



# Development of a Standardized Curriculum for Nursing Informatics in Korea

Myonghwa Park<sup>1</sup>, Bonkhe Brian Dlamini<sup>1</sup>, Jahyeon Kim<sup>1</sup>, Min-Jung Kwak<sup>1</sup>, Insook Cho<sup>2</sup>, Mona Choi<sup>3</sup>, Jisan Lee<sup>4</sup>, Yul Ha Min<sup>5</sup>, Bu Kyung Park<sup>6</sup>, Seonah Lee<sup>7</sup>

<sup>1</sup>College of Nursing, Chungnam National University, Daejeon, Korea

<sup>2</sup>Department of Nursing, College of Medicine, Inha University, Incheon, Korea

<sup>3</sup>Mo-Im Kim Nursing Research Institute, College of Nursing, Yonsei University, Seoul, Korea

<sup>4</sup>Department of Nursing Science, College of Life & Health Sciences, Hoseo University, Asan, Korea

<sup>5</sup>College of Nursing, Kangwon National University, Chuncheon, Korea

<sup>6</sup>College of Nursing, Kyungpook National University, Daegu, Korea

<sup>7</sup>College of Nursing, Chonnam National University, Gwangju, Korea

**Objectives:** This study explored the current status of nursing informatics education in South Korea and developed a standardized curriculum for it. **Methods:** Data were collected in two stages: first, an online survey conducted from December 2020 to February 2021 among 60 nursing schools to analyze the current status of nursing informatics education; and second, a two-round Delphi survey with 15 experts from March to April 2021 to determine the mean and standard deviation of the demand for each learning objective in nursing informatics education. A standardized curriculum proposal was developed based on the results of the two-round Delphi survey. **Results:** Nursing informatics was most commonly taught in the fourth year (34%), with two credits. The proportion of elective major subjects was high in undergraduate and graduate programs (77.4% and 78.6%, respectively), while the proportion of nursing informatics majors was low (21.4%). The curriculum developed included topics such as nursing information system-related concepts, definitions and components of healthcare information systems, electronic medical records, clinical decision support systems, mobile technology and health management, medical information standards, personal information protection and ethics, understanding of big data, use of information technology in evidence-based practice, use of information in community nursing, genome information usage, artificial intelligence clinical information systems, administrative management systems, and information technology nursing education. **Conclusions:** Nursing informatics professors should receive ongoing training to obtain recent medical information. Further review and modification of the nursing informatics curriculum should be performed to ensure that it remains up-to-date with recent developments.

**Keywords:** Nursing Informatics, Curriculum, Health Information Systems, Education, Nursing Schools

**Submitted:** February 14, 2022, **Revised:** 1st, August 16, 2022; 2nd, September 9, 2022, **Accepted:** September 15, 2022

## Corresponding Author

Bonkhe Brian Dlamini

Education and Research Center for Evidence-Based Nursing Knowledge, College of Nursing, Chungnam National University, 266 Munhwaro, Jung-gu, Daejeon 35015, Korea. Tel: +82-42-580-8328, E-mail: bonkhedlamini22@gmail.com (<https://orcid.org/0000-0001-8676-7912>)

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## I. Introduction

As part of the 21st-century scientific transformation, nursing informatics (NI) has improved the quality, safety, and effectiveness of healthcare [1,2]. NI has accelerated the computerization of human healthcare tasks, in particular the transition of paper nursing records to electronic Medical Records [3,4]. Security and patient safety have been enhanced by introducing information technology (IT) to nursing, which can achieve the goal of converting data into useful knowledge [5,6]. Applying IT to nursing helps to integrate data, information, and knowledge in all areas to help patients, nurses, and other healthcare providers make decisions [7]. NI education on how to integrate and manage IT in nursing has become urgently necessary.

Competence in NI is key to minimizing medical errors, improving documentation of clinical information (e.g., patients' diagnoses, treatments, and outcomes), and promoting evidence-based practice worldwide [5]. These competencies assist nursing students in acquiring computer utilization skills and information literacy, and being able to apply them to information management and clinical practice to achieve optimum safety and provide high-quality health services [7]. Computer and information literacy skills and overall information competencies have been identified as three core competencies that describe the ability of new nurses to learn NI [8]. Stagers et al. [9] proposed computer utilization technology, information knowledge, and IT as core competencies for nurses.

It is crucial for the NI curriculum to present the current and latest competencies and educational objectives presented by global administrators and organizations [10]. Various NI education models have recently been identified and introduced to highlight content that should be included in the curriculum. The concept of a curriculum refers to the learning expected to take place during a course or program [11,12]. Saba and McCormick [13] highlighted that a NI curriculum should include basic informatics concepts and applications, access to information systems, data and information system utilization, and the analysis, coordination, and integration of nursing information. This suggests that NI curricula must include fundamental skills based on the latest findings and learning experiences. Many institutions have introduced independent NI courses [2]. NI education has been found to reduce medication errors and improve productivity and enhance coordination among nurses and the rest of the multidisciplinary healthcare team [14].

A study conducted in 2016 in South Korea by Jeon et al. [2]

reviewed the status of NI education and found that 55.3% of nursing schools had introduced an informatics course within the previous 5 years; these courses were introduced as electives rather than as mandatory courses. A survey conducted on NI education in 1999 in Korea by Park et al. [15] found that curricula varied between nursing schools, with content consisting of computer basics, concepts and elements of NI, and NI utilization in practice, education, research, and administration. The first standardized, competence-based NI curriculum was developed in 2007 by Yom et al. [8]. According to their research results, four domains should be included in NI curricula: informatics fundamentals, NI fundamentals, NI applications, and public health informatics/social aspects.

Despite the efforts of previous researchers in NI, there remains a gap in the number of schools that offer NI classes and majors, and more schools still need to make NI courses mandatory. One of the major benefits of making NI courses mandatory is to keep electronic health records aligned with best practices for data processing, organization, and management [14]. Mandatory NI courses help develop and enforce privacy policies in accordance with ethics and regulations and enable more healthcare and IT professionals to communicate with each other more effectively [14]. An in-depth analysis of both the current status of NI and the development of a standardized curriculum is needed. This study, therefore, aimed to determine the current status of NI education and develop a standardized and up-to-date curriculum for both undergraduate and graduate programs as a collaborative project with the Korean Society of Medical Informatics Nursing Informatics Special Interest Group (KOSMI NI SIG).

## II. Methods

### 1. Research Subjects

Information was elicited in two ways: surveys from nursing schools and a two-round Delphi survey conducted with experts. Sixty nursing schools were investigated to determine the current status of NI education and to develop a standardized curriculum. This study developed a standardized NI curriculum and assessed the challenges and difficulties in NI classes, training on educational content that NI instructors wanted to receive, and the resources necessary for NI classes. A Delphi survey is a research technique consisting of a panel of anonymous experts who complete questionnaires and provide feedback to reach a consensus on a specific topic [16]. There are six common types of Delphi survey: (1) classic

Delphi, (2) modified Delphi, (3) decision Delphi, (4) policy Delphi, (5) real-time Delphi, and (6) Internet-based Delphi [16]. Fifteen experts—seven academics and eight practitioners—participated in the Delphi survey (Figure 1).

**2. Research Procedure**

The research procedure was conducted in three stages. First, the current status of nursing information education was researched. Second, a two-round Delphi survey based on a competence-based curriculum related to nursing information derived from 15 experts. In this stage, the experts tried to identify content suitable for the curriculum based on other local experts teaching NI. In the last stage, a standardized NI curriculum was developed based on content agreed upon by the 15 experts in the Delphi survey (Figure 2).

**1) Current status of nursing informatics education**

A survey was conducted to assess the status of NI education. The NI education survey included questions about the timing of NI courses within the program, the types of NI courses to be offered, the necessity to offer a required major (undergraduate) or major track (graduate school) in NI courses, the respective instructor in charge of NI within the last 2 years, the affiliation of the instructor responsible for teaching NI, the nursing major, or other major disciplinary specializations of the professor responsible for teaching NI, curriculum development for various major courses, the number of credits, the appropriateness of the credits, the necessity of a standardized NI curriculum, the location where NI is taught, teaching methods for NI classes, location of the practicum for NI courses, and sources of information for NI courses. The aspects assessed as part of the current status of nursing information included challenges and barriers to teaching NI classes, training on educational content that instructors wanted to receive, and the resources needed for NI classes.

**2) Curriculum development**

The NI curriculum was developed through a modified Delphi survey, in which experts met to discuss and rate the results. A two-round modified Delphi survey was conducted based on knowledge and skills presented in the Nursing Informatics Practice Standards and Scope of the American Nursing Association from 2015, the Technology Informatics Guiding Education Reform (TIGR)-based assessment on NI, the informatics competencies of the Quality and Safety Education for Nurses (QSEN) project and Healthcare Information Management System Society, and the Healthcare Leaders Association of the United States. It was also based on information and communication technology (ICT) competencies developed by the Canadian Association of Schools of Nursing. NI competencies were developed based on those from the American Nurses Association. These competencies included basic computer skills, information literacy, infor-

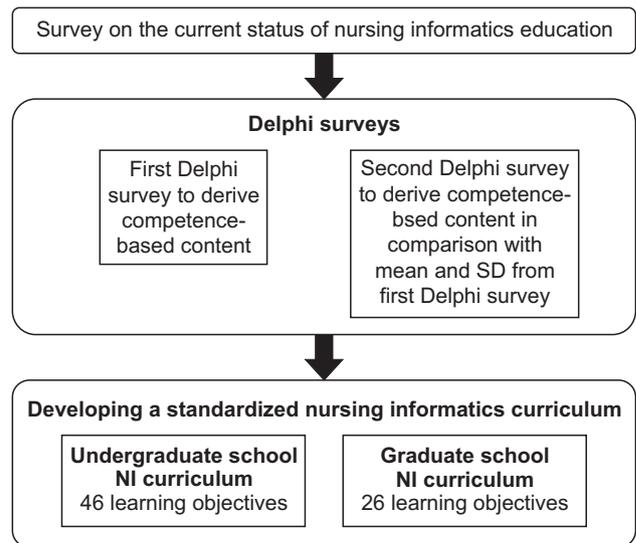


Figure 2. Procedure for developing a standardized nursing informatics curriculum. NI: nursing informatics, SD: standard deviation.

<p><b>1. Classic Delphi</b></p> <p>The use of sequential questionnaires to systematically collect specific information on a particular topic.</p>	<p><b>3. Decision Delphi</b></p> <p>The process is similar to classic Delphi, but mostly, the focus is not making decisions instead of coming to consensus.</p>	<p><b>5. Real-time Delphi</b></p> <p>No rounds are utilized in this type, but participants change their opinion as often as they like within set timeframe.</p>
<p><b>2. Modified Delphi</b></p> <p>It involves meeting of experts e.g., interview to discuss and rate results.</p>	<p><b>4. Policy Delphi</b></p> <p>The use of expert opinion to generate possible resolution to policy issues and guide future policies through innovation and ideas.</p>	<p><b>6. Internet-based Delphi</b></p> <p>Sometimes referred as e-Delphi, web-based Delphi. It follows the same process of classic Delphi, but now it is done through online platforms.</p>

Figure 1. Types of Delphi surveys and descriptions thereof. Adapted from Varndell et al. Int Emerg Nurs 2021;56:100867 [16].

mation management ability, practical guidelines for applying medical ICT to promote patient safety, health delivery system improvement, and policy development and supervision. Information literacy refers to a set of skills and abilities requiring people to recognize when information is needed [16]. Basic computer skills were an entry requirement, and practical guidelines for applying medical ICT were provided at a doctoral level and in advanced practice, making it a specialty [16]. A 5-point Likert-scale (1 = very unnecessary, 2 = unnecessary, 3 = not sure, 4 = necessary, 5 = very necessary) was used to rate the responses of the 15 experts participating in the Delphi survey to 72 learning objectives. A higher score indicated higher demand for the learning objective.

### 3. Data Collection

The study was approved by the Institutional Review Board of Chungnam National University (No. 202008-SB-110-01). Data were collected in two steps. The first step was an online survey that investigated the homepages of 200 nursing schools, of which only 104 of them offered NI courses. Sixty of these 104 schools agreed to participate and responded to the survey investigating the current status of NI education over a period of 3 months (from December 2020 to February 2021), resulting in a participation rate of 57.7%. Those who agreed to participate in the study provided informed consent, and then data were collected using an online survey questionnaire. The second step was a two-round Delphi sur-

vey among 15 nursing information experts (eight from academia and seven from practice). The Delphi survey was used to confirm the validity of NI topics and learning objectives for undergraduate and graduate courses. The two-round Delphi surveys were conducted 2 months after the online survey, from March 2021 to April 2021.

### 4. Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, such as frequencies, percentages, means, and standard deviations, were used.

## III. Results

### 1. Current Status of Nursing Informatics Education

Out of 60 nursing schools, 53 responded to this study, resulting in a response rate of 88.3%. Forty-two nursing schools were categorized as universities (4-year training) and 18 were nursing colleges (3-year training).

#### 1) Timing of nursing informatics classes within the program

NI classes were offered in 39 undergraduate programs (73.6%), and 11 NI courses (20.8%) were open to both undergraduates and graduate students. Eighteen out of 53 (34.0%) schools offered NI courses for fourth-year undergraduate students, while only two schools (3.7%) offered NI courses for first-year students (Table 1).

Table 1. Timing of nursing informatics classes within the programs

Variable	n (%)
Offering nursing informatics classes	
Undergraduate course	39 (73.6)
Both undergraduate and graduate courses	11 (20.8)
Undergraduate and graduate course offered	2 (3.8)
Graduate course offered	1 (1.8)
Offering nursing informatics classes in undergraduate schools	
First year	2 (3.7)
Second year	17 (32.1)
Third year	16 (30.2)
Fourth year	18 (34.0)
Offering nursing informatics classes in graduate schools	
Master's course	3 (23.1)
Doctorate	3 (23.1)
Master's and doctorate course	5 (35.7)
Other (master's and doctorate integrated course)	3 (23.1)

Undergraduate schools = 53, Graduate schools = 14.

Table 2. Characteristics of nursing informatics classes

Variable	Undergraduate school (n = 53)	Graduate school (n = 14)
Type of nursing informatics courses offered		
Major track required	12 (22.6)	3 (21.4)
Optional major subject	41 (77.4)	11 (78.6)
Necessity to introduce a nursing informatics major for undergraduates/graduates		
More necessary	32 (60.4)	6 (42.9)
Just necessary	15 (28.3)	7 (50.0)
Unnecessary	6 (11.3)	1 (7.1)
Instructor in charge of nursing informatics within the past 2 years (multiple responses)		
Full-time professor	35 (66.0)	11 (78.6)
Teacher	19 (35.8)	2 (14.3)
Other	2 (5.7)	1 (7.1)
Affiliation of professor in charge of nursing informatics		
Nursing department	51 (96.2)	-
Major of the professor in charge of nursing informatics (multiple responses)		
Basic nursing	6 (11.3)	-
Adult nursing	5 (9.4)	-
Geriatric nursing	3 (5.7)	-
Women's nursing	5 (9.4)	-
Community nursing	1 (1.9)	-
Psychiatric nursing	1 (1.9)	-
Nursing management	26 (49.1)	7 (50.0)
Nursing informatics	15 (28.3)	10 (71.4)
Other	9 (17.0)	2 (14.3)
Non-nursing majors (public health, computer science)		
	1 (100)	2 (100)
Curricula development for combined/integrated courses		
Opened	8 (15.1)	1 (7.1)
Not opened	45 (84.9)	13 (92.9)
Number of credits		
One	12 (22.6)	2 (14.3)
Two	34 (64.2)	12 (85.7)
Three	7 (13.2)	-
Appropriateness of opening credits		
Appropriate	38 (71.7)	11 (78.6)
Need to increase opening of appropriate credits	15 (28.3)	3 (21.4)
Necessity of a nursing informatics standard curriculum		
More necessary	23 (43.4)	3 (21.4)
Just necessary	25 (47.2)	9 (64.3)
Unnecessary	5 (9.4)	2 (14.3)

Values are presented as number (%).

### 2) Nursing informatics class characteristics

Among 53 undergraduate nursing schools, 41 schools (77.4%) offered NI courses as electives, and 35 full-time professors (66.0%) were responsible for teaching NI over the past 2 years. Fifty-one professors (96.2%) were affiliated with the nursing departments, and NI courses were usually allocated two credits (64.2%). Among the 14 graduate programs, three (21.4%) offered mandatory NI courses as part of the degree programs. Ten (71.4%) of the professors in charge specialized in NI, two credits were allocated to the NI course, and 11 schools (78.6%) reported that the number of credits offered for NI coursework was appropriate (Table 2).

### 3) Teaching methods in nursing informatics classes

Out of 53 undergraduate nursing schools, 42 (79.2%) preferred an on-campus classroom for teaching NI, and 50 schools (94.3%) chose lectures as the preferred teaching method. Twenty-one schools (39.6%) preferred universities as the practical location for NI classes, and 50 schools (94.3%)

selected textbooks as the main source of NI classes. Out of 14 graduate programs, 12 (85.7%) chose an on-campus classroom as a location for teaching NI. Half of the nursing schools preferred an in-school practicum as a teaching method for NI courses. Four schools (28.6%) preferred universities as the practicum location for NI classes. Fourteen schools (100.0%) preferred academic journals as the main source of information for NI classes (Table 3).

### 4) Difficulties in operating nursing informatics classes

Out of 53 schools, 10 (18.9%) indicated that a lack of educational materials was the most common challenge. Only three schools (5.7%) reported that a lack of instructor competence was a challenge.

Out of 53 schools, 21 (39.6%) needed environmental support, such as training-related equipment. In contrast, only seven schools (13.1%) needed support for enhancing instructors' abilities. Out of 43 schools that indicated their educational content needs, the instructors from nine schools

**Table 3. Teaching methods in nursing informatics classes**

Classification	Undergraduate school (n = 53)	Graduate school (n = 14)
Location of teaching nursing informatics (multiple responses)		
On-campus classroom	42 (79.2)	12 (85.7)
Campus computer laboratory	26 (49.1)	11 (78.6)
Other	7 (13.2)	-
Teaching method for nursing informatics courses (multiple responses)		
Lectures	50 (94.3)	10 (71.4)
School practice	17 (32.1)	7 (50.0)
Demonstration-laboratory practice	5 (9.4)	5 (35.7)
Team learning	17 (32.1)	2 (14.3)
Action learning	3 (5.7)	-
Other	2 (3.8)	-
Practice location of nursing informatics classes (multiple responses)		
Hospital	10 (18.9)	1 (7.1)
University	21 (39.6)	4 (28.6)
Community	2 (3.8)	-
Other	1 (1.9)	-
Source of information for nursing informatics classes (multiple responses)		
Textbook	50 (94.3)	13 (92.9)
Academic activities of professional societies	13 (24.5)	7 (50.0)
Professional academic journal	26 (49.1)	14 (100)
Internet	36 (67.9)	12 (85.7)
Medical institution	26 (49.1)	7 (50.0)

Values are presented as number (%).

(20.9%) specified that they wanted to receive education on information system utilization and training on the latest ICT skills (Table 4).

## 2. Development of a Standardized Nursing Informatics Curriculum

The results from the second round of the Delphi survey reflected that the following topics are appropriate for undergraduate curricula: nursing information system-related concepts, definition and components of healthcare information systems, electronic medical records, clinical decision support systems, mobile technology and health management, medical information standards, personal information protection and ethics, understanding of big data, IT in nursing research, and practical use of the latest ICT.

Topics identified as more appropriate for graduate curricula were healthcare IT concepts, the use of IT in evidence-based practice, the use of IT in community nursing, and the use of genome information, artificial intelligence, clinical information systems, administrative management systems, and IT in nursing education. The mean values in the second-round Delphi survey for undergraduate and graduate curricula ranged from 3.33 to 4.80 and from 3.66 to 5.00, respectively (Table 5).

## IV. Discussion

This study has provided comprehensive statistics on the current status of NI education in South Korea, challenges in providing NI classes, the resources needed by NI instructors, and the training on educational content that NI instructors want to receive, and developed a standard curriculum for NI for both undergraduate and graduate nursing schools using 72 learning objectives.

This study showed that 65.6% of undergraduate programs and 44.5% of graduate nursing programs offered NI courses. A study conducted by Park et al. [15] in Korea among 77 nursing schools found that 20.8% of undergraduate and 25.0% of graduate nursing programs offered NI courses. Later, another study conducted by Jeon et al. [2], among 38 nursing schools in Korea showed that 56.9% of undergraduate and 35.7% of graduate programs offered NI courses from 2005 to 2014. Even though increasingly many schools have introduced NI classes, more nursing schools should introduce NI as an additional major on top of the currently available majors.

In undergraduate schools, the findings of this study revealed that NI courses were offered from the first to fourth years, with many nursing schools introducing NI courses in year 2 (32.1%,) and year 4 (34.0%). In the similar study of

Table 4. Difficulties/barriers to operating nursing informatics classes

	Order	Category	n (%)
Challenges to providing nursing informatics classes (n = 53)	1	Lack of educational materials	10 (18.9)
	2	Lack of awareness of subject necessity	9 (17.0)
	3	Difficult in connection to practice	9 (17.0)
	4	Inconsistent opening of nursing informatics classes	8 (15.1)
	5	Lack of student understanding	5 (9.4)
	6	Broad content of nursing informatics	5 (9.4)
	7	Other	4 (7.5)
	8	Lack of instructor competence	3 (5.7)
Resources needed by instructors to teach nursing informatics (n = 53)	1	Environmental support such as training-related equipment	21 (39.62)
	2	Practice-location support	15 (28.30)
	3	Educational material support	10 (18.87)
	4	Support for increasing instructor ability	7 (13.11)
Educational content that nursing informatics instructors want to receive (n = 43)	1	Information system utilization education	9 (20.93)
	2	Training on the latest ICT skills	9 (20.93)
	3	Case sharing	8 (18.60)
	4	Curriculum standardization	8 (18.60)
	5	Latest trends in nursing information	7 (16.28)
	6	Information retrieval of electronic resources	3 (6.98)

Table 5. Development of a standardized nursing informatics curriculum using the second round of the Delphi survey

Competence-based learning objectives	Undergraduate	Graduate
Understanding of health and medical IT		
Explain development process of health information.	3.93 ± 0.88	4.13 ± 0.99
Specify the impact of ICT on healthcare.	4.40 ± 0.91	4.33 ± 0.89
Explain history of ICT in healthcare.	3.66 ± 0.89	3.66 ± 0.89
Discuss the role of information management in healthcare.	3.93 ± 0.96	4.20 ± 0.94
History and overview of nursing informatics <sup>a</sup>		
Explain the scope and function of nursing informatics.	4.80 ± 0.41	4.66 ± 0.81
Specify the key concepts of nursing informatics.	4.73 ± 0.45	4.66 ± 0.81
Explain the development process of nursing informatics.	4.40 ± 0.93	4.40 ± 0.98
Explain informatics competence of nurses.	4.50 ± 0.65	4.86 ± 0.35
Suggest the importance of nursing informatics education.	4.13 ± 0.83	4.73 ± 0.59
Development and implementation of health and medical information systems		
Define a health information system.	4.33 ± 0.81	4.60 ± 0.73
Explain the components and functions of a health information system.	4.20 ± 0.77	4.53 ± 0.74
Explain the role of nurses in implementing a health information system.	4.13 ± 0.74	4.73 ± 0.45
List the development process of a health information system.	3.60 ± 0.98	4.60 ± 0.63
Explain the life cycle of health information.	3.33 ± 0.72	4.46 ± 0.63
Clinical information systems <sup>a</sup>		
Explain electronic medical records, electronic and personal health, and electronic nursing records.	4.66 ± 0.48	4.73 ± 0.59
Explain the concept and purpose of clinical information systems.	4.60 ± 0.63	4.66 ± 0.72
Explain the development process of clinical information systems.	4.26 ± 0.79	4.40 ± 0.73
Discuss the factors to consider when improving nurse experiences with a clinical information system.	4.06 ± 0.59	4.66 ± 0.48
Evaluate the user experience, human-computer interactions, and usability.	3.60 ± 0.81	4.40 ± 0.63
Clinical decision support system		
Explain the concepts of clinical decision support and rights in practice.	4.53 ± 0.63	4.80 ± 0.41
List and describe the components of a clinical decision support system.	4.20 ± 0.67	4.80 ± 0.41
List and describe the types of clinical decision support systems.	4.20 ± 0.86	4.60 ± 0.63
Explain how clinical decision support systems can contribute to patient care.	4.46 ± 0.63	4.73 ± 0.45
Explain the relationship between artificial intelligence and clinical decision support systems.	3.86 ± 0.74	4.53 ± 0.63
Utilization of IT in evidence-based practice <sup>a</sup>		
Define evidence-based practice and explain the stages of practice and the role of informatics.	4.33 ± 0.72	4.66 ± 0.61
Explain the purpose of practice-based design analysis.	3.70 ± 0.88	4.66 ± 0.61
Explain the study of practice-based evidence analysis, the relationship with information systems, and the role of informatics.	3.80 ± 0.86	4.73 ± 0.59
Discuss the relationship between evidence-based practice and practice-based evidence using an informatics-based approach.	3.73 ± 0.79	4.73 ± 0.59
Use of IT in community nursing <sup>a</sup>		
Explain the role of IT in community nursing.	3.99 ± 0.70	4.40 ± 0.73
Describe community health information systems and list their functions.	3.80 ± 0.77	4.46 ± 0.63
Discuss the use of IT in disease surveillance, disease registration, and epidemiology.	3.86 ± 0.83	4.46 ± 0.48

Continued on the next page.

Table 5. Continued

Competence-based learning objectives	Undergraduate	Graduate
Nursing in genomic informatics <sup>a</sup>		
Explain the concepts of genomic informatics.	3.55 ± 0.74	4.06 ± 0.79
Discuss the contribution of IT in genomics to precision medicine.	3.46 ± 0.91	4.13 ± 0.83
Describe how IT is used in health risk identification, diagnosis, prognosis, and symptoms management in genomics.	3.60 ± 0.91	4.13 ± 0.83
Utilization of IT in nursing management <sup>a</sup>		
Explain the function of management information systems in nursing management.	3.86 ± 1.06	4.66 ± 0.61
Explain how to use IT for human, financial, and physical resource management.	3.73 ± 1.03	4.66 ± 0.61
Enumerate IT application methods to improve patient safety and quality.	3.80 ± 1.08	4.60 ± 0.73
Mobile-technology healthcare		
Explain the development of ICT.	4.00 ± 0.84	4.20 ± 0.86
Evaluate the quality of health information.	4.13 ± 0.74	4.53 ± 0.63
Explain the concept of mobile health (mHealth).	4.46 ± 0.83	4.46 ± 0.83
Discuss how to use mHealth.	4.40 ± 0.73	4.60 ± 0.63
Medical and nursing information standards		
Explain the concepts and importance of medical information and nursing information standards.	4.66 ± 0.51	4.80 ± 0.56
Explain the difference between terminology and taxonomy.	4.66 ± 0.63	4.73 ± 0.35
List health terminology and classification systems.	4.40 ± 0.61	4.80 ± 0.41
Explain the need for a minimum data set size.	4.33 ± 0.61	4.80 ± 0.35
Personal health information protection and ethics		
Explain the characteristics and concepts of personal health information.	4.66 ± 0.61	4.73 ± 0.59
Explain the concepts related to personal health information protection.	4.53 ± 0.74	4.66 ± 0.61
Describe laws related to the protection of personal health information.	4.33 ± 0.72	4.73 ± 0.59
Explain the role of information protection.	4.73 ± 0.59	4.73 ± 0.45
Compare information security methods.	3.73 ± 0.88	4.46 ± 0.74
Nursing information and big data		
Explain the concepts and characteristics of health and medical big data.	4.26 ± 0.88	4.80 ± 0.41
List the types of health and medical big data.	4.00 ± 1.00	4.66 ± 0.81
Explain the concepts and roles of data science.	4.06 ± 0.88	4.80 ± 0.41
Discuss the application of data science in nursing.	4.06 ± 0.79	4.80 ± 0.41
Utilization of IT in nursing research		
Suggest the role of informatics in nursing research.	4.13 ± 0.99	4.86 ± 0.35
Explain the use of IT in nursing research.	4.20 ± 0.94	5.00 ± 0.00
Explain how to search for nursing-related academic information.	4.40 ± 0.82	4.73 ± 0.59
Explain the collaboration between researchers and between researchers and subjects.	3.53 ± 0.83	4.73 ± 0.45
Uses of IT in nursing education <sup>a</sup>		
Explain the importance and content of the nursing informatics curriculum.	3.66 ± 0.97	4.53 ± 0.91
Discuss the current status and development direction of the nursing information education curriculum.	3.53 ± 0.91	4.53 ± 0.91
Present the role of ICT in nursing education.	3.73 ± 0.79	4.66 ± 0.48
Compare the advantage and disadvantages of education using ICT.	3.66 ± 0.81	4.53 ± 0.63
List the types of education using ICT in nursing education.	3.66 ± 0.81	4.73 ± 0.45
Discuss the methods for increasing the effectiveness of ICT in nursing education.	3.53 ± 0.83	4.73 ± 0.45

Continued on the next page.

Table 5. Continued

Competence-based learning objectives	Undergraduate	Graduate
Patient participation and social networking services		
Explain the relationship between patient-centered nursing and nursing information.	4.26 ± 0.96	4.66 ± 0.48
Explain the concepts and characteristics of the patient.	4.06 ± 0.96	4.66 ± 0.61
Explain the types and functions of social networking services and their role in healthcare.	4.06 ± 1.03	4.60 ± 0.63
Explain the concept and role of the online patient community.	3.93 ± 1.03	4.60 ± 0.63
Recent medical information in technology <sup>a</sup>		
Explain the impact of advances in IT on the future of healthcare and nursing.	4.33 ± 0.72	4.80 ± 0.56
Discuss the scope of application of artificial intelligence in nursing.	4.06 ± 0.88	4.86 ± 0.35
Discuss the scope of nursing applications of customized precision medicine.	4.06 ± 0.79	4.73 ± 0.59
Discuss the scope of the nursing applications of virtual reality.	4.13 ± 0.74	4.80 ± 0.41

Values are presented as mean ± standard deviation.

IT: information technology, ICT: information and communication technology.

<sup>a</sup>Graduate school curriculum.

Park et al. [15], NI classes were mostly introduced for first- (43.7%) and second-year students (37.5%), while Jeon et al. [2] revealed that NI classes were predominantly introduced in the second (31.6%) and third years (36.8%). The findings of Jeon et al. [2] are similar to those of this study. These comparisons indicate that NI classes could be offered at any level, depending on the school's preferences. More nursing schools have introduced NI classes for students in the third and fourth years to increase the time spent on its teaching. Many nursing schools have chosen to offer NI courses due to the importance of NI in supporting nurses and patients in making the best decisions to achieve optimum health outcomes.

This study found that 96.2% of professors in charge of NI courses were nursing professors who specialized in NI and nursing management. Park et al. [15] found that 50% of the professors in charge were nursing professors. Another study conducted in 2016 reviewing the current status of NI education found that 86.4% of professors in charge of NI courses were nursing professors [2]. The present study found that more nursing professors were in charge of NI courses than in previous studies conducted in Korea. This finding highlights that more nursing professors now specialize in NI, which reflects their broader knowledge in the field [17,18]. Nursing professors responsible for teaching NI help optimize health IT methods and software tools in nursing to improve healthcare outcomes [2,15,19]. These nursing professors are important in the development, management, and processing of data in healthcare facilities.

The most significant challenge to teaching NI is the lack of educational materials, which further leads to poor function-

ality and an impaired ability of nursing students and nursing professors to perform at an optimum level [20,21]. This challenge may be due to schools not prioritizing NI courses as essential, unlike other nursing courses, where it is ensured that materials such as books are always available. The optimum provision of proper NI educational materials is therefore important and should be addressed and improved upon at all nursing schools.

Practice equipment is one of the most important resources that NI instructors need to teach. Practice equipment in NI helps in the attainment of skills during class activity in a safe, acceptable, and effective way [22,23]. Practicing with the relevant equipment during NI classes helps improve performance, minimize errors, and increase accessibility during nursing practices in healthcare facilities [23,24]. Nursing schools that offer NI programs are advised to have all the necessary practice equipment to enable easy skill teaching by nursing professors and other instructors.

The Delphi survey provided experts an opportunity to reflect on the learning objectives selected based on the respective topics. Involving 15 experts working as nursing professors and practitioners in different universities made the curriculum unique and increased the likelihood of the results being relevant and applicable to undergraduate and graduate nursing programs [20].

The results obtained in this study indicate the topics that should be included in undergraduate program curricula. A study conducted in 2007 by Yom et al. [8] suggested four competencies for the curricula: informatics fundamentals, NI fundamentals, NI applications, and public health informatics and social aspects. A study conducted in 2017 found

that NI curricula should include informatics used in nursing and midwifery practice, the history of present health and nursing IT systems, tools used in IT, the proficient use of electronic patient records for patient assessments, performing a nursing diagnosis, designing and executing a care plan, evaluating a care plan and nursing interventions, the use of the internet and other research tools, the use of nursing and midwifery taxonomies and NI standards, the vocabulary of IT terminologies, and contemporary issues in nursing and midwifery informatics [25]. A study conducted by Saba and McCormick [13] highlighted that NI curricula should include basic concepts and application of informatics; access to information systems; the utilization of data, information systems, and analyses; and the coordination and integration of nursing information. These findings are all similar to those in the present study, but our findings covered more competencies to be included in the curriculum. The structured undergraduate curriculum will assist in promoting a sense of structure and consistency across all nursing schools.

This study found that 26 of the 72 learning objectives were more appropriate for graduate NI courses. A study conducted in the United States indicated that NI curricula should include historical perspectives of computers in nursing and healthcare; computer hardware and software; system analysis and design; applying computers to nursing in education, clinical practice, administration, and research; the role of the nurse in selecting, implementing, and evaluating hospital information systems; and professional issues related to the use of computer systems in healthcare [25]. These topics will assist in strengthening competence-based NI education for undergraduate and graduate nursing students [12,26]. A curriculum of this type can help to ensure that future graduate nurses are proficient and competent in NI.

The study has provided recommendations for improving NI curricula in Korea. First, nursing schools need to support NI learning by providing educational materials and practical equipment that are currently lacking. Secondly, more uninformed instructors and nursing professors should be given opportunities to attend training courses on understanding NI. An example of a training course for instructors and professors is furnished by the NI leadership and specialization courses provided by the University of Minnesota, United States of America [25]. This course focuses on going deeper into the training and education leadership skills that are helpful for NI leaders [25]. Voluntary refresher training programs should be introduced for NI instructors. These training programs would provide them with more knowledge about the NI field. Lastly, training of instructors on informa-

tion systems, the latest IT, and a standard curriculum in NI were considered important.

One limitation of this study was that not all selected nursing schools responded, with response rates of 48.6% and 62.7% for colleges and nursing schools, respectively. However, these response rates were markedly higher than that of 35.3% for the 77 nursing schools analyzed in 2016 by Jeon and colleagues.

## Conflict of Interest

Mona Choi is an editorial member of Healthcare Informatics Research; however, she did not involve in the peer reviewer selection, evaluation, and decision process of this article. Otherwise, no potential conflict of interest relevant to this article was reported.

## Acknowledgments

This study is supported by Chungnam National University.

## ORCID

Myonghwa Park (<https://orcid.org/0000-0002-0329-0010>)  
 Bonkhe Brian Dlamini (<https://orcid.org/0000-0001-8676-7912>)  
 Jahyeon Kim (<https://orcid.org/0000-0001-8468-9746>)  
 Min-Jung Kwak (<https://orcid.org/0000-0002-3853-4716>)  
 Insook Cho (<https://orcid.org/0000-0002-5152-9567>)  
 Mona Choi (<https://orcid.org/0000-0003-4694-0359>)  
 Jisan Lee (<https://orcid.org/0000-0002-9039-7448>)  
 Yul Ha Min (<https://orcid.org/0000-0002-1657-8582>)  
 Bu Kyung Park (<https://orcid.org/0000-0001-6714-4226>)  
 Seonah Lee (<https://orcid.org/0000-0003-2136-2601>)

## References

1. Garcia-Dia MJ. Nursing informatics: an evolving specialty. *Nurs Manage* 2021;52(5):56. <https://doi.org/10.1097/01.numa.0000743444.08164.b4>
2. Jeon E, Kim J, Park HA, Lee JH, Kim J, Jin M, et al. Current status of nursing informatics education in Korea. *Healthc Inform Res* 2016;22(2):142-50. <https://doi.org/10.4258/hir.2016.22.2.142>
3. Nelson TL, Parker CD. Nursing informatics: the EHR and beyond. *American Nurses Today* 2019;14(3):36-39.
4. Oh J, Kim SJ, Kim S, Kang KA, Kan J, Bartlett R. Development and evaluation of flipped learning using film clips within a nursing informatics course. *Jpn J Nurs Sci*

- 2019;16(4):385-95. <https://doi.org/10.1111/jjns.12245>
5. Harerimana A, Wicking K, Biedermann N, Yates K. Integrating nursing informatics into undergraduate nursing education in Africa: a scoping review. *Int Nurs Rev* 2021;68(3):420-33. <https://doi.org/10.1111/inr.12618>
  6. Oh J, Kim SJ, Kim S, Vasuki R. Evaluation of the effects of flipped learning of a nursing informatics course. *J Nurs Educ* 2017;56(8):477-83. <https://doi.org/10.3928/01484834-20170712-06>
  7. Kleib M, Chauvette A, Furlong K, Nagle L, Slater L, McCloskey R. Approaches for defining and assessing nursing informatics competencies: a scoping review. *JBIEvid Synth* 2021;19(4):794-841. <https://doi.org/10.11124/jbies-20-00100>
  8. Yom YH, Kim JE, Chun BC, Choi S, Whang DH, Park KM, et al. Development of standardized and competency-based curriculum in nursing informatics. *J Korean Soc Med Inform* 2007;13(3):227-36. <https://doi.org/10.4258/jksmi.2007.13.3.227>
  9. Staggers N, Gassert CA, Curran C. Informatics competencies for nurses at four levels of practice. *J Nurs Educ* 2001;40(7):303-16. <https://doi.org/10.3928/0148-4834-20011001-05>
  10. Hunter K, McGonigle D, Hebda T. The integration of informatics content in baccalaureate and graduate nursing education: a status report. *Nurse Educ* 2013;38(3):110-3. <https://doi.org/10.1097/nne.0b013e31828dc292>
  11. Wilson ML, Elias BL, Moss JA. Education in Nursing Informatics. In: Berner ES, editor. *Informatics education in healthcare*. Cham, Germany: Springer; 2014. p. 59-75. [https://doi.org/10.1007/978-1-4471-4078-8\\_5](https://doi.org/10.1007/978-1-4471-4078-8_5)
  12. Taymoori P, Moshki M. A Delphi study to curriculum modifying through the application of the course objective and competencies. *J Educ Health Promot* 2014;3:124. <https://doi.org/10.4103/2277-9531.145936>
  13. Saba VK, McCormick KA. *Essentials of computers for nurses: Informatics for the new millennium*. 3rd ed. New York (ny): McGraw-Hill; 2001.
  14. Collins S, Yen PY, Phillips A, Kennedy MK. Nursing informatics competency assessment for the nurse leader: the Delphi study. *J Nurs Adm* 2017;47(4):212-8. <https://doi.org/10.1097/nna.0000000000000467>
  15. Park HA, Kim JE, Yang YH, Hyun SY. A survey study of nursing informatics education in Korea. *J Korean Soc Med Inform* 1999;5(1):11-25. <https://doi.org/10.4258/jksmi.1999.5.1.11>
  16. Varndell W, Fry M, Lutze M, Elliott D. Use of the Delphi method to generate guidance in emergency nursing practice: a systematic review. *Int Emerg Nurs* 2021;56:100867. <https://doi.org/10.1016/j.ienj.2020.100867>
  17. Anderson C, Sensmeier J, Kwiatkoski T. Results of the 2020 HIMSS nursing informatics workforce survey-growth in education and leadership. *Comput Inform Nurs* 2020;38(9):431-2. <https://doi.org/10.1097/cin.0000000000000679>
  18. Hart MD. Informatics competency and development within the US nursing population workforce: a systematic literature review. *Comput Inform Nurs* 2008;26(6):320-9. <https://doi.org/10.1097/01.ncn.0000336462.94939.4c>
  19. Moen A, Maeland Knudsen LM. Nursing informatics: decades of contribution to health informatics. *Health Inform Res* 2013;19(2):86-92. <https://doi.org/10.4258/hir.2013.19.2.86>
  20. Seo K, Min YH, Choi SH, Lee H. Evaluation of the Korean version of the self-assessment of nursing informatics competencies scale. *BMC Nurs* 2019;18:68. <https://doi.org/10.1186/s12912-019-0392-5>
  21. Hussey P, Hannah KJ. Nursing informatics: a core competency for the profession. In: Hussey P, Kennedy MA, editors. *Introduction to nursing informatics*. Springer, Cham. 2021. pp. 55-85. [https://doi.org/10.1007/978-3-030-58740-6\\_3](https://doi.org/10.1007/978-3-030-58740-6_3)
  22. Cummings E, Borycki EM, Madsen I. Teaching nursing informatics in Australia, Canada and Denmark. *Stud Health Technol Inform* 2015;218:39-44.
  23. Fagerstrom C, Tuveesson H, Axelsson L, Nilsson L. The role of ICT in nursing practice: an integrative literature review of the Swedish context. *Scand J Caring Sci* 2017;31(3):434-48. <https://doi.org/10.1111/scs.12370>
  24. Asiri H. An overview of nursing informatics (NI) as a profession: how we evolved over the years. *Proceedings of the 9th International Joint Conference on Biomedical Engineering Systems and Technologies*; 2016 Feb 24-26; Rome, Italy. p. 200-12. <https://doi.org/10.5220/00056582020000212>
  25. McNeil BJ, Odom SK. Nursing informatics education in the United States: proposed undergraduate curriculum. *Health Inform J* 2000;6(1):32-8. <https://doi.org/10.1177/146045820000600107>
  26. Shah S, McCann M, Yu C. Developing a national competency-based diabetes curriculum in undergraduate medical education: a Delphi study. *Can J Diabetes* 2020;44(1):30-6.e2. <https://doi.org/10.1016/j.jcjd.2019.04.019>