ORIGINAL RESEARCH

An instrument for assessing advanced nursing informatics competencies

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Abstract

Background/Objective: Researchers set out to develop reliable, valid instruments for nurses to self-assess nursing informatics (NI) competencies at the basic and advanced levels. The focus of the research presented in this article is measurement of competencies at the advanced level, which includes Level 3, the informatics specialist and Level 4, the informatics innovator. Informatics competencies are critical in the technology-rich healthcare delivery system. Nurse leaders experienced in informatics need to be prepared to consistently mentor nurses to use health information technology (HIT) in ways that foster continual growth in nursing informatics competencies. This article addresses the research problem, the concept of competency, previous work on NI assessment, instrument development, and pilot results.

Methods: Resulting items from round one and two were reworded to reflect measurable behaviors then subjected to a third round of reviews to establish content validity, using the content validity index (CVI). The Nursing Informatics Competency Assessment L3/L4 (NICA - L3/L4) © instrument development began with a synthesis of seminal and current literature. Participants were asked to rate themselves in one of the categories for each item: beginner or N/A, comfortable, proficient or expert. The NICA-L3/L4© instrument was piloted following Institutional Review Board (IRB) approval using a purposeful, convenience sample from the NI community.

Results: For NICA-L3/L4©, the CVIs demonstrated strong content validity and the Chronbach's alpha showed high internal consistency. The initial data from both the Delphi and pilot studies indicated the need for self-assessment of NI competencies.

Conclusion: Results of this study indicate that continued education in NI is necessary to reach the level of nurse innovator, a Level 4 competency. As the healthcare system continues to rely on electronic means of gathering, storing, and retrieving data, self-assessment of informatics competencies is key to providing a benchmark for the identification of skills that require further development.

Key words

Nursing Informatics (NI), Competencies, Instrument development, Innovator, Technology Informatics Guiding Educational Reform (TIGER), TIGER-based Assessment of Nursing Informatics Competencies (TANIC)

1 Introduction

Nurses specializing in nursing informatics (NI) must be able to demonstrate NI competencies commensurate with their education and experience. A review of the literature in nursing informatics competencies revealed few contemporary scholarly articles or other sources. Seminal sources were used extensively in this research. Valid and reliable instruments

for assessing individual competencies related to NI are scarce. Hunter, McGonigle, and Hebda [1] developed a measure of basic informatics competencies. The basic competencies include Level 1, the beginning nurse and Level 2, the experienced nurse. The aim of this research study was to develop a reliable and valid instrument for nurses to utilize when completing self-assessment of perceived Level 3 (informatics specialist) and Level 4 (informatics innovator) competencies. The 2008 *Nursing Informatics: Scope and Standards of Practice* [2] relied heavily on the original research from Staggers, Gassert, and Curran [3]. Additionally, the competencies matrix in the 2008 scope and standards of practice also relied on information derived from the American Nurses Credentialing Center (ANCC) NI certification exam [2]. The scope and standards are reviewed and revised for each nursing specialty every five years. However, at the time of this article, the new standards for nursing informatics are not yet published. Both Staggers, Gassert, and Curran [4] and the 2008 *Nursing Informatics: Scope and Standards of Practice* [2] identified the Level 3 nurse as the informatics specialist; a registered nurse who has advanced preparation and knowledge in information management. The skills necessary for the Level 3 informatics nurse include (1) a focus on information needs for nursing practice that include education, administration, research, and clinical practice, (2) the integration and application of information science, computer science, and nursing science and, (3) incorporates critical thinking, process skills, data management skills, systems development life cycle skills, and computer skills into areas of nursing practice. The Level 4 nurse is known as the informatics innovator and is a registered nurse who has been prepared to conduct informatics research and generate informatics theory. The skills necessary for this level of informatics nurse include (1) possessing a vision of what is possible in informatics and the ability to bring this vision to reality, (2) leads the advancement of informatics research, (3) completes ongoing assessment of data management, (4) owns creative problem solving practices in developing solutions for data management, (5) maintains a refined level of understanding and skills in information management and computer technology and, (6) understands the interdependence of systems and can manage systems for improved outcomes [2, 4]. A variety of nursing informatics specialization areas were considered in this pilot study.

The current study was intended to assess specialty competencies in NI. Even though NI has been recognized as a specialty for decades, nursing education does not always clearly address informatics competencies. Many nurses are not fully prepared to adequately use health information technology (HIT) as it is intended to support patient care. A recent study by Hunter, McGonigle, and Hebda [5] of nursing-school course offerings showed an absence of clear delineation of nursing informatics content across graduate curricula. As the demand for informatics competencies in nursing increases, nurse educators must be able to prepare not only nurses as basic users of HIT but also informatics nurse specialists (INSs) as innovators and leaders in the evolution of NI. In the clinical setting, it is imperative to have an innovative leader in NI to inform nursing practice, enhance patient care, and advance the nursing profession. Nursing informatics certification is an important step in the development of the nurse informaticist. It allows the nurse the ability to gain and develop the skills necessary to move from basic nurse informaticist to nurse informaticist innovator and can be completed through initial certification and continued lifelong learning. Certification, though, is an assessment of knowledge and knowledge application, not an approach to identification of one's perceived competencies. Assessment of perceived competencies is one method of preparing for professional certification.

This article is a presentation of the work completed in developing and testing an online instrument for self-assessment of perceived Level 3 and Level 4 competencies in NI. This instrument is derived from the seminal work of Staggers, Gassert, and Curran [4]. Discussed in this paper are the research problem, some definitions of the concept of competency, previous work on instruments to assess NI, the instrument-development process, and results of the pilot test.

With the information era upon us, nurses and nurse educators must acquire or teach competencies in using health information technology (HIT). As the concept of nursing informatics continues to evolve across all healthcare settings, it is imperative that nurses be competent in nursing informatics skills and knowledge as they relate to their practice setting. This article will discuss the advanced informatics skills and knowledge needed by the informatics nurse specialist (INS).

NI professionals are in demand in healthcare settings. Nurses specializing in NI must be able to demonstrate NI competencies commensurate with their education and experience. Valid and reliable instruments for assessing individual

competencies related to NI are lacking in the scholarly literature. Assessment tools are needed to judge the capabilities, progress and development of NI competencies. Currently, few of the resources for NI competencies address the unique knowledge and skills that are required for the role of the informatics nurse specialist (INS). The purpose of this study was to develop a Level 3 and Level 4 NI competencies on-line self-assessment tool.

1.1 Identifying the problem

Hunter, McGonigle and Hebda [1] identified that one of the gaps in NI competency development is the measurement of competencies. Self-assessment of NI competencies needs to be an area of focus for research. However, there is a lack of standardized self-assessment tools to identify self-perceived levels of competency. The purpose of their research was to develop a reliable and valid instrument for the self-assessment of Level 1 and Level 2 NI Competencies. The original work stemmed from the Technology Informatics Guiding Educational Reform (TIGER) competencies as a foundation for developing valid and reliable competency tests. That tool is known as the TIGER-based Assessment of Nursing Informatics Competencies (TANIC).

The NICA – L3/L4 research study was a continuation of the original work and was dedicated to identifying a self-assessment tool for Level 3 and Level 4 NI Competencies The aim of this research was to develop such a tool for graduate level NI competencies.

1.2 Review of literature

According to Hunter, McGonigle, and Hebda [1], individuals studying competencies must first comprehend the meaning of the term, competency. This may prove challenging since there is not one universally accepted definition of competency. Several definitions were presented within the literature review. First, competency has been defined as selected skills developed in a pattern and behaviors that contribute to exceptional performance [6]. Secondly, Washington State Human Resources [7] stated that it is "measurable or observable knowledge, skills, abilities, and behaviors (KSABs) critical to successful job performance" (para. 1). Additionally, the TIGER Initiative [8], dedicated to the preparation of a workforce enabled to work in the technology related healthcare system, identified informatics competencies for all practicing nurses. Competencies were listed in three areas: basic computer skills, information literacy, and clinical information management. TIGER did not operationalize competencies into a tool that could be used for assessment.

McKee [9] noted that competency is the "ability to integrate knowledge and skill to perform a task under the varied circumstances of the real world" (slide 5). Lastly, Hunter, McGonigle, and Hebda [5] concluded that

> Competency, then, is a concept applicable to multiple situations. At its most basic, competency denotes having the knowledge, skills, and ability to perform or do a specific task, act, or job. Depending on the context, competency can refer to adequate or expert performance. For this research, competency was used to mean adequate knowledge, skills, and ability. Nursing-informatics competency was defined as adequate knowledge, skills, and ability to perform specific informatics tasks (p. 71).

Therefore, it is proposed that a competency is any knowledge or skill that an individual possesses that has been shown to cause or forecast excellent performance. In nursing, competencies range along a continuum of care and must include competencies in NI.

Chang, Poynton, Gassert, and Staggers [10] identified through literature review that competency in nursing informatics can increase time spent at the bedside. The additional time gained can be used to improve critical thinking and problem solving; thereby, increasing clinical reasoning skills. The era of electronic medical documentation and innovation in informatics is upon the healthcare community, driving the need for Level 3 and Level 4 competencies that are assessed through self-assessment.

NI competencies must be identified and assessed in order to evolve the specialty beyond the current recommendations. Seminal work by Staggers, Gassert, and Curran [4] identified that level 3 and level 4 NI competencies must be developed in the nurse informaticist. A common listing of these competencies would enhance the ability to assess the INS's skills and knowledge in relation to job descriptions. Instruments have been developed to identify and list competencies [3, 10, 11]. The missing component is the reliable assessment and measurement of Level 3 and Level 4 NI competencies. The validity must also be assessed. According to Davis [12], researchers should seek a content validity index of 0.8 or better when testing new instruments.

According to Doman and Bahadur [13], "little has been written about the effectiveness of self-assessment tools in contributing to learners' performance in specific modules pertaining to the Mauritian context as well as students' perception of a Self-Assessment Tool in learning" (p. 2). Therefore, it is important that we develop and test self-assessment tools designed to facilitate student awareness of their knowledge and skill level as well as helping to identfy their educational and experiential needs. Self-assessment of professional competencies will help guide learning experiences and practice. These competencies are adapted from numerous scholarly resources but were initially identified through the Delphi study conducted by Staggers, Gassert and Curran [4]. Assessing the level of knowledge or skill for each core competency indicator described will guide the learning experiences and determine the level of practice. This will help teachers and learners focus on those areas that are most important and concentrate attention where further learning and experience is needed.

2 Method

The aim of this research was to develop a reliable, valid online self-assessment tool of perceived Level 3 and Level 4 NI competencies. The original self-assessment tool for Level 1 and Level 2 focused on basic computer skills, information literacy, and the ability to navigate computer information systems to store, collate, and retrieve data [1]. This article presents the development of the L3/L4 instrument for advanced nursing informatics practice. In this section, the instrument development and assessment of content validity and reliability are discussed.

2.1 Instrument development

Instrument development began with a synthesis of both seminal and current literature. An initial review of the instrument by the researchers initiated instrument testing and a Delphi approach using two rounds of surveys with NI experts. The Delphi resulted in the identification and corroboration of Level 3 and Level 4 NI competencies for INSs; these competencies deal with computer skills, informatics knowledge, and informatics skills.

The experts were asked to read every competency under each key dimension. For each competency, they were asked to reflect on the competency and determine how relevant it was to assessing the informatics specialist's and informatics innovator's ability to exhibit the behavior or perform the skill. They then rated each competency on a scale from 1 to 4 by deciding if it was 1) not relevant and should be removed; or 2) somewhat relevant/maybe keep it; 3) quite relevant or keep; or 4) highly relevant or definitely keep it. For the content validity result for each section, please see Table 1.

Table 1. Content Validity Indicator (CVI)

Section	Round 1	Round 2
Computer Skills	1.0	1.0
Informatics Knowledge	0.9	0.9
Informatics Skills	1.0	1.0
S-CVI/Ave	0.98	0.98

Following the first round of the Delphi, it was determined that all of the items had merit; however, the experts felt that some items were missing. For round two, we added 3 items to the computer skills section, 16 items to the informatics

knowledge section including one new subset, data mining, and 4 items to the informatics skills section. For a list of the changes, please see Table 2.

Table 2. Added Items Resulting from Delphi

Computer Skills	Informatics Knowledge	Informatics Skills
	Data subset: • Teach nurses to find, retrieve, and evaluate information **Education subset:** • Assist with and support others engaging in social media (Facebook, Twitter, etc.) to benefit the patient **Impact subset:** • Participate with and adhere to IRB regulations for patient safety • Assist in developing clinical practice environments that support the knowledge work of nurses • Assess clinical workflow • Support and maintain clinical workflow	
System subset: • Support research efforts through the use of specific types of software (for example, statistical or qualitative data management software). • Determine the impact of computerized information management on manager and executive roles through program evaluation • Utilize pattern recognition technologies for mathematical analysis	**Privacy/Security subset:** • Participate with and adhere to IRB regulations for data/HIT security **Regulations subset** • Support adhering to ADA technology accessibility guidelines **Usability subset** • Use cognitive science principles and artificial intelligence theories to participate in the design of technology appropriate to the cognitive abilities of the user • Develop algorithms for clinical decision support in nursing practice	**Analysis subset:** • Understands and can retrieve information using data mining **Design and Development subset:** • Analyze the system in use through internal environment scanning **Fiscal Management subset:** • Conduct return on investment (ROI) analysis regarding IT systems **Role subset:** • Consult with clinical, managerial, educational, and or research entities about informatics
	Data Mining subset was added: • Utilize data mining to predict future uses and trends • Provide value in foreseeing future trends with data mining • Utilize data mining to describe patterns within a data set • Utilize statistics to provide complete analysis patterns within a data set • Utilize data mining to provide informed decision making • Utilize data mining to provide quality data metrics for proposed practice change	

2.2 Pilot

The study design and instrument were submitted for review and approval to the Institutional Review Board (IRB) at the researchers' college to ensure compliance with established conventions for the protection of research participants. The Level 3 and Level 4 NI competencies online self-assessment instrument was converted to the format of a Qualtrics online survey with 4 parts: demographics and 178 items covering three sections: computer skills, informatics knowledge, and informatics skills. Each of the skills and knowledge sections' items had 4 rankings: beginner or N/A, comfortable, proficient, or expert. The beginner / N/A category reflected that the respondent was unaware of or had limited knowledge and/or skills The comfortable ranking related to easy association with the information, knowledge, or skill necessary to be able to function with ease and able to use their judgment to problem solve, infer, and interpret. At the proficient rank, the respondent is informatics competent, well-advanced, and fluent in the ability to bilingually address nursing and IT; and able to analyze and synthesize data, information and knowledge into wisdom to inter-professionally guide other healthcare team members. The expert ranking reflected extraordinary or exceptional proficiency that progresses the data, information, knowledge, and wisdom pathway to intuition; the breadth of experience provides the ability to assess the context of each situation intuitively and respond and perform appropriately.

2.3 Participant characteristics

A purposeful sample was obtained from the NI community participating in the American Nursing Informatics Association (ANIA) listserve, Healthcare Information and Management Systems Society (HIMSS) email, and the Information and Technology Expert Panel of the American Academy of Nursing via email. This sample of 88 participants completed the three L3 and L4 sections; the number of respondents answering an individual item varies, therefore, the number for each item may not total 88. The percentages for each item are calculated based on the item respondents.

The demographic section was completed by 100 respondents, unless noted. This section consisted of the following: age, gender, highest education preparation, length of practice in informatics, board certification in nursing informatics, and other certification in informatics. The mean age range was 46-55 with an age range of 26-70. There were 12 males and 87 females. The highest education preparation responses were as follows:

Table 3. Breakdown of Participant Characteristics

Education	Number
Diploma	1
Associate in Nursing	4
Bachelor in Nursing	20
Other Baccalaureate	3
Master in Nursing	50
Other Master Degree	13
PhD	9

The average length of practice in informatics was 7 years. Additionally, 37 of these respondents were board certified in nursing informatics, while 15 held other certifications in informatics.

3 Results

The process and outcomes of this study have implications not only for NI specialists but also for nursing education, research and practice. Self-assessment of Level 3 and Level 4 competencies can assist in identifying strengths and weaknesses across the spectrum of NI. Imperative to this assessment is the validity and reliability of a tool to measure the competencies; identifying a master list of Level 3 and Level 4 competencies that are needed to continue innovation in nursing informatics.

The majority of study respondents were female, and the mean age range was 46-55, which follows the population of nursing. Seventy-five were prepared in nursing at the diploma, associate, baccalaureate or master level. Fifty-two were certified in informatics with 37 of those being board certified in NI. As the mean age of nurses evolves, careful identification of level 3 and level 4 NI competencies that can be integrated across nursing curricula is imperative.

The responses from the three sections, computer skills, informatics knowledge, and informatics skills, were analyzed separately (see Table 4). From this analysis, the following results were reviewed. The first section, the computer-skills section, consisted of 13 items across 3 subsets: computer skills, systems, and quality improvement. The item in this section that had the highest percentage of self-rating as an expert was: *determine aspects of nursing-informatics practice important for quality monitoring*. This percentage was 21.4%.

The informatics-knowledge section consisted of 56 items across 8 subsets: data, education, impact, privacy/security, regulations, systems, usability and data mining. The table below shows the items with the highest and lowest percentage for the categories of expert and proficient.

The informatics-skills section consisted of 109 items across 13 subsets: analysis, data/data structures, design/development, fiscal management, implementation, management, programming, requirements, role, systems maintenance, system selection, testing and training. The table below shows the items with the highest and lowest percentage for the categories of expert and proficient.

Table 4. The responses from computer skills, informatics knowledge, informatics skill

Sections	Rating	Highest Scored Item	Lowest Scored Item
Computer Skills	Expert	21.4% - determine aspects of nursing-informatics practice important for quality monitoring	1.9% - write macros or shortcuts for spreadsheets
	Proficient	46.6% - develop or modify spreadsheets used for complex problems	10.7% - utilize pattern recognition technologies for mathematical analysis
Informatics Knowledge	Expert	46.6% - serve as an informational resource person for applications and systems.	7.8% - utilize data mining to predict future uses and trends
	Proficient	34% - determine the limitations and reliability of computerized patient-monitoring systems.	12.6% - integrate nursing taxonomies, unified nomenclatures, and other data needed by nurses within database design.
Informatics Skills	Expert	39.8% - collaborate with nursing personnel and interdisciplinary teams to accomplish information-management work.	2.9% - differentiate between machine and high-level programming languages.
	Proficient	28.2% - consult with clinical, managerial, educational, and or research entities about informatics.	19.4% - apply ergonomics principles in the selection and use of information-management technologies.

The participants were also given the opportunity to respond to a series of items concerning the survey itself. Sixty-seven percent felt the overall length of the survey was fine or OK. The design of the survey was deemed easy to use, easy to follow, or efficient by 59% of the respondents. Ten percent stated that there were format issues, such as readability and spacing, as well as issues with the terms for ranking competence such as beginner, comfortable, and proficient. Two percent believed that the sections were not clear, font was not crisp, a qualitative component should be added, and they preferred to click rather than scroll through the survey. The remainder did not comment on the design, and no comments were recorded for the last three sections: wording of the competency questions, items needing to be removed, and items needing to be added.

The Cronbach's alpha is one of the most frequently reported underestimates of internal consistency, making it a conservative estimate. It estimates the proportion of variance that is systematic or consistent in a set of items. A score of

1.0 indicates that all variance is consistent, or it is 100% reliable or 0% unreliable. The computer skills section is 90% reliable, informatics knowledge is 98% reliable, and the informatics skills section is 99% reliable (see Table 5).

Table 5. Internal Consistency Reliability

Category	Cronbach's Alpha	Number of Items
Computer Skills	0.909	13
Informatics Knowledge	0.982	56
Informatics Skills	0.992	109

According to Cortina [13], the alpha is a function of how many items are included in the scale and must be interpreted with this in mind. For example, to show intercorrelation, validity, and internal consistency, tools containing 14 items or more and having an alpha of .70 or higher show high reliability. Drawing from the results of the Cronbach's alpha for this study, it can be determined that all items have high internal consistency reliability.

4 Discussion

It is important to note that the study sample is reflective of the current nursing population, with the majority of respondents being female between the ages of 46-55. The findings from this study support expanded inclusion of competencies within programs to prepare advanced nursing informatics practitioners. While the importance of self-assessment has been identified through this study, the authors agree with the assertion identified by Doman and Bahadur [14] that additional work on this subject is needed. However, as NI continues to advance the nursing profession, the need for nurses to gain competency with NI increases. Through the completion of this study, it became apparent that the highest self-stated degree of competency with level 3 and level 4 NI competencies was less than 24% in a sample including 52% certified in informatics and, of those, 37% certified in nursing informatics. In order to advance NI practices within healthcare, an increased number of NI specialists should feel confident with Level 3 and Level 4 NI competencies.

The time for action is upon us. While a low number of respondents identified with mastery of the competencies, we must also note that NI is constantly evolving. Across all competencies surveyed using this tool, respondents felt most comfortable, at 39.8%, with this item: *collaborate with nursing personnel and interdisciplinary teams to accomplish information-management work.* This information provides a baseline for moving forward with educating nurses on NI competencies, and this education should stress the importance of collaborative efforts in order to support the NI profession. The area of competency requiring the most attention was 1.9% with this item: *write macros or shortcuts for spreadsheets*. Proficiency with this item can allow NI specialists the ability to manage cumbersome programs and increase the speed and efficiency of nurses at the bedside; thereby, allowing the nurse to spend more time devoted to direct patient care.

This validated competency assessment adds additional information to the importance of education across all program curricula in nursing to provide support to nurses working in a field where technology and NI competencies can maintain and support the ever-evolving healthcare system.

5 Conclusion

Initial data from the pilot test supports that the Level 3 and Level 4 NI competencies online self-assessment tool, the NICA -L3/L4, assesses the level of knowledge or skill for each competency indicator described. Preliminary data analysis revealed that the tool can differentiate among the various levels of competencies. Using this tool will help prioritize learning time to focus on those areas that are most important to the respondent's situational context and concentrate on areas where the need for training and learning may be greatest.

The outcomes from this pilot study can facilitate educators in developing curricula for building Level 3 and Level 4 NI competencies. It is extremely important that our practicing nurses and graduate-student nurses are able to self-assess their NI competencies and address gaps in their knowledge and skills in order to plan initiatives and learning opportunities to improve their competence and subsequently enhance the evolution of NI.

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