

F E A T U R E

A R T I C L E


A Study of the Informatics Literacy of Clinical Nurses in Taiwan

HSIN-GINN HWANG, PhD
RAI-FU CHEN, PhD
LI-HUI CHANG, RN
JU-LING HSIAO, PhD

Recently, with the rapid advances of health information technologies (HITs) and the complexity of the health-care environment, Taiwanese hospitals are facing many managerial challenges in providing high-quality patient care at a reasonable cost. These cost issues are made more urgent because of the constantly changing nature of the national insurance reimbursement mechanism. Hospital administrators are aggressively adopting innovative information technology (IT) to cope with these cost issues and other managerial challenges. For these reasons, about 95% of Taiwanese hospitals have already developed computerized physician order entry (CPOE) systems to assist physicians in their clinical activities. In addition, the data-related CPOE systems are used to greatly expedite the filing of insurance reimbursements. In this role, HIT has been essential in streamlining Taiwanese hospital operations.

Nursing practitioners are being required to acquire informatics literacy in the hopes of increasing their effectiveness, particularly in light of widespread nursing staff shortages. Because of its obvious ability to ease hospital operations, HIT has become better recognized and desired by the entire staff, especially nurses, who are the largest working group in any hospital. The study conducted by Jiang et al¹ indicated a gap between the computer competencies of clinical nurses and Taiwanese nursing school curriculum. Ironically, the desire and demand for HIT integration in nursing are not matched by a cogent approach to teaching the necessary skills.

Because of the inappropriate HIT-related curriculum and limited hands-on experience, graduates from



The purpose of this study is to identify the essential components for informatics literacy for clinical nurses working in Taiwanese hospitals. We developed a framework to explore the critical informatics literacy factors that clinical nurses should understand to be proficient in performing their professional duties. Survey methodology was used and the participants were senior administrators of nursing and other personnel in charge of implementing nursing information systems for 84 regional hospitals and medical centers. A total of 50 valid questionnaires was returned, with a 59.5% response rate. In summary, the results of the Taiwanese study are divided into three factors: informatics knowledge, informatics skills, and computer attitudes. A total of 58 questions was used for the measurement of initial nursing informatics literacy, and 49 items were considered to be the most required informatics literacy skills specifically for clinical nurses.

KEY WORDS

Clinical nurses • Informatics literacy •
Nursing informatics

Taiwanese nursing schools have not learned sufficient HIT-related knowledge and skills needed to use either hospital information systems (HIS) or nursing information systems (NIS) with proficiency during their clinical activities. Therefore, the nursing departments of Taiwanese hospitals have urgent needs for their clinical nurses to possess necessary informatics literacy to facilitate their nursing activities.

Author Affiliations: Department of Information Management and Healthcare Information Management Institute, National Chung Cheng University, Chia-yi, (Drs Hwang and Chen); Chi Mei Medical Center, Tainan (Dr Hwang); Department of Information Management Chia Nan University of Pharmacy & Science, Tainan (Dr Chen); Department of Nursing, Tai-Chung Hospital, and Department of Health, Executive Yuan, Tai-Chung (Ms Chang); and Department of Hospital and Health Care Administration, Chia Nan University of Pharmacy & Science, Tainan, Taiwan (Dr Hsiao).

Corresponding author: Ju-Ling Hsiao, PhD, Department of Information Management and Healthcare Information Management Institute, National Chung Cheng University, No 168, University Road, Min-Hsiung, Chia-yi 621, Taiwan, ROC (mayo5012@yahoo.com.tw).

Bowles² reported that the informatics literacy of clinical nurses would influence the quality of their care. In 1999, Marion et al³ indicated that a lack of required knowledge about IT is one of the major obstacles in most hospitals. Therefore, informatics literacy of clinical nurses is a fundamental requirement. It is a critical issue for nursing administrators to assess the informatics literacy of clinical nurses to provide them with high-quality continuing education programs.

Our research was motivated by the following. First, although there are a few informatics literacy-related studies on clinical nurses in Taiwan, those studies focus only on the topic of computer skills, which is just one component of informatics literacy.^{4,5} Moreover, the differences in nursing information education between Taiwan and other countries show that there is an urgent need to investigate exactly what informatics literacy practices are required in Taiwan. Furthermore, the innovative nature of IT is a major driving force for the needs in the workplace. Therefore, the purposes of this study include (1) identifying the current informatics literacy requirements of clinical nurses from the nursing directors' point of view, (2) identifying the current teaching strategies and classroom delivery of informatics literacy courses in Taiwanese hospitals, and (3) making comparisons between Taiwan and other countries regarding informatics literacy education in clinical nursing.

LITERATURE REVIEW

Informatics Literacy

In 1999, Bruce⁶ investigated workplace-oriented informatics literacy and found that when a workplace has a higher degree of computerization, its employees are more motivated by the needs of the workplace. Breivik and Gee⁷ define informatics literacy as the ability to effectively access and evaluate information for a given need. The informatics literacy includes an integrated set of skills and knowledge of tools and resources. Saranto and Hovenga⁸ demonstrated that the concept of informatics literacy does not exist as such in their investigated literature, but it can be found as a synonym to computer literacy or even more obscure concepts, such as informatics awareness or computer experience. Therefore, the definitions of these concepts vary considerably, and much effort still needs to be applied to compile educational programs in health informatics to enhance knowledge and skills in computer use among healthcare professionals. Stagers et al⁹ indicated that various terms, such as *computer skills*, *computer literacy*, *computer competence*, *informatics literacy*, and *IT needs*, were used to express informatics require-

ments. They reported that focusing only on technology or computer literacy would be a narrow definition for determining information requirements. In their definition, informatics competencies were the integration of knowledge, skill, and attitudes in the performance of various nursing informatics (NI) activities with prescribed levels of nursing practices. Because the concepts of informatics literacy and informatics competencies of this study are similar, we revised the definition of Stagers et al to our definition of informatics literacy as "the integration of knowledge, skills, and attitudes in the performance of various nursing informatics activities" to have a broader viewpoint on the informatics literacy that clinical nurses truly need.

Nursing Informatics Literacy

Thomas¹⁰ pointed out that nurses' attitudes toward computer applications and the impact of computer attitudes on nurses' general informatics literacy can be measured based on their ideas, concerns, and initiative toward using computers. Stagers et al¹¹ asserted that the assessment of clinical nurses' informatics literacy, includes computer skills, informatics knowledge, and informatics skills. Some research consists of the issue of incorporating IT into nursing students' curriculum. In 1996, Birx et al¹² indicated that basic computer skills, such as the ability to use e-mail and word processing programs and search for library information, is the basis for measuring the informatics skills of nursing students. Saranto and Leino-Kilipi¹³ indicated that the cultivation of computer literacy in nursing information education included using the computer for word processing purposes, accessing and using the HIS, and sending/receiving e-mails. Nurses must be aware of system security and show a positive attitude toward computers. HIS and NI also should be integrated into laboratory and hospital training.

Many studies have found that increasing the informatics knowledge of nursing personnel helps their clinical effectiveness.^{14,15} Graveley et al¹⁶ also asserted that undergraduate nursing students should have computer literacy suitable for entering an upper division nursing program, including the ability to use word processing, spreadsheet, and presentation/graphics programs, Internet, and e-mail. In 2000, Liu et al¹⁷ investigated the informatics literacy of clinical nurses and found that it is composed of computer knowledge, attitudes, and skills. In their study, three significant relationships among those factors were identified. Hobbs¹⁸ also analyzed relevant articles on NI literacy published after 1988 and the measurement items used. They stated that the informatics literacy of clinical nurses should include three major categories: computer

knowledge, computer attitude, and computer skills. The category of computer knowledge is composed of basic computer knowledge, word processing, management and control of information system security, and nursing personnel using HIS. The category of computer skills encompasses basic operating ability, word processing, the ability to use electronic forms and graphic tables, information security, e-mail, and the ability to use the Internet and correctly execute specialized HIS. The category of computer attitudes consists of the degrees of satisfaction with the use of systems and belief in choosing better systems and motivation of the users and their intellectual models of positive orientation. Based on this literature review, we proposed a framework to explore what the informatics literacy of clinical nurses is.

RESEARCH METHODS

Research Framework

Based on this discussion, a conceptual framework was proposed in this study. In this framework (Figure 1), the informatics literacy of clinical nursing consists of three parts: (1) informatics knowledge, (2) informatics skills, and (3) computer attitudes. The concepts of informatics knowledge and informatics skills were adapted from informatics competencies in Staggers et al.⁹ They indicated that without informatics competencies (which is used as a synonym for informatics literacy in this article), an individual cannot master the information and knowledge needed to succeed in today's healthcare environment or to undertake evidence-based practice. Staggers et al.⁹ also asserted that nursing information competencies encompass all skills, not only computer-

related skills. In addition, many studies indicated that the attitudes of nursing practitioners toward information competency must be included as an essential component of informatics literacy.¹⁸⁻²⁰ Therefore, computer anxiety and cyberphobia must be overcome.

The rapid expansion of communications technology is the distinguishing feature of the last century. Informatics knowledge refers to communications-related knowledge that one should have in the digital age. Informatics covers knowledge such as basic computer concepts, information security, and use of HIS. Informatics skills refer to the ability to use tools such as the computer, the Internet, and communication technology and basic abilities to operate data input-output equipment and systems. For our research, we considered basic informatics skills to include such things as the ability to operate computers and use IT and network basics.

Many studies indicate that the adoption of computer technology has been either facilitated or impeded by attitudes toward automation. In 1991, Igbaria and Parasuraman¹⁹ demonstrated that work in the business sector has shown that user attitudes are a key determinant of the effective use of computers in the workplace and that employees may resist using computers if they have a negative attitude. In the study by Hobbs,¹⁸ attitudes toward computers were regarded as a key component of nursing computer competency. In this study, computer attitudes refer to an individual's emotional set. These emotions have inevitable behavioral consequences toward the use of computers, the Internet, and communications technology.

For the purpose of this study, a research framework was developed to verify the informatics literacy of clinical nurses, which is composed of the following three factors: informatics knowledge, informatics skills, and computer attitudes.

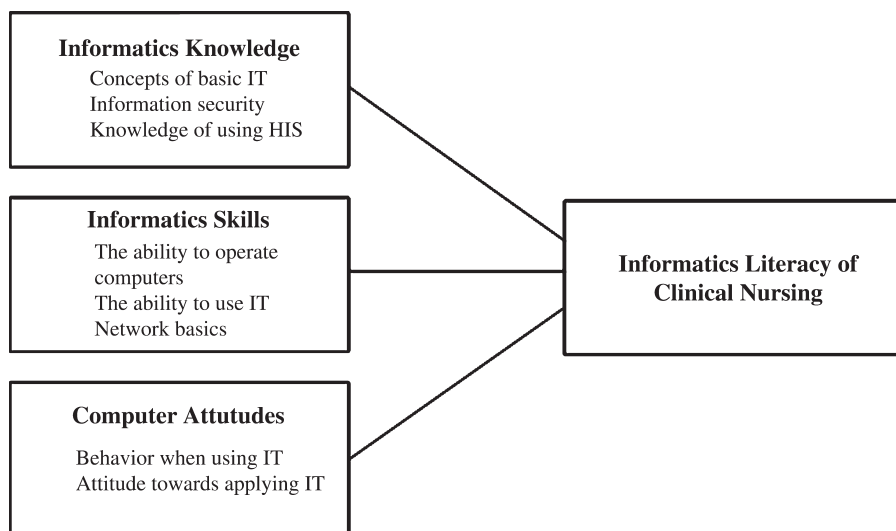


FIGURE 1. Research framework.

DESIGN AND PARTICIPANTS

Participants

The participants in this research were nursing administrators or personnel in charge of implementing an NIS for a total of 84 regional hospitals and medical centers in Taiwan.

Instrument

A questionnaire divided into two sections was used to collect necessary data. The first section recorded the respondents' demographic information. The second section measured informatics knowledge, informatics skills, and computer attitudes, encompassing a total of eight variables. The informatics knowledge factor included three variables: concepts of basic IT (seven items), information security (nine items), and knowledge of using HIS (five items). The informatics skills factor included three variables: the ability to operate computers (13 items), the ability to use IT (measured by five items), and network basics (seven items). The computer attitudes factor includes two variables: behavior when using IT (five items) and attitudes toward applying IT (seven items). Measures for each variable were selected for their interpretability and empirical support in prior research. Survey questions used a 5-point Likert scale, with choices ranging from 1 to 5 (1 = strong disagreement, 5 = strong agreement). Only results with a mean value more than 4 were arbitrarily chosen to represent the important factors influencing informatics literacy.

A two-stage process was used to refine the instrument. The first stage included an expert panel discussion with three functions: (1) If the questionnaire was deemed incomplete, the panel added items. (2) If the meaning of a question was not translated completely from English into Mandarin, the panel revised the translation to fit more accurately with the literature. (3) If a question from the literature did not fit in with the Taiwanese situation, it was deleted.

First, a total of three rounds of meetings was attended by expert panel members to approve the questionnaire. If the panel found that the questionnaire items deviated greatly from literature-based items, or if the questions were not appropriate for real-world applications, they were revised to become more suitable for the research purpose. Second, a pilot study was conducted in a regional hospital to increase the construct validity. Several senior nursing administrators of this particular hospital were asked to participate in this pilot study. Comments and suggestions were incorporated into the final instrument.

PROCEDURES

This study was conducted in two stages. In stage 1, a research framework prototype that was summarized from the literature review, was revised by three experts and by conducting a pilot study. The three experts were a nursing professor and two practitioners. The academician was a departmental chairperson of a junior college of nursing with more than 10 years of teaching experience who had been developing NIS for 10 years. The others were the directors of the nursing department at medical centers in central Taiwan with experience in implementing NIS totaling more than 10 years.

A 5-point scale was used to rate items from strong disagreement (1) to strong agreement (5). Only the items with a mean value more than 4 were considered as acceptable. The experts recommended deleting 33 items from the initial questionnaire, leaving a total of 91 items, and the final content validity index of the 58 items for the measurement of informatics literacy was 0.88 to 0.92. In the pilot study, a regional hospital in central Taiwan was used for the case study. This hospital currently strives to create a paperless workplace environment through the use of HIS. In addition, the nursing director and supervisors of this hospital have decision-making authority over clinical affairs, and through close participation, they made a large contribution to the development of this NIS project.

At the second stage, the completed questionnaire was sent to 84 regional hospitals and medical centers around Taiwan. To improve the response rate, several promotions were launched, including some motivational gifts and offers to freely share the study results to encourage them to answer this questionnaire. As further support for study participation, reminder phone calls were made to give notice and to explain the purpose of this study. Explaining the purpose of the study more than once also contributed to the external validity of the questionnaire.

DATA ANALYSIS AND RESULTS

Reliability and Validity

Prior to data analysis, the research instrument was assessed for its reliability and validity. Cronbach coefficient α was computed for each variable to test for reliability. The result is presented in Table 1. The Cronbach α value of the questionnaire was found to range between .76 and .96.

In terms of validity analysis, the principal component method of analysis was conducted for factor extraction whose Eigenvalue is greater than 1 to evaluate the

Table 1**Reliability and Construct Validity**

Factor	Variable	Cronbach α	Factor Loading	Explanatory Variance
Informatics knowledge	Concepts of basic IT	.924	0.859	70.128
	Information security	.943	0.608	69.436
	Knowledge of using HIS	.894	0.843	72.473
Informatics skills	The ability to operate computers	.957	0.704	67.370
	The ability to use IT	.761	0.809	51.798
	Network basics	.957	0.796	79.731
Computer attitudes	Behavior when using IT	.924	0.859	70.128
	Attitude toward applying IT	.865	0.843	56.721

efficiency of measurement. Three factors were extracted based on the values of characteristics and screen plot. To facilitate explanation, a varimax (orthogonal) rotation method was used to display the results. The composing factors after the rotation are similar to our preliminary research framework. Three factors, which accounted for 80.61% of the variance, were extracted and labeled: informatics knowledge, informatics skills, and computer attitudes. Based on the data from the table, all the variables have high factor loading and variance; thus, this study is of high validity.

Survey Results

DEMOGRAPHIC DATA

A total of 50 valid questionnaires was returned, for a 59.5% response rate. The demographic data of the respondents showed that more than 89.8% are working at the middle and senior management level. The age range of 56% of the participants was between 40 and 50 years, and 64% of the participants have received master's degrees and above. Of the respondents, 87.6% have worked at a hospital for more than 10 years, 60% of respondents have held executive positions for less than 5 years, and 22% of the respondents have been in executive positions for 5 to 10 years. These results indicated that the education, job experience, and positions of the respondents were representative of the average hospital staff and were appropriate for this study.

INFORMATICS LITERACY EDUCATION IN CLINICAL NURSING PRACTICE

Regarding the cultivation of informatics literacy among nursing personnel, 44% of the respondents agreed or strongly agreed that the hospital puts emphasis on the development of NIS. Among the hospitals investigated, 70% of them provide in-service training, 32% of them arrange information courses as part of their preservice

training, 14% of them have advanced nursing information education, 34% of them have trained NIS instructors by the nursing department, and 24% of them include IT application courses in their in-service training for executives.

THE CONTENT OF THE INFORMATICS LITERACY OF CLINICAL NURSES

The relevant variables influencing the three factors of informatics literacy are summarized in Tables 2, 3, and 4. Means and standard deviations on the degree of agreement of each measurement item were calculated.

Informatics knowledge (mean, 4.04) consisted of three variables: concepts of basic IT (mean, 4.19), information security (mean, 4.05), and knowledge of using HIS (mean, 4.04). As shown in Table 2, each measurement item of informatics knowledge factors had a mean of no less than 4, except for five items (items 14–16 on information security and items 19 and 20 on knowledge of using HIS). Therefore, seven items (items 1–7), six items (items 8–13), and three items (items 17, 18, and 21) were regarded as the required factors that define the concepts of basic IT, information security, and knowledge of using HIS, respectively.

Informatics skills (mean, 4.15) included three variables: the ability to operate computers (mean, 4.17), the ability to use IT (mean, 4.07), and network basics (mean, 4.21). Every measurement item of informatics skills had a mean no less than 4, except for four items (items 25 and 26 on the ability to operate computers and items 35 and 37 on the ability to use IT). Eleven items (items 22–24 and 34), three items (items 36, 38, and 39), and seven items (items 40–46) were regarded as the required factors that define the ability to operate computers, the ability to use IT, and network basics, respectively.

Computer attitudes (mean, 4.32) consisted of two variables: behavior when using IT (mean, 4.36) and attitude toward applying IT (mean, 4.28). The mean of each measurement item of computer attitudes had a

Table 2

The Informatics Knowledge Factor Obtained From Data Analysis



Variable	No.	Measurement Item (or Informatics Competencies)	Mean	SD
Concepts of basic IT	1	Knows the basic components of a computer's hardware system and their function (eg, features of a personal computer, workstation)	4.02	0.769
	2	Knows basic principles of computer networks (eg, sending and receiving e-mail, browsing Web pages, downloading or uploading documents, searching for information on the Internet, etc)	4.32	0.587
	3	Recognizes that it takes time, persistent effort, and skill for computers to become an effective tool	4.26	0.723
	4	Uses existing external peripheral devices (eg, CD-ROMs, portable disk, printer)	4.22	0.616
	5	Understands basic knowledge about the Internet and communication technology	4.04	0.638
	6	Explains the use of networks for electronic communication (eg, Internet)	4.22	0.708
	7	Understands how to conduct online literature search	4.26	0.723
Information security	8	Knows the importance of confidentiality	4.26	0.633
	9	Describes patients' right as they pertain to computerized information management	4.16	0.766
	10	Knows the importance of confidentiality when processing computerized data and medical records	4.10	0.735
	11	Describes clearly what laws will be violated in the wake of leaking information about patients and the possible consequences	4.06	0.843
	12	Recognizes viruses and other system risks	4.04	0.832
	13	Knows about the laws regarding protecting personal information in computers	4.18	0.691
	14	Describes critical points or conditions in which threats to security in transmitting data may likely happen	3.82	0.941
Knowledge of using HIS	15	Knows which computer files need to be backed up	3.98	0.915
	16	When any damage happens, can promptly find out the needed data backup files	3.88	0.872
	17	Knows how to use medical information systems for retrieval of patient data	4.12	0.627
	18	Enters and retrieves data used locally for patient care (eg, uses HIS and clinical information system for plans of care, assessments, interventions, notes, discharge planning)	4.16	0.548
	19	Knows how to use different information systems used in patient care setting	3.88	0.849
	20	Knows how to use the HIS to help decision making or differential diagnosis	3.94	0.682
	21	Knows how to use HIS to help managed care	4.10	0.622

value greater than 4. Twelve items—five items (items 47–51) on behavior when using IT and seven items (items 52–58) on attitude toward applying IT—were relevant to the required NI literacy.

In descending order of importance, according to our findings, the three critical factors were computer attitudes, informatics skills, and informatics knowledge. Among the eight variables (concepts of basic IT, information security, knowledge of using HIS, the ability to operate computers, the ability to use IT, network basics, behavior when using IT, and attitude toward applying IT) belonging to these three factors, the average degrees of agreement obtained from this study were 4.19, 4.05, 4.04, 4.17, 4.07, 4.21, 4.36, and 4.28, respectively. They showed that these eight are considered important variables for the measurement of NI literacy. As a result, the variables “the behavior of using IT,” “attitude toward applying IT,” and “network basics” were highlighted as the top three variables regarding degree of agreement. In summary, a total of 58 questions was used for the measurement of initial NI

literacy, and 49 items were considered to be the most required informatics literacy skills for clinical nurses.

DISCUSSION

The discussion of our results is divided into two parts. First, we describe the informatics literacy situation in Taiwan. Second, comparisons are made between Taiwan and other countries regarding informatics literacy education in clinical nursing content and practice.

The Informatics Literacy Education in Clinical Nursing Practice

The current status of nursing information education among the investigated hospitals has shown that 70% of them have information education in their in-service education of front personnel and executives and 32% of them hold information education in their preservice

Table 3**The Informatics Skills Factor Obtained From Data Analysis**

Variable	No.	Measurement Item (or Informatics Competencies)	Mean	SD	
The ability to operate computers	22	Uses word processing to complete a report	4.38	0.602	
	23	Uses basic functions of word processing (eg, format, table design)	4.40	0.639	
	24	Uses advanced functions of word processing (eg, find and replace, bullets and numbering)	4.08	0.724	
	25	Uses basic functions of spreadsheets (eg, cell editing, function operation)	3.78	0.798	
	26	Uses advanced functions of spreadsheets (eg, data sorting and filtering, macro, chart wizard)	3.84	0.817	
	27	Uses PowerPoint to create slides, displays	4.24	0.716	
	28	Uses PowerPoint to execute the basic functions in the projector transparency (eg, add, delete, copy, move, etc)	4.02	0.685	
	29	Executes advanced functions of PowerPoint (eg, drawing pictures, movies and sounds, etc)	4.34	0.688	
	30	Uses basic functions of directory management (eg, add, delete, etc)	4.32	0.713	
	31	Knows how to manage and store files	4.00	0.835	
The ability to use IT	32	Uses e-mail (eg, create, send, reply, file)	4.34	0.688	
	33	Establishes e-mail distribution lists and alters the data in these lists	4.14	0.774	
	34	Uses attachments to e-mail messages	4.32	0.713	
	35	Prints documents and removes paper jams	3.95	0.835	
	36	Knows how to turn computer off and on	4.24	0.716	
	37	Be able to resolve common error reports (windows)	3.84	0.817	
	38	Be able to use common computerized equipment for patient monitoring and care (eg, electrocardiogram monitor)	4.20	0.728	
	39	Knows how to operate HIS skillfully	4.14	0.535	
	Network basics	40	Knows how to connect to the Internet and to manipulate search engines and directories (eg, key word search)	4.30	0.614
		41	Uses intranet to upload and download business-related documents	4.28	0.701
42		Be able to obtain suitable assistance through the intranet when simple problems are encountered	4.18	0.700	
43		Be able to conduct literature searches online	4.18	0.774	
44		Be able to classify and organize Internet data into a report or document	4.18	0.720	
45		Uses the Internet to locate and download items of interest (eg, patient or nursing resources)	4.30	0.647	
46		Be able to retrieve and store data according to one's authority and functions	4.06	0.652	

education programs, but only 14% of the investigated hospitals have advanced program of nursing information education. Furthermore, 34% of the hospitals investigated have prepared to teach nursing information, and 24% of them offer information education for executive levels. These findings indicate that most hospitals have made considerable efforts to implement nursing information education, and those efforts are primarily focused on preservice education. However, much effort is needed for advanced information education among executives. The widespread use of computerization in hospitals will have a stronger impact on clinical nurses than on other employee groups. Thus, the need for continuous in-service training should be emphasized. This result confirms previous findings that the cultivation of an employee's ability to use computers will affect their acceptance/attitude toward IT and their subsequent performance in these areas. Therefore, education and training are indispensable

activities to promote the IT skills of clinical nurses; these findings are also consistent with those of Marion et al.³

When clinical nurses lack the ability to use IT, the development of HIS is impeded. Thus, there is an urgent need to ensure that clinical nurses have sufficient informatics literacy. In addition, nursing personnel at different levels have different functions and responsibilities, so their information abilities differ accordingly. Therefore, nursing executives should not ignore the topic of how to develop informatics literacy courses relevant to the needs of nursing personnel at different levels. It is suggested that nursing executives give the necessary training to nursing personnel at different levels according to the specific conditions of their hospital so as to facilitate computerization.

In their study, Jiang et al¹ indicated that many nursing schools in Taiwan focus on teaching students the use of Microsoft Office (Microsoft, Redmond, WA),

Table 4**The Computer Attitudes Factor Obtained From Data Analysis**

Variable	No.	Measurement Item (or Informatics Competencies)	Mean	SD
Behavior when using IT	47	Has perseverance and patience in regard to the tools required to use IT at work	4.06	0.652
	48	Is willing to use IT to improve quality of patient care	4.32	0.587
	49	Is willing to learn new IT so as to elevate one's competitiveness	4.40	0.535
	50	Strictly conforms to work ethics	4.52	0.544
	51	Strictly conforms to laws and regulations governing the right to intellectual property	4.52	0.544
Attitude toward applying IT	52	Develops positive attitude toward computers, not afraid of using them	4.30	0.678
	53	Is willing to enroll in courses on new IT	4.12	0.689
	54	Develops positive attitude toward life-long learning, is happy to take on-the-job training	4.30	0.580
	55	Knows that the computer will not be a powerful nursing tool until users put effort into learning how to use it	4.40	0.535
	56	Knows that one does not need to be a programmer before one can make computers more effective	4.40	0.571
	57	Knows how to obtain effective resources to improve one's daily activities through IT	4.20	0.535
	58	Feels that applying IT can help elevate efficiency or increase competitiveness	4.26	0.527

searching for information from the World Wide Web, and editing Web pages. Consequently, some missing links exist between clinical nursing education and nursing school curriculum planning. Because of the limited class hours in school, teaching student nurses all the skills required for informatics literacy is impossible. It is necessary to enhance the clinical nursing information education of hospitals to cope with the increasing complexity of the healthcare environment.

Comparisons of Taiwanese Informatics Literacy of Clinical Nurses With Other International Studies

The results of the Taiwanese study were divided into three sections: informatics knowledge, informatics skills, and computer attitudes. All respondents agreed that the items measuring the concepts of basic IT, network basics, behavior when using IT, and attitude toward applying IT should be considered required informatics literacy content for teaching clinical nurses. Computer attitudes were ranked as the most important factor among the three informatics literacy factors. The results were consistent with the findings of previous studies about the attitudes of nursing staff toward using computers.^{10,18,20,21} Although not all respondents agreed that some items should be included in the three main categories, these items represented only a small portion of each variable. Sixteen items in informatics knowledge, 21 items in informatics skills, and 12 items

in computer attitudes were considered essential for NI literacy.

INFORMATICS KNOWLEDGE

Informatics knowledge is subdivided into the following: (1) concepts of basic IT, (2) information security, and (3) knowledge of using HIS. The results pertaining to concepts of basic IT were consistent with those of previous studies. Information security comprised three of the questionnaire items, and in Taiwan, this issue is regarded as inconsequential because unlike other countries, the hospital systems in Taiwan are exclusively self-contained and not connected to external systems. As a consequence, the Taiwan study found that many respondents do not consider the following items to have any significance: (1) "Describe critical points or conditions in which threats to security in transmitting data may likely to happen," (2) "Knows which computer files need to be backed up," and (3) "When any damage happens, can promptly find out the needed data backup files." Furthermore, because most clinical nurses are not familiar with these information security-related tasks and consider them the exclusive responsibility of the Information System department, participants did not regard them as required informatics literacy.

Knowledge of using HIS comprised two of the questionnaire items, and likewise, in Taiwan, they are also regarded as inconsequential, whereas the other international studies regarded them as significant. Most respondents did not consider the following to be a

required part of informatics literacy for clinical nurses: (1) "Knows how to use different information systems used in patient care setting" and (2) "Knows how to use the HIS to help decision making or differential diagnosis," and these items did not have a consistent result compared with that of Hobbs.¹⁸ A possible explanation may be that most nursing personnel focus on their nursing practice and daily data processing and lack the appropriate training and education on the use of HIS to improve their decision making and judgments.

Some difference exists between our study and previous findings, especially for information security and knowledge of using HIS. The possible reasons can be categorized into two explanations. First, other cultures outside of Taiwan place more emphasis on information security. Second, in US nursing, informatics has been in development for more than 20 years and has a complete curriculum for nursing education, whereas in Taiwan, the development of NI is still in its early stages and lacks a well-planned nursing curriculum. Taiwan lacks NI specialists, which makes the implementation of advanced applications such as decision making and clinical judgments impossible.

INFORMATICS SKILLS

Informatics skills are subdivided into the following: (1) the ability to operate computers, (2) the ability to use IT, and (3) network basics. Among these three variables, only the results of network basics are consistent with those in previous studies.^{9,22} The ability to operate computers and the ability to use IT comprised four questionnaire items (two each), and in Taiwan, they were regarded as inconsequential, whereas the other international studies regarded them as significant. In this study, two items pertaining to the ability to operate computers were not considered to be essential requirements for nurses in Taiwan. They concerned both the basic and advanced functions of spreadsheets. Under the category of the ability to use IT, the items of "Print documents and remove paper jams" and "Be able to resolve common error reports (windows)" were not required of nurses in Taiwan. To paraphrase (in translation) the work of other Taiwanese researchers in this field, we concur that "because these four abilities are regarded as the most fundamental skills for contemporary clinical nurses they should be developed in nursing school curricula. Nevertheless, most respondents do not regard them as required items for clinical nurses."

COMPUTER ATTITUDES

Computer attitudes are subdivided into behavior when using IT and attitude toward applying IT. The results of these two categories are consistent with those of

previous studies. Therefore, positive computer attitudes are the basis for the cultivation of informatics literacy. Thomas¹⁰ also pointed out that the impact of information attitude on the general information literacy of nursing personnel can be evaluated by their belief in, concern about, and initiative for computer use. According to our findings, we can infer that nursing executives will have a special interest regarding the attitudes of clinical nurses toward the cultivation of informatics literacy. Although it takes a significant amount of time for clinical nurses to cultivate positive attitudes, this investment of energy is very helpful to staff members. Moreover, with the innovative nature of IT and the ever-increasing complexity of medical information, continuing education of nursing personnel and their understanding about IT are essential tools that can aid nursing care.

CONCLUSION

Because of the high degree of automated and computerized hospital equipment reported in an official census performed by the Department of Health of Taiwan,²³ clinical nurses require sufficient informatics literacy to deal with their environment. In our investigation, three factors (with a total of 49 items) regarding workplace-oriented informatics literacy of clinical nurses were identified. These informatics literacy items will help hospitals in planning programs for the cultivation of informatics literacy of clinical nurses.

According to a national survey of nursing education programs in the United States conducted by McNeil et al²⁴ in 2005, the most frequent informatics tools used by practicing nurses included (1) remote monitoring devices, (2) online consumer health tools (including those that serve to access and evaluate online healthcare resources), and (3) handheld computers that document care or retrieve health information at the point of care. The same study also predicted that the most needed NI positions in the future will be (1) systems analysts, (2) clinical use, (3) on-site educators, (4) quality improvement nurses, and (5) specialist positions needed or already in place. Each position needs various informatics tools. Although the United States has provided a well-formalized nursing curriculum for several years, Staggers et al⁹ reported that the integration of IT knowledge and skills into nursing education curricula has been a slow process, and no consistent curricula for nursing IT exist in nursing education programs. In comparison with the United States, the development of NI in Taiwan is still in its early stages and lacks a formalized curriculum plan. Therefore, the integration of IT knowledge and skills into nursing education curricula will be required in the near future.

In addition, our research shows that most respondents have a high degree of consensus with previous studies on nurses' behavior when using IT and attitudes toward applying IT.^{3,18} According to the results of this study, we can infer that nursing executives must put much emphasis on nurses' attitudes toward IT for the cultivation of informatics literacy of clinical nurses. To reiterate, although it takes a significant amount of time for nursing personnel to cultivate positive attitudes, it will be helpful to aid staff in learning essential skills.

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