Important Computer Competencies for the Nursing Profession

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ABSTRACT: Nursing requires computer competencies. This study aimed at identifying those competencies required for the nursing profession in Taiwan. The Delphi technique was deployed in this study. In the Delphi questionnaires, computer competencies were sorted into seven domains: concepts of hardware, software, and networks; principles of computer applications; skills of computer usage; program design; limitations of the computer; personal and social issues; attitudes toward the computer. In three Delphi questionnaires, nursing informatics experts gave us their opinions on the importance of each computer competency for the nursing profession. The experts also designated when the competency should be cultivated. This study provides a comprehensive list for nursing professionals to check on their computer competence. The results of this study should also serve as good references for teachers and schools in designing related curriculums.

Key Words: nursing informatics, computer competence, Delphi technique.

Introduction

Nowadays, more and more computers are being used in health care systems to store, organize, and transmit information. Although nurses do not need a high degree of computer expertise, their performance will be much more efficient if they have good computer skills. In other words, nurses who operate computers proficiently can quickly access health care-related information using computers. And they may be able to provide more appropriate and efficient care to their patients.

Wilkinson (1996) predicted that, in the near future, those who could not use computers would be as disadvantaged as those who could not read and write. The study by Ngin, Simms, and Erbin-Roesemann (1993) suggested that the introduction of computers could not only improve unit morale but could also stimulate the learning of new skills related to effective and quality care delivery. An examination of the roles of nurses revealed that nurses are high level information processors in all areas of nursing practice (Hovenga, 1998). Some hospitals even use computers to provide Intranet-delivered training for nurses (Wolford & Hughes, 2001).

With the increasing versatility and power of personal computers, the use of information technology has a central role in all areas of health care delivery. However, many staff dislike using computers and often it is left to one or two people to use the machine (Hellan, McGuire, & Cooper, 1998). Therefore, every nurse needs appropriate knowledge and skills about computers. Since new entrants to nursing diploma programs often have varying degrees of competence and experience with information technology (Sinclair & Gardner, 1999), some effort has to be made to raise their information technology competence to an adequate level.

This paper describes a research project that was concerned with identifying important computer competencies for nurses. The data were collected using the Delphi technique, which has not been previously used in nursing informatics studies in Taiwan. Nursing schools can educate their students toward the identified competencies. Student nurses with the competencies will adapt themselves quickly to their computer environment at work once they graduate. We hope the competencies will help nursing professionals to work efficiently and serve as the basis of life-long learning, enabling them to maintain up-to-date computer knowledge

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and skills. Nursing professionals may also use the research results to check on their computer competence and try to make up any shortcomings.

Literature Review

Nurses need appropriate knowledge and skills to use computers. Many previous papers have addressed the required computer competencies for nurses. Since competencies are often cultivated through nursing informatics curriculums, the content of those curriculums provide strong evidence of the important competencies. There are many papers which describe the design of those curriculums.

Early works

An early book by Ronald and Skiba (1987) provided guidelines for basic computer education in nursing. In 1990, Romano and Heller described a prototype educational program to prepare nurses for the role of information systems specialist. Bryson (1991) developed a list of competencies from nursing educators' perceptions about the computer training needed in nursing degree programs. Bryson concluded that nursing educators desired nursing graduates to understand how a computer works and to develop skills in using application programs. Carter and Axford (1993) identified computer learning needs of practicing nurses at the bedside. These works are the foundations of much later research.

Computer uses

McDaniel, Matlin, Elmer, Paul, and Monastiere (1998) reported a national survey done in the United States. Current and anticipated computer uses by staff nurses and by staff development professionals were provided. McNeil et al. (2003) did a survey to establish the perceived current and future uses of information technology tools by practicing nurses.

Computer competencies

Sinclair and Gardner (1999) identified core competencies in information technology (IT) to educate nursing students with a consistent level of IT literacy. Staggers, Gassert, and Curran (2002) produced a research-based master list of informatics competencies for nurses of four levels: beginning nurses, experienced nurses, informatics specialists, and informatics innovators. Curran (2003) further defined and validated the competencies for advanced practice nurses. Yee (2002) addressed minimum information technology competencies needed in Singapore nursing education. The needs assessment was conducted with a panel representing nursing education, nursing management, and nursing practice. Two main categories of information technology (IT) were identified: basic IT skills and work-related IT skills.

Curriculums

In the paper by Reinhard and Moulton (1995), a nursing informatics curriculum for graduate students was described. It consisted of a pre-course workshop and four-course sequence. Topics in the pre-course workshop included computer hardware and software; fundamentals of microcomputers; computer applications in practice, education, administration, and research; nursing informatics; information systems; and expert systems. Vanderbeek and Beery (1998) provided a detailed description of an undergraduate healthcare informatics course. An article by Travis and Bernnan (1998) discussed the design, implementation, and evaluation of an innovative nursing informatics curriculum incorporated into a baccalaureate nursing program. Inman, Johansen, Powlas, Timm, and Turner (2000) did a survey to determine learning needs of nurses and developed a curriculum with three classes: computer concepts for nursing, computer basics for nursing, and computer applications for nursing. In the work of Rosenfeld, Salazar-Riera, and Vieira (2002), a pilot information literacy program was offered. However, the unit-based instruction in that program presented significant obstacles for effective learning of new technological skills for staff nurses.

European projects

There was a European Union funded project called NIGHTINGALE, which focused on the nursing profession's needs related to the telecommunication and informatics area (Mantas, 1998). The project tried to provide consensus curriculum development in nursing informatics. Kokol, Zazula, Brumec, and Kolenc (1999) reported another European project called NICE. It was about developing a new nursing informatics curriculum for the 21st century. In Finland, Saranto, and Leino-Kilpi (1997) developed the information technology syllabus for nursing education using the Delphi technique. In their study, nurses' qualifications in nursing informatics and recommendations for teaching information technology were provided.

Courses in Taiwan

Our Ministry of Education has also stipulated content standards of computer courses for students in vocational schools, including nursing schools. Currently, many nursing schools in Taiwan provide computer courses to educate students in competence areas such as processing of text, data, graph, image, video, and sound files. There are also courses on network usage and digital data storage and analysis.

The Study

Changes in computer technology are occurring at a rapid pace: new technology comes along every day. And nursing professionals in different countries may need to have different computer competencies. The purpose of this study was to address the following questions.

1. What are the computer competencies required for the nursing profession in Taiwan?
2. When is the proper time to cultivate those competencies?

Method

Participants

The Delphi technique is often used for gathering opinions and achieving a consensus (Cohen, Manion, & Morrison, 2000; Thomas & Nelson, 2001). Because there are not many experts who are conversant with both computers and nursing in Taiwan, investigation on a large scale is not feasible. Not many experts are required when using the Delphi technique, and experts may answer questionnaires at their convenience without joining a meeting. The authors therefore, adopted the Delphi technique to conduct the investigation.

A total of 29 experts were recruited to the panel. The panelists consisted of 11 males and 18 females. They all worked at nursing-related institutions, including clinical practice, community, computer companies, or schools. They had an average age of 40 and average working experience of 14 years. More than three-quarters of the experts had a master's degree or higher. They had been using computers for 14 years on average. The profile of the experts is shown in Table 1.

Procedure

Sometimes, it is difficult to answer an open-ended questionnaire, and experts need a lot of time to think. This could result in a low return rate. A constructed questionnaire was therefore, developed for the first run. The authors adopted domains and skills/objectives defined in Bryson (1991). Modification of domain titles and competences was done by the authors after reviewing the articles mentioned in the literature review section. It was also done based on the authors' own teaching and working experience. The content standard of our country was taken into account as well.

The first questionnaire contained 74 competency items in 7 domains: concepts of hardware, software, and network; principles of computer applications; skills in computer usage; program design; limitations of the computer; personal and social issues; attitudes toward the computer.

In the first questionnaire, computer competencies were sorted into seven domains, and each domain was listed with several competency items. Experts were asked to rank the importance of each competency item using a Likert-type scale with choices ranging from 1 to 5 (1 = not at all important; 2 = not important; 3 = neither important nor unimportant; 4 = important; 5 = very important). Experts could propose competencies which they were felt important but which were not listed in the questionnaire.

In the questionnaires, experts were also asked to check when each competency item should be cultivated. Should a competence be cultivated at student's high school level or college level? Or should it be cultivated by self-learning or through on-the-job training? In Taiwan, vocational nursing schools include vocational high schools of nursing (three-year program after junior high school), junior college of nursing (five-year program after junior high school or two-year program after vocational high school), colleges of nursing (four-year program after vocational high school or two-year program after junior college), and graduate school of nursing. Figure 1 depicts the nursing programs in Taiwan. Since not many students attend graduate programs of nursing in Taiwan, we did not consider competencies to be cultivated in graduate programs.

The three-run Delphi postal survey was carried out between May and September 2002. All 29 experts participated in the three runs. In other words, the response rate was 100% for all runs. When responses of a run were collected, the mean of importance of each competency item was listed in the questionnaires for the next run. Competency items proposed by experts in that run were also listed in the questionnaire for the next run.

Table 1.
***Profile of the Experts* (*N* = 29)**

Variable	*n*	%
Number of experts with nursing background	18	62.1
Number of experts with management background	10	34.5
Number of experts with information technology background	9	31.0
Number of experts with master's degree or higher	23	79.3
Number of experts who work in clinical institutions	15	51.7
Number of experts who work in academic institutions	10	34.5
Number of experts who work as heads in their organizations	18	62.1

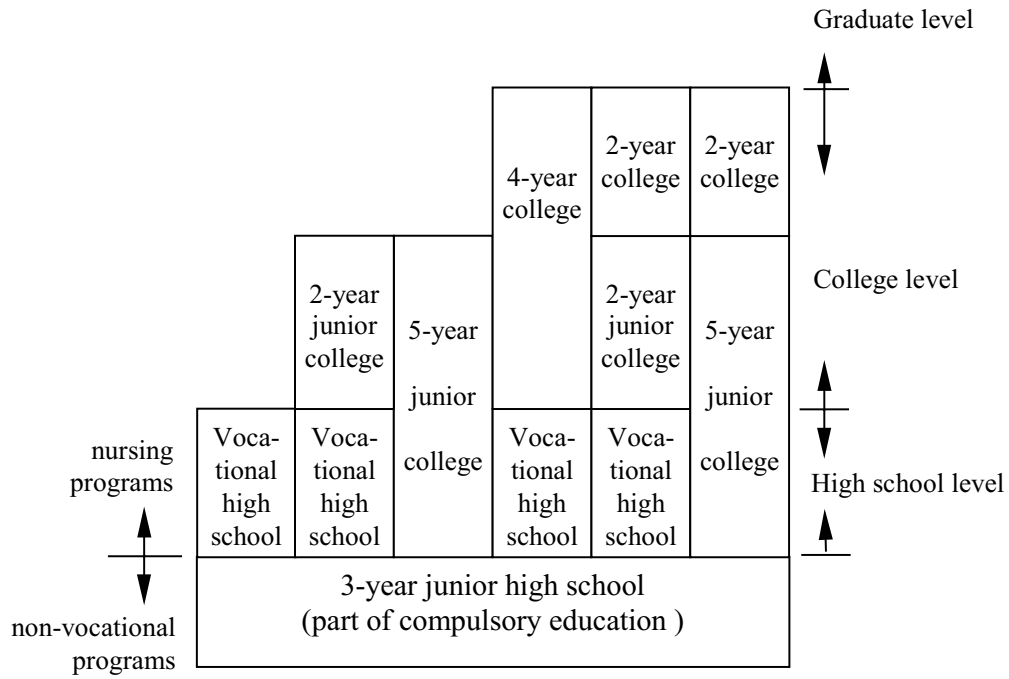

Figure 1. Tracks of nursing programs in Taiwan.

In the first run, the questionnaires with 74 competency items in seven domains were sent to 29 experts. Every competency item obtained a mean of importance larger than 3.0 in that run. Therefore, all those items were listed on the questionnaire for the second run to get more consentaneous opinions. No item was withdrawn. Some experts proposed new competency items in the first run. Those items were included in the second run questionnaire to obtain all panelists' opinions.

In the second run, questionnaires listed with 87 competency items were sent out. Again, every competency item in the second run obtained a mean of importance larger than 3.0 and some new competency items were proposed. Based on the response of the second run, the questionnaire for the third run, with 94 competence items, was generated. In the third (final) run, no new competence was proposed.

Because standard deviation (*SD*) is associated with the distribution of scores around the mean, *SD* can be used as a measure of consensus. Saranto and Leino-Kilpi (1997) defined consensus using the value of *SD*. In their study, *SD* < 0.75 indicated strong consensus. In our third run, the *SD* of importance of each competency item is about the same as it was in the second run. This implied that the *SD* would not converge to a smaller value. Therefore, no further run was conducted. Through 3 runs of Delphi questionnaires, experts reached quite consentaneous (small *SD*) opinions. And there were 94 competency items in seven domains in the final run.

Results

Average Importance of Competencies in Seven Domains

Average importance of competency items in each domain was calculated. The average importance obtained from the final (third) run is shown in Table 2. They were 3.91, 4.39, 4.21, 3.53, 4.31, 4.34, and 4.51, respectively. It shows that "concepts of hardware, software, and network" and "program design" were less important. "Attitudes toward the computer" were the most important (had the highest mean) among the competency domains in the questionnaire.

Cutoff Values for Mean and *SD*

Since a rating of four or five indicated that the expert thought the competency item was important or very important, and a rating of three indicated that the expert was neutral, a mean rating of 3.5 indicated that experts were not neutral or negative toward the competence, but rather they were at least somewhat positive toward it. In the present study, the authors adopted the consensus definition used by Saranto and Leino-Kilpi (1997). There was a strong consensus when $SD \leq 0.75$. Competency items with means significantly larger than 3.5 and $SD \leq 0.75$ were regarded as important competencies.

Table 3 shows competence items listed in the final run of the research. Mean and *SD* of importance of each competence item were calculated. In Table 3, every competence item has mean of importance no less than 3.5, except three items (No. 10, 17, and 18) in domain one and six items (No. 60 through 65) in domain four. In order to know which competence items have mean of importance significantly larger than 3.5, a single sample t-test was done using statistical software SPSS. Results showed there were 75 items whose importance was significantly larger than 3.5 (2-tailed, $p < .05$). Those items are marked with a symbol ‡ in Table 3. They all had $SD \leq 0.75$. Competence items 19, 37, 58, 71, 81, 94, and 101 were open questions of the seven domains, and the experts did not propose any new competence in those questions in the final run. Those items are therefore, not shown in Table 3.

Very Important Competencies

A rating of 4 indicated that the expert regarded the competency item as an important item. A rating of 5 indicated that it was considered to be very important. Therefore, a mean larger than 4.5 indicated that more than 50 percent of the experts regarded the competency item as a very important item. Let us have a closer look at items with Mean > 4.5.

From Table 3 we know: competency items No.s 6, 7, and 8 in domain one were very important, especially item No. 8. Those three items were all basic competencies for operating computers. In domain two, most experts agreed that competency items No.s 20, 21, and 22 were very important, especially item No. 21 (be able to use the World Wide Web to search for information). All experts gave highest importance to item No. 21. Searching information from the World Wide Web is a key competency for the nursing profession.

In domain three, competency items No.s 38, 39, 40, 42, 44, 45, 52 and 54 received very high importance, among which item No. 38 (be able to use word processing software) was considered the most important. Indeed, it is a very basic skill for today's nurses. No competency item in domain four had an importance mean greater than 4.0, which shows most experts did not think "program design" was very important for the nursing profession. Nevertheless, "be able to communicate with software developers" (item No. 66) had the highest mean (3.9).

Table 2.
The Mean of Importance of Each Competency Domain

Domain No.	Competency Domain	*M*	Rank
1	Concepts of hardware, software, and network	3.91	6
2	Principles of computer applications	4.39	2
3	Skills in computer usage	4.21	5
4	Program design	3.53	7
5	Limitations of the computer	4.31	4
6	Personal and social issues	4.34	3
7	Attitudes toward the computer	4.51	1

Table 3.
The Competence Data Obtained From the Final Run (N = 29)

Domain	Competency Item	*M*	*SD*	CS* %	H-sch† *n*	Colg†† *n*	Self††† *n*
1	1. Know today's popular types of computer systems such as Apple Macintosh and IBM-compatible.	3.86‡	0.69	76	22	1	10
1	2. Know the common computer terminology, e.g. bit, byte, RAM, ROM, HD.	4.07‡	0.65	83	27	1	5
1	3. Know the basic components of a computer's hardware system and their function.	3.86‡	0.64	72	27	1	4
1	4. Know input and output devices of computers.	3.97‡	0.50	86	26	1	4
1	5. Know the basic components of a computer's software system and their function.	4.03‡	0.42	93	26	2	3
1	6. Know the basic usage of a computer, e.g. login/ logout a computer, use a mouse.	4.55‡	0.57	97	22	3	9
1	7. Know the usage of file management functions in computer operating systems.	4.62‡	0.49	100	26	3	3
1	8. Know how to operate computer systems (e.g., Windows).	4.72‡	0.45	100	29	2	3
1	9. Know how to install software drivers for peripherals.	4.07‡	0.59	86	25	3	7
1	10. Be able to assemble basic components of computer hardware.	3.31	0.60	38	5	4	25
1	11. Be able to resolve common error situations.	4.07‡	0.59	86	23	7	10
1	12. Know basic principles of computer networks.	3.79‡	0.62	76	20	10	5
1	13. Know basic structures of computer networks.	3.72	0.65	69	15	10	11
1	14. Know today's major network types.	3.69	0.60	69	13	13	8
1	15. Know common network hardware devices, e.g. network adapters, hub, modem.	3.66	0.55	62	23	7	9
1	16. Know how to setup communication software in computers.	4.17‡	0.60	90	24	7	6
1	17. Know the difference between analog and digital signals.	3.10	0.49	17	20	6	5
1	18. Know important milestones in the evolution of computer technology.	3.14	0.64	21	20	4	8
2	20. Be able to use a library information retrieval system to search for references, e.g. Medline.	4.93‡	0.26	100	10	23	5
2	21. Be able to use the world wide web (WWW) to search for information.	5.00‡	0.00	100	27	5	6
2	22. Be able to send/receive mails and transfer files through networks.	4.90‡	0.31	100	26	7	4
2	23. Know there are video discs for nurses' continuing education, patients' health education, etc.	4.45‡	0.63	93	6	27	2
2	24. Know there is simulation software for continuing education and training.	4.28‡	0.59	93	4	27	2
2	25. Be able to use computerized self-learning equipment.	4.38‡	0.68	90	16	16	2
2	26. Know what a nursing information system is.	4.48‡	0.51	100	2	28	3
2	27. Know what today's major nursing information systems are.	4.48‡	0.57	97	2	29	3
2	28. Know what a hospital information system (HIS) is.	4.45‡	0.57	97	1	29	3

(Continued)

2	29. Know that HIS are useful tools in promoting hospital running efficiency.	4.41‡	0.57	97	2	28	4
2	30. Know the significant highlights in the evolution of computer applications in nursing.	3.97‡	0.42	90	3	26	2
2	31. Know about applications of computer networks and telecommunications in nursing.	4.31‡	0.60	93	2	27	1
2	32. Know about applications of robotics and expert systems in nursing.	3.90‡	0.62	76	1	28	1
2	33. Know about computer applications in medical decision analysis.	4.21‡	0.63	86	1	28	1
2	34. Know there are package software and software tools which can be used in nursing.	4.36‡	0.56	93	4	26	2
2	35. Know about common computerized equipment in medicine and health care, such as CAT scan and MRI.	3.97‡	0.57	83	1	27	3
2	36. Know how to apply computers for personal use.	4.17‡	0.54	93	21	7	9
3	38. Be able to use word processing software to generate nursing documents, e.g. reports, patient care plan, etc.	4.86‡	0.35	100	26	5	2
3	39. Be able to use a spreadsheet program (e.g. MS Excel) as a management tool in nursing.	4.66‡	0.48	100	12	20	2
3	40. Be able to use presentation editing software (e.g. MS PowerPoint) for preparing lectures or patient education.	4.59‡	0.57	97	23	9	2
3	41. Be able to use database software to construct nursing databases.	4.07‡	0.75	76	1	28	2
3	42. Be able to use nursing information systems.	4.59‡	0.57	97	1	28	3
3	43. Be able to maintain nursing information systems.	3.86‡	0.69	69	1	26	3
3	44. Be able to use HIS to do nursing work, e.g. nursing records.	4.62‡	0.56	97	2	28	1
3	45. Be able to use HIS to store/retrieve and transfer data such as patient information or drug information.	4.72‡	0.45	100	3	27	4
3	46. Be able to use common computerized equipment for patient monitoring and care.	4.45‡	0.57	97	1	28	4
3	47. Understand the output data from computerized equipment for patient monitoring and care.	4.34‡	0.55	97	1	28	2
3	48. Be able to use packaged software (e.g., Front-Page) to create web pages.	3.59	0.57	55	3	27	3
3	49. Be able to create multimedia files for web pages.	3.55	0.51	55	2	26	3
3	50. Know how to use statistical software (e.g. SPSS, SAS, etc.)	3.90‡	0.56	79	0	28	2
3	51. Be able to use statistical software for nursing research.	3.90‡	0.67	79	0	28	3
3	52. Know how to manage and store files.	4.59‡	0.68	97	23	8	4
3	53. Be able to convert files for different application software.	4.14‡	0.52	93	4	25	3
3	54. Know how to use common peripherals such as printers and scanners.	4.52‡	0.51	100	26	5	5
3	55. Know how to create multimedia files.	3.55	0.57	52	5	21	4
3	56. Know how to edit multimedia files.	3.52	0.51	45	3	21	3
3	57. Be able to use computers as self-learning tools.	4.21‡	0.62	90	26	6	5
4	59. Know what a computer program is.	3.55	0.57	59	22	9	1

(Continued)

Domain	Competency Item	*M*	*SD*	CS* %	H-sch† *n*	Colg†† *n*	Self††† *n*
4	60. Be able to identify today's common programming languages.	3.34	0.55	38	20	7	3
4	61. Be able to read a short computer program.	3.41	0.63	41	2	24	4
4	62. Be able to make changes to a short computer program.	3.17	0.54	17	0	25	4
4	63. Be able to design a short computer program.	3.24	0.58	24	0	25	4
4	64. Know what an algorithm is.	3.21	0.62	31	1	26	4
4	65. Know the characteristics of good computer programs.	3.45	0.63	52	1	26	4
4	66. Be able to communicate with software developers.	3.90‡	0.67	79	1	27	4
4	67. Know procedures for developing nursing application programs.	3.76‡	0.64	72	0	26	4
4	68. Be able to design a flowchart for a nursing information system.	3.76	0.69	69	0	27	3
4	69. Be able to understand flowcharts of HIS.	3.79‡	0.68	72	0	28	2
4	70. Know the importance of procedure integration before program design.	3.79	0.90	62	0	24	3
5	72. Know that a computer program has limitations in its design and capability.	4.10‡	0.56	90	28	4	2
5	73. Know that computers are not intelligent in themselves and must be programmed based on our needs.	4.21‡	0.49	97	27	3	1
5	74. Know that the computer is only a tool to provide better nursing care. It cannot replace the role of nurses.	4.41‡	0.50	100	28	4	1
5	75. Know limitations and reliability of computerized patient monitoring systems.	4.41‡	0.50	100	6	25	1
5	76. Know the reasons for slow response time such as heavy demands on computer systems.	4.10‡	0.56	90	26	4	2
5	77. Know that computer files need to be backed up.	4.76‡	0.44	100	27	5	4
5	78. Know about problems of data integrity.	4.55‡	0.51	100	28	5	2
5	79. Know that computer users are usually the ones who make mistakes.	4.45‡	0.57	97	28	4	2
5	80. Know that computers in use today do not have good enough ability to interpret natural language.	3.83‡	0.66	69	27	3	2
6	82. Know the importance of computer technology to us and our society.	4.21‡	0.42	97	26	4	3
6	83. Know that the use of computers may result in manpower shifts within the hospital organization.	4.14‡	0.36	97	25	4	3
6	84. Know that the computer can be used as a tool for staffing, scheduling, quality control, etc.	4.21‡	0.42	97	9	22	1
6	85. Know that the use of the computer might result in dehumanization of patient care.	3.93‡	0.60	76	6	23	1
6	86. Be concerned about how data is collected and used.	4.11‡	0.58	83	6	22	0
6	87. Know the importance of confidentiality when processing computerized data and medical records.	4.75‡	0.44	97	28	10	3
6	88. Know about the laws regarding protecting personal information in computers.	4.43‡	0.69	86	28	5	2
6	89. Know about the copyrights regarding computer programs and electronic files.	4.50‡	0.58	93	28	4	2

(Continued)

6	90. Know the basic technique of encryption and access control.	4.39‡	0.50	97	23	13	3
6	91. Know what computer viruses are.	4.46‡	0.58	93	27	4	5
6	92. Know how to prevent and handle attacks by viruses.	4.57‡	0.57	93	28	4	3
6	93. Know about ergonomics as related to the design of the computer screen, location of computer devices to minimize harm from computers.	4.43‡	0.57	93	27	4	1
7	95. Develop positive attitude toward computers. Not be afraid of using computers.	4.62‡	0.56	97	28	4	3
7	96. Know that females can be computer literate, just likes males are.	4.48‡	0.63	93	28	4	3
7	97. Develop a positive attitude toward the computer as a good nursing tool.	4.45‡	0.50	100	28	3	2
7	98. Know that the computer will not be a powerful nursing tool until users put efforts into learning how to use it.	4.48‡	0.50	100	26	6	3
7	99. Develop positive attitude toward life-long learning. Be happy to take on-the-job training.	4.52‡	0.57	97	28	6	5
7	100. Know where to find resources to resolve computer problems.	4.48‡	0.57	97	27	6	3

Note. Competency items which had more experts marked in the college column than in the high school column are shaded with gray background. * Denotes consensus; † Denotes how many experts thought the competence should be cultivated during students' high school time; †† Denotes how many experts thought the competence should be cultivated during students' college time; ††† Denotes how many experts thought the competence should be cultivated through self-learning or on-the-job training; ‡ Denotes mean of the competence was significantly larger than 3.5 (2-tailed, $p < .05$).

In domain five, most experts thought competency items No. 77 and 78 were very important, especially item No. 77 (know that computer files need to be backed up). Today, computer systems are often attacked by computer viruses. With files backed up, users will avoid losing precious data. As for domain six, most experts agreed that competency items No. 87 and 92 were very important. However, competencies listed in domain six are often neglected by nursing educators in Taiwan. Competency items No. 95 and 99 in domain seven had means of importance larger than 4.5. Attitude toward the computer and attitude toward life-long learning were regarded as very important.

Consensus

Traditionally, items considered very important or important are counted to find a consensus. Consensus is defined either as unanimity (100%) or as a majority view (> 67%). In this study, consensus was calculated using this traditional measure. With 29 panelists, at least 67%, or 19 panelists, had to rate an item as 4 or 5, for that item to be considered as within the consensus.

In Table 3, Delphi consensus was recorded in 78 competency items. Among those items, 16 scored a 100 percent consensus. There were 16 items with a consensus value less than 67% (non-consensus). By observing the data listed in Table 3, we can see the following fact. If items did not reach consensus, their means of importance were not significantly larger than 3.5. Items with large mean importance and items that reached consensus are important competencies required for the nursing profession.

Competencies for Nurses at Different Levels

The 29 experts all participated in three runs. The high school (fifth) column of Table 3 shows how many experts thought the competency should be cultivated at students' high school level. The college (sixth) column of Table 3 shows how many experts thought the competency should be cultivated at students' college level. Numbers in the far right-hand column denote how many experts thought the competence should be cultivated through self-learning or on-the-job training. Experts could mark in multiple columns for each competency item.

When to Cultivate Competencies

Competency items which had more experts marked in the college column than in the high school column are shaded in Table 3. There are 42 competency items in the shaded cells. We can see that nursing profession-related competency items tended to have more experts marked in the college column. On the other hand, competency items that are useful to everyday life had more experts marked in the high school column than in the college column. It shows that most experts thought those basic competency items should be cultivated at high school level. Only advanced competencies should be cultivated at college level.

Very few experts thought nursing professionals should obtain the listed competencies through self-learning or on-the-job training. However, 25 of the experts thought nurses should learn how to assemble the basic components of computer hardware through self-learning or on-the-job training. This shows that most experts believe that computer competencies should be cultivated in nursing degree programs.

Competencies such as "be able to use nursing information systems," "know that computer files need to be backed up," and "know the importance of confidentiality when processing computerized data and medical records" are not commonly taught in Taiwan. However, they received great attention from the experts. This implies that we should reconsider the contents of computer courses for nursing students.

Discussion

Compared with Previous Works

In our research, the seven computer literacy domains used by Bryson's study (1991) were adopted and modified. The competency items were sorted into those seven domains. Many of the items came from Bryson's work and other previously mentioned articles. Some of them were from panelists' suggestions and the authors' teaching and working experience. After three runs of Delphi questionnaires, experts reached broadly concurrent opinions. There were 94 competency items in the final run. Table 4 shows the domains in this research and Bryson's work. Numbers of competency items in each domain are also compared in Table 4. In our study, domain one and domain three had a lot more items than the corresponding domains in Bryson's work.

Table 4.
Comparison of Domains in This Research and Bryson's Study

Domains	*CP**
This Research	
1. Concepts of hardware, software, and network	18
2. Principles of computer applications	17
3. Skills in computer usage	20
4. Program design	12
5. Limitations of the computer	9
6. Personal and social Issues	12
7. Attitudes toward the computer	6
Bryson's Study	
3. Skills in hardware and software principles	11
4. Uses and application principles	13
2. Skills in computer usage	10
1. Programming and algorithm skills	10
5. Limitations of the computer	10
6. Personal and social aspects	10
7. Relevant values and attitudes	4

Note.*: Number of competence items in the domain with mean of importance no less than 3.0.

Since Bryson's work was done 15 years ago, out-of-date items in his list were withdrawn and new competency items were added. For example, "know about disk operating systems (DOS) for the microcomputer" was in Bryson's list, but not in our list. While "know basic principles of computer networks" was listed on our questionnaires, it was not on Bryson's.

In Saranto and Leino-Kilpi's study (1997), nurses' competences in nursing informatics were put in seven content areas: Basic components of the computer system; skills in computer use; ability to resolve error situations; ability to use hospital information systems; skills in computerized patient monitoring; systems security; obstacles and prerequisites of automated data processing. A total of 33 competency items (94 items in our study) were listed in their final run. While items 20 and 21 in our study had great importance ($M > 4.9$), they were not shown in Saranto's list of competencies. Our study provided a comprehensive list for today's nursing profession.

In Taiwan, many nursing schools focus on teaching students the skills for using Microsoft Office, searching for information from the World Wide Web, and editing Web pages. The contents identified in our study had a much wider scope. The identified important items should be covered in nursing education.

Opinions of Participants from Different Backgrounds

Although the Delphi technique was used to obtain a consensus about the research topic, we wanted to know if experts from different backgrounds tended to have different opinions on some competency items. An independnt-samples t-test was conducted using SPSS. Experts with a certain background were put into one group, experts without that background into the other group. For grouping variables with more than two values, the cut-off point was chosen based on balancing the numbers of experts in the two groups. Means of importance of the two groups were compared by 2-tailed t-test.

Competency items having significant mean difference ($p < .05$) are shown in Table 5. For example, experts younger than 40 gave higher importance to item No.s 23, 24, and 87; but they gave lower importance to item No.s 48, 49, 53, 61, and 68. Experts with nursing major tended to give higher importance to competency item No.s 5, 13, 14, 17, 33, 50, 51, 54, 57, 72, 74, 83, 84, 91, 92, and 96. They did not give lower importance to any other items.

In Table 5, competency item No.s 13, 50 and 83 show up the most (four times each). Let us take competency item No. 50 (know how to use statistical software) as an example. Experts from different backgrounds had quite different opinions about that competency item. Female experts gave higher importance to that item than male experts did. Also, experts with nursing major and experts who worked as heads tended to give higher importance to that competency item than their counterparts did. By contrast, experts with information science majors gave lower importance to the item than experts with out the majors did. These findings somewhat reflected the needs of the experts' working environments.

Conclusions

The authors used the Delphi technique to conduct the study and identify the important competencies for the nursing profession. The proper time to cultivate each competence was investigated. Results showed importance of the

Table 5.
Competency Items Having Significant Mean Difference Between Different Background Expert Groups

Background expert groups	Competency item number	Means
Nursing major/Not nursing major	5, 13, 14, 17, 33, 50, 51, 54, 57, 72, 74, 83, 84, 91, 92, 96	higher/lower
Management major /Not management major	27, 43	higher/lower
Information science major/ Not information science major	13, 14, 31, 50, 51, 53, 54, 74, 75, 80, 83, 84, 86, 91, 92	lower/higher
With master or higher degree/ Without master or higher degree	13, 77	lower/higher
With master or higher degree/ Without master or higher degree	55, 56, 59, 61, 63, 64, 65, 69	higher/lower
Work at clinical institution/ Work at non-clinical institution	26, 33, 41, 80, 83, 88	higher/lower
Work at an academic institution/ Work at a Non-academic institution	26, 80, 83, 88, 99	lower/higher
Work as a head/Non-head	50, 55, 56, 63	higher/lower
Work as a head/Non-head	13, 82, 84, 95, 96, 97, 98, 99, 100	lower/higher
male/female	5, 50, 51, 72	lower/higher
age < 40 years/age ≥ 40 years	23, 24, 87	higher/lower
age < 40 years/age ≥ 40 years	48, 49, 53, 61, 68	lower/higher
Working experience < 12 years/ Working experience ≥ 12 years	53, 61, 63	lower/higher
Using computer experience < 14 years/ Using computer experience ≥ 14 years	55, 56	lower/higher
Using computer experience < 14 years/ Using computer experience ≥ 14 years	85, 88, 96, 99	higher/lower

competency items in seven domains. The domain of "attitude toward the computer" was viewed as the most important. These research results can serve as a comprehensive list for nursing professionals to check on their computer competence and try to make up any shortcomings. They are also good references for teachers and schools in designing computer curricula. Because of limited class hours, teaching students toward all the competency items may be impossible. If that is the case, teachers may choose more important items among the listed competencies. For example, competency items with importance significantly larger than 3.5 are good candidates for teaching content.

Limitations

The authors used the Delphi technique to conduct the study and identify the important competencies. Due to the shortage of companies working in the area of nursing informatics in Taiwan, we only recruited 2 experts from companies which design hospital information systems.

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