au critère d'inclusion établi pour l'étude, nombre auquel les chercheuses ont ajouté 21 autres articles en fonction de listes de mots clés de référence. L'examen des articles ainsi retenus a permis de constater des écarts quant à l'attention et au temps accordés à l'informatique dans les programmes de formation pour l'obtention du B.Sc.Inf., et quant aux stratégies déployées pour l'intégration de celle-ci. Les principaux problèmes cernés par les auteures sont une absence d'uniformité dans l'intégration des contenus en informatique et un manque d'études rigoureuses sur le processus et les résultats d'une formation en informatique. Il est donc nécessaire que les recherches se poursuivent afin de préciser, dans un premier temps, le contenu de base en informatique que doit comporter la formation de niveau baccalauréat en sciences infirmières, et d'effectuer, dans un deuxièmement temps, une évaluation systématique des effets de cette formation.

Mots clés : informatique, baccalauréat en sciences infirmières, programmes de formation, intégration des contenus

Status of Informatics Integration in Baccalaureate Nursing Education: A Systematic Review

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The purpose of this study was to map out results of research studies and other projects on the integration of informatics into BScN education and to highlight implications of this work for education and research. The systematic review of the literature from 1990 to 2011 excluded articles reporting on non-BScN students or nurses already in practice. A total of 440 articles were found, 53 of which were eligible for inclusion in this review; 21 articles were added based on reference lists of key works. Integration of informatics into BScN education was found to vary in terms of focus, duration, and strategies used. The main issues identified were inconsistent integration of informatics content and lack of rigorous research studies on the process and outcomes of informatics education. More work is needed to specify the core informatics content needed in BScN education, followed by a systematic evaluation of the effect of this education.

Keywords: nursing informatics, informatics, baccalaureate nursing students, curriculum integration

Inadequate informatics education affects the ability of graduate nurses to understand how informatics relates to patient care and nursing practice. Institutions charged with the education of health professionals have a responsibility to ensure that students acquire this knowledge (Canadian Association of Schools of Nursing [CASN], 2012). Nevertheless, the literature on the topic is limited and educational outcomes have not been tracked. This review was designed to address the gap. Its purpose was to map out the results of studies and other projects that have focused on informatics in baccalaureate nursing education and to highlight the implications of this work for education and research.

Literature Review

Defining Health Informatics and Nursing Informatics

Health-care informatics (HCI) is "the study of how health data, information, knowledge, and wisdom are collected, stored, processed, communicated, and used to support the process of health care delivery to clients and for providers, administrators, and organizations involved in health care delivery" (Englebardt & Nelson, 2002, p. 528). As an umbrella term,

HCI encompasses the various subspecialties of informatics, such as medical, nursing, and dental informatics. The development of these subspecialties enables better understanding of how information and communication technologies (ICTs) can be employed to meet the information needs of various disciplinary groups. Nursing has been among the first disciplinary groups to embrace informatics. According to Staggers and Bagley-Thompson (2002), nursing informatics (NI) "facilitates the integration of data, information, and knowledge to support patients, nurses, and other providers in their decision-making in all roles and settings . . . through the use of information structures, information processes, and information technology" (p. 260). Because nurses work in a multidisciplinary health-care environment, they benefit from both a general understanding of HCI and a more focused understanding of NI.

Enhancing Informatics Preparedness Among Nurses

Concerns about quality of care and patient safety have been key drivers of the increased interest in improving informatics competencies among health-care providers, especially nurses. Initiatives in these areas, such as TIGER (Technology Informatics Guiding Education Reform) and the Clinicians in Training initiative by Canada Health Infoway and CASN, are currently under way to accelerate informatics capacity-building among nurses and nurse educators (CASN, 2012; Weaver & Skiba, 2006). The American Association of Colleges of Nursing (2008) has mandated that graduates of BScN programs possess competence in informatics upon entry to practice. In Canada, the Canadian Nurses Association (2006) has affirmed that nurses' utilization of ICT is important for improving health-care and patient outcomes and therefore nurses should develop competence in ICT, have access to health information systems, and participate in decision-making related to investments in information technology.

Informatics Competencies

In professional education, the word "competence" is often used to denote performance expectations. A competency-based approach has been proposed for teaching informatics to nurses. Specifying informatics competency expectations for nurses guides the integration of these competencies in undergraduate and graduate nursing education as well as the pursuit of professional development through continuing education (CASN, 2012; Staggers, Gassert, & Curran, 2002).

A number of NI competencies have been proposed in the literature. The most commonly cited are those proposed by Staggers et al. (2001, 2002) in the United States. In this model, competencies are outlined in relation to the nurse's level of practice — novice nurse, experienced

nurse, informatics nurse specialist, informatics innovator. For each level, Staggers et al. (2002) propose a set of behaviours that nurses must display in order to meet the standard of competence. Recently, CASN in collaboration with Canada Health Infoway published *Nursing Informatics: Entry-to-Practice Competencies for Registered Nurses* (CASN, 2012). The Canadian model identifies an overarching competency that emphasizes proper use of ICT in the context of patient care and professional practice and three specific competencies with a set of indicators for each: (1) information and knowledge management, (2) professional and regulatory accountability, and (3) use of ICT in the delivery of care. Computer literacy is considered a foundational skill that candidates should possess upon entry to nursing programs.

Integration of Informatics Competencies in Baccalaureate Nursing Education

In spite of the availability of NI competency lists, the utilization and integration of informatics concepts in BScN curricula are still not fully developed (Nagle & Clarke, 2004; Thompson & Skiba, 2008). As Fetter (2009a) notes, "nursing programs have embraced distance learning and added informatics content, courses, and specific technologies; however, undergraduates students' and educators' skills are still considered inadequate" (p. 78). Fetter identifies several barriers contributing to this situation, the greatest being those related to wide variations in access to informatics and technologies in clinical agencies and inconsistent integration of informatics content into theory and clinical courses. In addition, the lack of consultation and collaboration between education and service providers often results in a mismatch between competencies required for employment and outcomes of education programs (Fetter, 2009a). Another key barrier to embracing informatics in BScN education is the lack of faculty knowledge, skills, and motivation to integrate informatics competencies into the curriculum (Curry, 2010; Thompson & Skiba, 2008). In a US national survey of nursing education programs, Thompson and Skiba (2008) found that faculty members considered online course work the same thing as informatics. With regard to faculty members' competence in informatics, 37% rated themselves as "competent" and 26% as "advanced beginners." The majority (82%) indicated that they were self-taught. In several instances faculty members equated being involved in distance learning, online learning, and Web-based instruction as being informatics-prepared. Nagle and Clarke (2004) report similar findings from a national survey of Canadian nursing schools. Less than 25% of faculty members surveyed integrated common software skills into their teaching and approximately 33% rated themselves as having little or no knowledge of the five areas of NI

educational requirements. Although faculty generally agreed that NI and ICT competencies are essential components of nursing practice, some still questioned the relevance of ICT for quality patient care. Furthermore, faculty felt that they had poor access to research databases, clinical information systems, and NI instructional development courses and stated that ICT systems were underdeveloped in a majority of institutions.

Two recent reviews of the literature on the integration of informatics into BScN education highlight additional shortcomings. Gracie (2011) examined literature in the period 2007 to 2011, with a specific focus on studies within the US baccalaureate nursing student population, and found 24 articles, with only four meeting the criteria of the review (conference proceedings were excluded from the review). The author reports inconsistencies in definitions of NI among academic settings and inadequate computer and informatics skills for today's health-care environment. De Gagne, Bisanar, Makowski, and Neuman (2011) evaluated the literature on informatics integration in BScN education from 2000 to 2010. The search yielded 59 articles, with 25 fully reviewed and 19 selected for inclusion. The authors report a lack of consensus on informatics concepts that should be included in BScN curriculum, concepts that should be considered a prerequisite to BScN education, and content that should be specifically covered in the program. Although these two reviews point to significant concerns and challenges in current informatics education at the BScN level, the issues identified are no different from those noted by Staggers and her team over a decade ago (Staggers et al., 2001). This begs the question, What has been achieved thus far in terms of enhancing capacity in informatics among future nurses?

Methods

We used a systematic review methodology guided by the research question *What methods/strategies and outcomes are associated with integration of informatics in BScN education?* The search criteria were limited to English-language articles published in CINAHL Plus with Full Text, Academic Search Complete, ERIC, Medline, and Science Direct from 1990 to 2011. The search terms were *computer literacy, information literacy, nursing informatics, health informatics, education, baccalaureate nursing students, integration in curriculum,* and *educational interventions.* Additional articles were included based on a review of the reference lists published in key peer-reviewed journals. Publications that reported on non-BScN students or nurses already in practice were excluded. All results were uploaded to a RefWorks account and duplicates were removed.

The authors reviewed the selected studies independently. For articles reporting on research studies, the data abstracted included author(s), year of publication, study design, type of educational strategy/method used, sample and response rate, outcomes examined, findings, and recommendations made by the authors. Only key recommendations were abstracted from publications classified as discussion reports. The authors checked one another's work for a random sample of 10 articles and found that they abstracted the same information for all of these articles with no discrepancies. Synthesis of study findings and statistical results could not be performed due to the heterogeneity of studies included in our review; therefore, the results will be reported using a narrative approach.
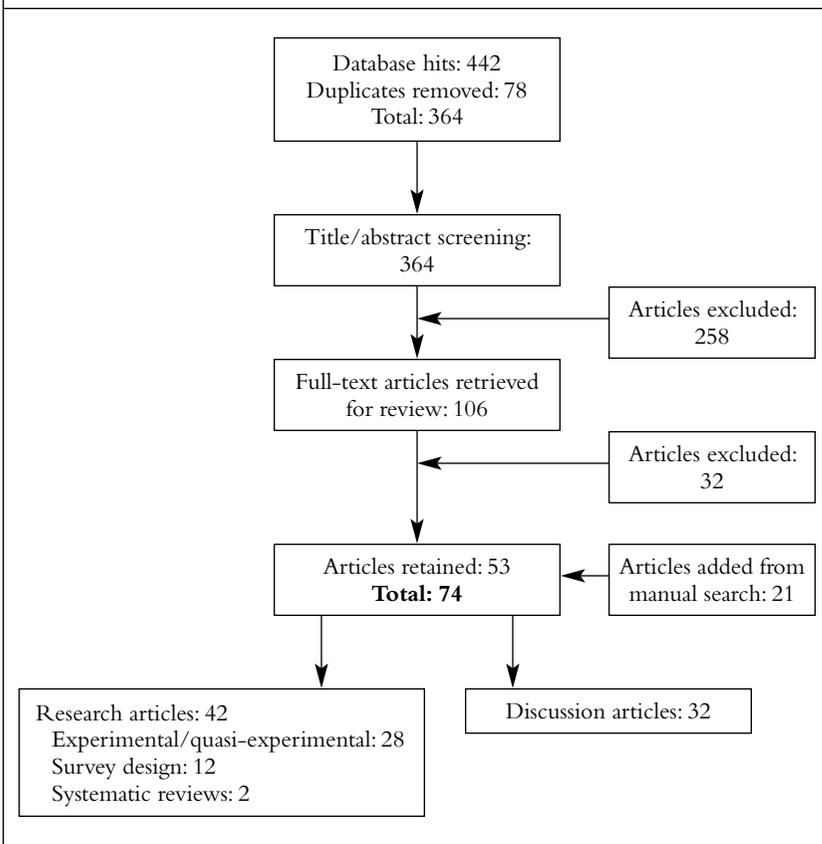
Results

Literature searches yielded 442 articles (Figure 1). After removal of duplicates and screening of titles, abstracts, and full-text articles for relevancy, 53 articles discussed the topic under review. An additional 21 articles were included following a manual search of the reference lists of peer-reviewed articles. For organizational purposes, we grouped the results into two categories: discussion articles ($n = 32$) and research articles ($n = 42$). Research articles were further classified by study design. In this review we focus on recent publications, with the exception of a few older articles that support key themes identified in relation to NI education. Access to all abstracted articles is available by contacting the authors.

Themes in Discussion Articles on Informatics Education in Nursing

The importance of informatics education among nursing students was a central theme in all articles. Skiba (2011) warns against a quick-fix approach to integrating informatics and calls for integrating informatics into all aspects of the curriculum. Building capacity in informatics among future nurses is a complex and multifaceted process requiring collective efforts. Initiatives such as TIGER and HITS effectively embed informatics across the curriculum using various strategies to enhance informatics competencies among both nursing faculty and nursing students and therefore should be promoted (Connors, Warren, & Weaver, 2007; Weaver & Skiba, 2006). Faculty buy-in and informatics preparedness facilitates the development of informatics competencies among nursing students; therefore, supporting faculty members in this process is key for accelerating development of competence among future nurses (Curry, 2010; Taylor, Hudson, Vazzano, Naumann, & Neal, 2010).

A number of strategies are recommended for enhancing readiness in informatics, including simulation (Donahue & Thiede, 2008; Linder & Pulsipher, 2008), PDAs (Martin, 2007), and online learning tools (Skiba,

Figure 1 *Informatics Integration in BScN Education: Search Strategy*

Database hits: 442
Duplicates removed: 78
Total: 364

Title/abstract screening:
364

Articles excluded:
258

Full-text articles retrieved
for review: 106

Articles excluded:
32

Articles retained: 53
Total: 74

Articles added from
manual search: 21

Research articles: 42
Experimental/quasi-experimental: 28
Survey design: 12
Systematic reviews: 2

Discussion articles: 32

Connors, & Jeffries, 2008). Access to health-care technology and experience with hospital information systems are identified as necessary for having students and nursing faculty relate to technology in the context of care (Borycki, Kushniruk, Armstrong, Joe, & Otto, 2010). Collaboration between service and academia as well as between faculty members and librarians is noted as important for facilitating informatics education (Melo & Hodson-Carlton, 2008; Schulte, 2008). Given the availability of research-based lists of competencies in informatics, some authors cite the importance of embracing these lists to help guide the integration of informatics in the nursing curriculum (Gassert, 2008). Fetter (2009c) outlines several challenges facing educational institutions, such as the lack of an appropriate informatics infrastructure to support student learning and collaboration between service and academia.

Themes in Research Studies on Informatics Education in Nursing

Findings from the research articles included in this review show a variety of methods and approaches currently being used to incorporate informatics into BScN education. Some programs offer NI as an elective course (Marini, 2000) and some offer assignments (Jacobsen & Andenaes, 2011). Few studies report on a systematic threading of informatics content across the nursing program (Desjardins, Cook, Jenkins, & Bakken, 2005; Travis & Brennan, 1998). Some programs provide laboratory learning experiences (Donahue & Thiede, 2008) and others a combination of theory and clinical application (Desjardins et al., 2005; Travis & Brennan, 1998). Some offer a theory component alone (Kenny, 2002). Content focuses mostly on skills related to computer and information literacy (Jacobsen & Andenaes, 2011; Marini, 2000). Few studies report on teaching core content in HCI and NI (Desjardins et al., 2005; Kenny, 2002; Travis & Brennan, 1998).

A variety of pedagogical strategies are currently being used in the delivery of informatics education. Some programs use simulation technology to provide hands-on experience in hospital information systems (Jones & Donelle, 2011; Lucas, 2010). The utility of mobile technology such as PDAs as a learning tool in clinical education is examined in a number of studies (Goldsworthy, Lawrence, & Goodman, 2006; Kuiper, 2010). Kenny (2002) reports on use of online learning to teach informatics content at the undergraduate level.

Outcomes associated with informatics education include attitudes, self-efficacy, gain score before and after an intervention, satisfaction with technology, and learning experiences. Evaluations of these outcomes are conducted using quasi-experimental/observational designs. Only one study used an experiment design (Goldsworthy et al., 2006). There are no follow-up studies examining the value of informatics education after graduates have joined the workforce.

A number of studies use a survey design to assess outcomes related to informatics competence. Most of these focus on outcomes related to computer and information literacy skills (Deltsidou, Gesouli-Voltyraki, Mastrogiannis, & Noula, 2010; Elder & Koehn, 2009; Jacobsen & Andenaes, 2011; Nayda & Rankin, 2009). Their findings show that computer and information literacy is relatively poor among nursing students (Deltsidou et al., 2010; Nayda & Rankin, 2009), with a tendency for students to overrate their computer skills (Elder & Koehn, 2009). Edirippulige, Smith, Beattie, Davies, and Wootton (2008) point out that self-reported mastery of computer skills is not an accurate indicator of the level of informatics competence required to safely use e-health applications. Other outcomes examined in these survey studies include self-

reported perceptions of and attitudes towards e-health (Edirippulige et al., 2008). Students' perceptions of and confidence in using ICT are identified as important predictors of use of ICT applications in clinical practice (Levett-Jones et al., 2009); however, nursing students' understanding of the relevance of ICT to clinical practice and their confidence in using these applications are hindered by lack of access and training in the hospital information systems being used in practice settings (Fetter, 2009b; Jetté, Tribble, Gagnon, & Mathieu, 2010; Levett-Jones et al., 2009). Moreover, students in rural settings tend to have less preparedness in information technology than their urban counterparts (Caison, Bulman, Pai, & Neville, 2008).

Discussion

Results from this review show the limited number of research studies reporting on integration of informatics at the BScN level. They also point to a number of variations in informatics education related to core informatics content being offered, type of learning experiences offered, and the approaches used for evaluation/assessment of learning or outcomes of education.

Theory and Clinical Informatics Content Being Offered

Competence is a major determinant of performance, encompassing knowledge, skills, attitudes, and traits (Kak, Burkhalter, & Cooper, 2001). Because education is one route to the acquisition of competence in a particular domain, it follows that curricula must address all aspects of informatics. According to Hwang and Park (2011), both basic computer skills and formal informatics education are strongly associated with informatics competence. Interestingly, most of the educational efforts reported in the literature are geared towards computer competency and information literacy. Theoretical core content on informatics is very limited at the undergraduate level. These findings are consistent with those of previous reviews on the topic (De Gagne et al., 2011; Gracie, 2011). While we agree that computer skills and information literacy are important for interacting with technology, we stress that these must be directly applied to patient care so that undergraduates learn to meaningfully use information technology applications in the clinical context (Jetté et al., 2010; Levett-Jones et al., 2009). A helpful strategy for nursing educators involved in the design of informatics instruction is to use the informatics competency lists available in the recent literature, as these detail aspects of expected competence for nursing graduates (Gassert, 2008). Clinical exposure and experience with clinical information systems are critical for

demonstrating to students how these applications work and how they affect patient care. Without such exposure, graduates' ability to manage day-to-day practice and safely use these applications may be compromised. In a survey of baccalaureate nursing graduates, respondents gave their lowest competence rating to "care documentation, planning, valuing informatics knowledge, skills development, and data entry competencies" (Fetter, 2009b, p. 86). Interestingly, these are some of the key skills that employers expect new graduates to possess upon entry to practice (McCannon & O'Neal, 2003). Graduates entering the workforce with perceived low levels of informatics competence learn by trial and error during the transition to practice and may become too focused on the technology to grasp the broad scope of informatics in the context of patient care. In order to enhance future nurses' competence and confidence in using health-care technology, nurse educators could, in collaboration with service providers, develop hands-on training in the informatics systems currently being used in health-care facilities (Jetté et al., 2010). Such learning experiences could help students develop their thinking and their decision-making in using technology in health care, both of which are highly desired outcomes of education for effective integration in current complex work environments (Candela, Dalley, & Benzel-Lindley, 2006).

Methods and Strategies for Teaching Informatics

In terms of pedagogical strategies, the increased use of simulation technology related to hospital information systems is encouraging. Students participating in these projects found that hands-on experiences with simulated hospital information systems boosted their confidence and eased their transition to clinical roles (Borycki et al., 2010; Lucas, 2010). Also encouraging is the increased use of mobile technology such as PDAs at the undergraduate level. PDAs facilitate learning through access to patient-related information or evidence-based resources in the clinical setting (Goldsworthy et al., 2006; Kuiper, 2010; Newman & Howse, 2007). In addition, PDA use improves students' confidence regarding computer ability, computer self-efficacy, and clinical reasoning skills (Kuiper, 2010). Studies have found significant associations between satisfaction with PDA use for learning and attitudes towards computerized documentation (Newman & Howse, 2007).

Surprisingly, few programs use online technologies to teach informatics at the undergraduate level (Kenny, 2002). In terms of efficacy, when compared to face-to-face instruction, online learning is equally effective and in some instances leads to better outcomes (Bloomfield, Roberts, & While, 2010; McMullan, Jones, & Lea, 2011). Online education as a

means for training nurses in informatics could facilitate the delivery of informatics education to a large number of students as well as help streamline faculty resources, thus addressing limitations related to the shortage of qualified faculty members with NI or HCI expertise (Gassert, 2008).

Evaluation/Assessment of Learning Outcomes

A wide range of variables, such as knowledge gain, self-efficacy, confidence, attitudes, perceptions, experiences, satisfaction, and motivation, have been examined in research studies on informatics educational interventions among BScN students. These are all relevant outcomes for NI research, as they influence behaviour and performance and hence competence development (Kak et al., 2001). The majority of the studies included in this review, however, examine these outcomes in relation to some aspect of informatics — that is, computer literacy, basic computer skills, or information literacy — as opposed to comprehensively evaluating informatics competency. Few authors demonstrate links to clinical practice through the use of PDAs and simulated hospital information systems as tools for educating nursing students in informatics. In addition, the assessment of informatics competence focuses largely on self-reported assessment, without accounting for factors that could have contributed to the outcome.

Evidence on the Effectiveness of Informatics Education

Evidence on the effectiveness of informatics education at the BScN level remains unclear. First, research on informatics education at the BScN level is relatively recent, with most studies being small in scale and mainly descriptive and/or quasi-experimental. Such designs do not allow for much control over possible known and unknown confounders that could contaminate the intervention effect (Shadish, Cook, & Campbell, 2002). In addition, rigour becomes even more difficult to achieve when tools used for measuring outcomes do not adhere to appropriate psychometric principles to ensure validity and reliability (Staggers et al., 2001). Second, issues related to sample size and the heterogeneity of outcomes measured in such a limited number of studies preclude synthesis of evidence generated to date. Future research should consider rigorous research methodology with a focus on evaluation, to better capture the impact and value of informatics education in both the short and the long term. In addition, mixed-method studies could be used to generate evidence on the effectiveness of informatics education from multiple perspectives. Lastly, we need follow-up studies on the effectiveness of informatics education in the work life of graduates.

Implications and Suggestions for Improving Educational Outcomes in Informatics

Educational institutions, service providers, and nurse educators play an important role in shaping the learning experiences of nursing students in informatics. Educational institutions need to make a clear commitment to informatics education at the undergraduate level by identifying informatics competencies in their program outcomes. In 2010, entry-to-practice competencies related to information collection, management, and use were introduced in the Canadian Registered Nurse Examination (Nagle, Hannah, & Hammell, 2011). The incorporation of NI content in licensing examinations may encourage undergraduate nursing programs to embrace NI in their curricula.

Nursing educators need to consider multifaceted strategies when designing informatics education in order to obtain the desired change in all outcomes related to competency development. As Fetter (2009c) notes, a variety of strategies and the intensive use of technology throughout curricula would be most effective for improving students' informatics competencies. An example of such a multifaceted intervention is noted in the work of Travis and Brennan (1998) at Case Western Reserve University. A sequential method was adopted to integrate theoretical and relevant clinical experiences into the undergraduate curriculum using the framework of technology, information, and clinical care processes. This approach to integration allowed for levelling informatics education according to the level of education in the program — that is, computer and information focuses were offered in the first 2 years of the program and more advanced skills and clinical experiences in the second 2 years. Integration of theoretical knowledge and clinical experiences related to informatics education enhances students' ability to understand how informatics relates to nursing and to patient care (Fetter, 2009a, 2009c; Staggers et al., 2001). Educational interventions that are pedagogically informed and systematically designed have an increased likelihood of achieving the desired outcomes (Kaakinen & Arwood, 2009). Selected resources that may be helpful are listed in Appendix 1.

Lastly, policy-makers in institutions of higher learning and in service sectors should create more opportunities for collaboration, to support and facilitate development of informatics competencies among nursing students (Gassert, 2008). With the systematic integration of informatics theory and practice applications, and the use of a variety of pedagogical strategies in the delivery of informatics instruction during basic nursing education, nursing students will develop confidence and competence in using health-care technology within the security of the educational setting prior to entering the work environment.

Conclusion

Our review of the literature on integration of informatics in BScN education reveals wide variations in methods and strategies. These variations impact educational outcomes in relation to informatics and consequently the level of competence expected from graduates of BScN programs. First, variations exist in the core content of informatics, with a tendency to focus on computer and information literacy without effectively linking these skills to nursing practice. Nursing programs need to consider the distinct differences between such concepts and develop content that reflects the practical application of ICT in the context of care and nursing practice. Second, there is inconsistent integration of theoretical knowledge and clinical experiences related to informatics education as well as variations in the duration and sequencing of informatics instruction. Informatics education should be tailored to address both aspects of theory and clinical applications in health information technology, with appropriate sequencing throughout the nursing program. Third, variations exist in relation to teaching strategies used for integrating relevant informatics content in the curriculum, especially the limited use of online learning modalities to facilitate delivery of informatics education at the undergraduate level. Online learning offers an array of possibilities and could help accelerate the process of building competence among BScN students. Fourth, the effectiveness of informatics education at the BScN level remains unclear given the limited number of studies undertaken, the quality of evidence generated to date, and the lack of follow-up studies. Careful planning and evaluation of informatics education interventions would help ensure effective and efficient use of resources and a realistic view of the level of informatics competence among BScN students. This should be followed by evaluation studies that systematically assess the status of informatics competency among future graduates.

Appendix 1	*Recommended Resources to Guide Nursing Educators in Developing Informatics Education*

The Nurse Educator eHealth Resource, published in 2012: http://rnao.ca/sites/rnao-ca/files/RNAO.NurseEducator.eHealth_-_Draft_2_-_10252012.pdf

The CASN Nursing Informatics Inventory: A Report of Existing Teaching and Learning Resources, published in 2012: http://www.casn.ca/vm/newvisual/attachments/856/Media/20122CASNNIInventorywithCompetencies FINALwcover.pdf

The Essentials of Baccalaureate Nursing Education: www.aacn.nche.edu/education-resources/baccessentials08.pdf

References

American Association of Colleges of Nursing. (2008). *The essentials of baccalaureate education for professional nursing practice.* Washington: Author. Retrieved January 15, 2013, from www.aacn.nche.edu/education-resources/BaccEssentials08.pdf.

Bloomfield, J., Roberts, J., & While, A. (2010). The effect of computer-assisted learning versus conventional teaching methods on the acquisition and retention of hand-washing theory and skills in pre-qualification nursing students: A randomized controlled trial. *International Journal of Nursing Studies, 47*(3), 287–294.

Borycki, E., Kushniruk, A., Armstrong, B., Joe, R., & Otto, T. (2010). Integrating electronic health records into health professional and health informatics education: A continuum of approaches. *Acta Informatica Medica, 18*(1), 20–24.

Caison, A. L., Bulman, D., Pai, S., & Neville, D. (2008). Exploring the technology readiness of nursing and medical students at a Canadian university. *Journal of Interprofessional Care, 22*(3), 283–294.

Canadian Association of Schools of Nursing. (2012). *Nursing informatics: Entry-to-practice competencies for registered nurses.* Ottawa: Author. Retrieved January 15, 2013, from http://www.casn.ca/vm/newvisual/attachments/856/Media/NursingInformaticsEntryToPracticeCompetenciesFINALENG.pdf.

Canadian Nurses Association. (2006). *E-Nursing strategy for Canada.* Ottawa: Author. Retrieved July 10, 2012, from http://www.cna-aiic.ca/CNA/documents/pdf/publications/E-Nursing-Strategy-2006-e.pdf.

Candela, L., Dalley, K., & Benzel-Lindley, J. (2006). A case for learning-centered curricula. *Journal of Nursing Education, 45*(2), 59–66.

Connors, H., Warren, J., & Weaver, C. (2007). HIT plants SEEDS in healthcare education. *Nursing Administration Quarterly, 31*(2), 129–133.

Curry, D. G. (2010). Selection and implementation of a simulated electronic medical record (EMR) in a nursing skills lab. *Journal of Educational Technology Systems, 39*(2), 213–218.

De Gagne, J. C., Bisanar, W. A., Makowski, J. T., & Neumann, J. L. (2011). Integrating informatics into the BSN curriculum: A review of the literature. *Nurse Education Today, 32*(6), 675–682.

Deltsidou, A., Gesouli-Voltyraki, E., Mastrogiannis, D., & Noula, M. (2010). Undergraduate nursing students' computer skills assessment: A study in Greece. *Health Science Journal, 4*(3), 182–188.

Desjardins, K. S., Cook, S. S., Jenkins, M., & Bakken, S. (2005). Effect of an informatics for evidence-based practice curriculum on nursing informatics competencies. *International Journal of Medical Informatics, 74*(11/12), 1012–1020.

Donahue, B., & Thiede, K. (2008). Innovative strategies for nursing education: Enhancing curriculum with the electronic health record. *Clinical Simulation in Nursing, 4*(1), e29–e34.

Edirippulige, S., Smith, A. C., Beattie, H., Davies, E., & Wootton, R. (2007). Pre-registration nurses: An investigation of knowledge, experience and comprehension of e-health. *Australian Journal of Advanced Nursing, 25*(2), 78–83.

Elder, B., & Koehn, M. (2009). Assessment tool for nursing student computer competencies. *Nursing Education Perspectives, 30*(3), 148–152.

Englebardt, S. P., & Nelson, R. (Eds.). (2002). *Health care informatics: An interdisciplinary Approach.* St. Louis: Mosby.

Fetter, M. S. (2009a). Curriculum strategies to improve baccalaureate nursing information technology outcomes. *Journal of Nursing Education, 48*(2), 78–85.

Fetter, M. S. (2009b). Graduating nurses' self-evaluation of information technology competencies. *Journal of Nursing Education, 48*(2), 86–90.

Fetter, M. S. (2009c). Improving information technology competencies: Implications for psychiatric mental health nursing. *Issues in Mental Health Nursing, 30*(1), 3–13.

Gassert, C. A. (2008). Technology and informatics competencies. *Nursing Clinics of North America, 43*(4), 507–521.

Goldsworthy, S., Lawrence, N., & Goodman, W. (2006). The use of personal digital assistants at the point of care in an undergraduate-nursing program. *Computers, Informatics, Nursing, 24*(3), 138–143.

Gracie, D. (2011). Nursing informatics competencies and baccalaureate nursing students. *ANIA-CARING Newsletter, 26*(2), 7–10.

Hwang, J., & Park, H. (2011). Factors associated with nurses' informatics competency. *Computers, Informatics, Nursing, 29*(4), 256–262.

Jacobsen, H. E., & Andendaes, R. (2011). Third year nursing students' understanding of how to find and evaluate information from bibliographic databases and Internet sites. *Nurse Education Today, 31*(1), 891–903.

Jetté, S., Tribble, D. S., Gagnon, J., & Mathieu, L. (2010). Nursing students' perceptions of their resources toward the development of competencies in nursing informatics. *Nurse Education Today, 30*(8), 742–746.

Jones, S., & Donelle, L. (2011). Assessment of electronic health record usability with undergraduate nursing students. *International Journal of Nursing Education Scholarship, 8*(1), 1–18.

Kaakinen, J., & Arwood, E. (2009). Systematic review of nursing simulation literature for use of learning theory. *International Journal of Nursing Education Scholarship, 6*(1), 1–20.

Kak, N., Burkhalter, B., & Cooper, M. (2001). *Measuring the competence of healthcare providers.* Operations Research Issue Paper 2(1). Bethesda, MD: Quality Assurance Project for US Agency for International Development. Retrieved January 15, 2013, from http://www.hciproject.org/sites/default/files/Measuring%20the%20Competence%20of%20HC%20Providers_QAP_2001.pdf.

Kenny, A. (2002). Online learning: Enhancing nurse education? *Journal of Advanced Nursing, 38*(2), 127–135.

Kuiper, R. (2010). Metacognitive factors that impact student nurse use of point of care technology in clinical settings. *International Journal of Nursing Education Scholarship, 7*(1), 15.

Levett-Jones, T., Kenny, R., Van der Riet, P., Hazelton, M., Kable, A., Bourgeois, S., et al. (2009). Exploring the information and communication technology competence and confidence of nursing students and their per-

ception of its relevance to clinical practice. *Nurse Education Today, 29*(6), 612–616.

Linder, L. A., & Pulsipher, N. (2008). Implementation of simulated learning experiences for baccalaureate pediatric nursing students. *Clinical Simulation in Nursing, 4,* e-41–e47.

Lucas, L. (2010). Partnering to enhance the nursing curriculum: Electronic medical record accessibility. *Clinical Simulation in Nursing, 6*(3), e97–e102.

Marini, S. D. (2000). Introduction of nursing informatics in the nursing baccalaureate program at the American University of Beirut. *Computers in Nursing, 18*(5), 240–247.

Martin, R. R. (2007). Making a case for personal digital assistant (PDA) use in baccalaureate nursing education. *Online Journal of Nursing Informatics, 11*(2), 8.

McCannon, M., & O'Neal, P. V. (2003). Results of a national survey indicating information technology skills needed by nurses at time of entry into the work force. *Journal of Nursing Educa*tion, *42,* 337–340.

McMullan, M., Jones, R., & Lea, S. (2011). The effect of an interactive e-drug calculations package on nursing students' drug calculation ability and self-efficacy. *International Journal of Medical Informatics, 80*(6), 421–430.

Melo, D., & Hodson-Carlton, K. H. (2008). CIN plus: A collaborative model to ensure graduating nurses are ready to use electronic health records. *Computers, Informatics, Nursing, 26*(1), 8–12.

Nagle, L. M., & Clarke, H. F. (2004). Assessing informatics in Canadian schools of nursing. *Studies in Health Technology and Informatics, 107,* 912–915.

Nagle, L. M., Hannah, K. J., & Hammell, N. (2011). Nursing informatics in Canada. In V. K. Saba & K. A. McCormick (Eds.), *Essentials of nursing informatics* (5th ed.) (pp. 685–695). New York: McGraw-Hill.

Nayda, R., & Rankin, E. (2008). Information literacy skill development and life long learning: Exploring nursing students' and academics' understandings. *Australian Journal of Advanced Nursing, 26*(2), 27–33.

Newman, K., & Howse, E. (2007). The impact of a PDA-assisted documentation tutorial on student nurses' attitudes. *Computers, Informatics, Nursing, 25*(2), 76–83.

Schulte, S. J. (2008). Integrating information literacy into an online undergraduate nursing informatics course: The librarian's role in the design and teaching of the course. *Medical Reference Services Quarterly, 27*(2), 158–172.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* New York: Houghton Mifflin.

Skiba, D. J. (2011). Informatics and the learning healthcare system. *Nursing Education Perspectives, 32*(5), 334–336.

Skiba, D. J., Connors, H. R., & Jeffries, P. R. (2008). Information technologies and the transformation of nursing education. *Nursing Outlook, 56*(5), 225–230.

Staggers, N., & Bagley-Thompson, C. (2002). The evolution of definitions for nursing informatics. *Journal of the American Medical Informatics Association, 9*(3), 255–261.

Staggers, N., Gassert, C. A., & Curran, C. (2001). Informatics competencies for nurses at four levels of practice. *Journal of Nursing Education, 40,* 303–316.

Staggers, N., Gassert, C., & Curran, C. (2002). A Delphi study to determine informatics competencies for nurses at four levels of practice. *Nursing Research, 51*(6), 383–390.

Taylor, L. A., Hudson, K., Vazzano, J., Naumann, P., & Neal, M. (2010). The electronic health record meets baccalaureate-nursing curriculum: Stories from the battlefield. *Nurse Leader, 8*(3), 40–44.

Thompson, B. W., & Skiba, D. J. (2008). Headlines from the NLN. Informatics in the nursing curriculum: A national survey of nursing informatics requirements in nursing curricula. *Nursing Education Perspectives, 29*(5), 312–317.

Travis, L. L., & Brennan, P. F. (1998). Information science for the future: An innovative nursing informatics curriculum. *Journal of Nursing Education, 37*(4), 162–168.

Weaver, C. A., & Skiba, D. (2006). TIGER initiative: Addressing information technology competencies in curriculum and workforce. *Computers, Informatics, Nursing, 24*(3), 175–176.

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