CHAPTER 2

LITERATURE REVIEW

Literature review

The literature reviewed for this study included:

1. Computers and nursing.
2. Nurses' computer knowledge.
3. Nurses' computer attitudes.
4. Nurses' computer skills.
5. Relationship among nurses' computer knowledge, attitudes, and skills.

Computers and nursing

Development of computer in nursing practice

Beginning in the 1950s, as the computer industry grew, computer use in health care facilities also developed. Computers were used initially for financial, accounting, and administrative purpose (Saba & McCormick, 1986; Sullivan & Decker, 1985). By the mid-1960s, hospitals began to include some patient care applications in their computer systems.

However, because of the limitations of technology, the progress was during the late 1960s and early 1970s, as computers were improved and technological advancements were devised, computer applications and information systems in health care facilities grew. During this period, nurses began to recognize the computer's potential for improving documentation of nursing practice and the quality of care. Nurses began initially to use computers for repetitive activities inherent in managing hospital patient care. Then, some nurses assisted computer professionals to design and develop the nursing components of information systems (Saba & McCormick, 1986). By the early of 1980s, as the appropriate nursing information systems were available, computers were used both direct and indirect applications in nursing (Sullivan & Decker, 1985). At the moment, a rapidly growing literature about computers in nursing has been published (Axford & Carter, 1996).

Direct applications of computers in nursing include patient monitoring, patient charting, scheduling and staffing, training and evaluating. Indirect applications include pharmacy, laboratory and radiology systems, supply and material management. Each of the applications could be used independent of one another. However, the most effective use of computers is a Hospital Information System (HIS) which

integrates all computers use in one system (Sullivan & Decker, 1985).

Hospital Information System

Hospital Information System (HIS) is the dedicated use of a computer with associated hardware, software and terminals to collect, store, process, retrieve and communicate relevant patient care and administrative information, to support health care personnel to provide direct patient care within a hospital, and support its associated clinical departmental subsystems, and its outpatient services (Collen, 1983 cited in Saba & McCormick, 1986). The purpose of HIS is to provide a computer-based framework to facilitate the communication of information within a hospital, and provide management support (Hannah, 1976).

HIS is designed to incorporate administrative, clinical and other special information systems to satisfy medical, nursing, and other departments' requirements. Administrative information systems include budgeting and payroll, cost accounting, patient billing, inventory control, bed census, and medical records. Clinical information system (CIS), include order entry and order transmission, vital signs, shift report, nursing care plans, nurses' notes, and

other areas regarding patient care. Special applications refer to the services other than medical and nursing that a patient receives, for example, laboratory tests, medications, and x-ray studies (Collen, 1983 cited in Saba & McCormick, 1986).

Chinese hospital information system (CHIS) was the first HIS in China. People's Hospital served as the pilot hospital installed and implemented CHIS since September of 1996 (He, 1996). This pilot implementation of CHIS in this hospital will be used to evaluate the effectiveness of CHIS and summarize the experience of successful implementation.
The functions of CHIS related to nursing include patient index; admission, discharge and transfer; nursing station based order entry to ancillary departments; and resulting from laboratory. Many subsystems, such as nursing care plan, nursing note, computerized scheduling and computer-assisted instruction, are still process and not available for nurses. When a patient is admitted, his/her registration information is entered into the system. After admission, the ward nurse will enter the physician's orders into the system. Requisitions for tests, medications, and supplies will automatically be sent to appropriate departments. The laboratory automatically receives admission and order data from the CHIS. At discharge, all the charges associated with

medication, tests and treatment have been automatically captured and transferred to the financial system (Sullivan & Decker, 1985).

For People's Hospital, the utilization of CHIS has brought many benefits. For nursing, using the manual system, the nurse spent substantial time completing the following tasks: (1) paperwork, including physician order's management, filling out medication sheet, calculating order's schedule and stop time, transcribing order to requisition; checking chart, and stamping pharmacy request with patient plate; (2) collaboration with other units, call technologist regarding stat test, ask or wait for the important results from laboratory, phone the dietary department to prepare diet for a new admission patient; and (3) running errands, including going to pharmacy for getting stat medicine, sending requisition sheets for medications, tests and supplies to appropriate department, and so on. After the implementation of CHIS, nurses have only to enter the information on the terminal and all paperwork is completed and all orders sent automatically. Furthermore, the computerized system eliminates delays in sending or receiving orders and decreases the errors.

Nursing Information System

Computerized Nursing Information System (NIS) is a subsystem of computerized CIS. It is used to monitor the quality of patient care, manage nursing services, and evaluate the nursing process (Saba, & McCormick, 1986). NIS has been increasingly used in hospitals for various nursing functions as follows (Sullivan & Decker, 1985):

(1) Patient monitoring system: It is one of the first applications of computers in patient care. It can accurately monitor and record patient's physiological data and alert nurses when a significant change occurs by alarm system. So, it can make nurses to handle patient problems in time (Sullivan & Decker, 1985).

(2) Patient charting: Patient charting includes patient's index, vital signs, order entry, and nursing care plan, which can simplify and automate nurses' clerk tasks, improve documentation quality, and eliminate charting repetition (Burkes, 1991). All information can be recorded more easily, and saves nurses' time, since nurse can select items from a preparative menu (Pabst, Scherubel, & Minnick, 1996). Computerized nursing care plan system have been thought capable of systematically using the nursing process to advance nursing knowledge, practice, and to improve quality of patient care (Study Group on Nursing Information

Systems, 1983 cited in Burkes, 1991). The computerized chart is also able to rearrange data in any desirable form by health care professional, for example, look up the patient's medical history, the diagnostic test results, the specified regimen, and nursing care plan and it's effect (Sullivan & Decker, 1985). A nursing care plan can be developed using the preprogrammed standard nursing care plan system, then, the nurse can make it individual for each patient by additions or deletions from the standards (Catanzano, 1994; Sullivan & Decker, 1985; Walters, 1986).

(3) The computerized scheduling and staffing: Catanzano (1994) reported that computerized staffing system increased the accuracy for nursing staffing. At the end of each shift, the nurse evaluated the care provided to the patient and then entered any revisions to the nursing care plan, the computerized system automatically computed direct and indirect nursing time for patient and identified the required skills level of nurse to predict staffing needs for the next shift.

(4) Computer-assisted instruction (CAI): Many lessons can be developed as computerized systems, which are CAI. Therefore, it provides a useful tool to transmit new information to nurses or to refresh their acquired information by a self-learning program (Sullivan & Decker,

1985).

(5) Laboratory and radiology systems: Entering an order into a patient's chart will automatically alert the appropriate department to schedule the test. Once the test has been scheduled, some systems will send a pretest regimen for the patient or reminders of scheduler to the nursing station.

The impact of computerized CIS on nursing practice

The impact of computerized clinical information systems (CIS) on nursing practice and quality of patient care were flagged in the late 1980s (Axford & Carter, 1996; Gross, 1988; Staggers, 1988; Walters, 1986). It was reported that use of CIS could relieve nurses of repetitive time consuming clerical and monitoring tasks; increase the time available for direct patient care (Ford, 1990; Hendrickson & Kovner, 1990); standardized nursing practice and more complete document of patient care (Ford, 1990); increase use of clinical data (De Calonne, Hornaday, Schmitt & Stanford, 1983); improve unit morale, and stimulate learning of new skills related to the delivery of effective care (Burkes, 1991; Ngin, Simms & Erbin-Roesemann, 1993). It was also found that CIS influenced substantially the roles and functions of nurses, and assisted in the nursing process by computerized

care plans and charts (Burkes, 1991), shorten patient stay (Catanzano, 1994; Walters, 1986). Studies have shown that nurses believed that computers provided assistance in nursing care and increased both productivity and effectiveness (Hendrickson & Kovner, 1990; Krampf & Robinson, 1984; Staggers, 1988).

An early study found computerized care plans could significant enhance the speed, quality, comprehensives, and effectiveness of creating individual patient care plans, and help nurses achieve high quality of patient care. Moreover, computers help nurse administers efficiently use of nursing resources, and improve patient management (Walters, 1986).
In summary, the computer, a powerful tool in the broad field of technology, is modernizing the nursing profession. It is essential equipment in many hospitals, and becomes a part of the nurse's routine work (Manning & McConnell, 1997; Saba, cited in Saba & Pocklington, 1989). The benefits for nursing in a computerized system are the decrease in time spent in paperwork and the associated increase in time available for professional nursing functions. It can enable nurses to become more accountable and to handle society's health care needs more efficiently. However, as in all fields, efficiency and accountability depend largely on how well computers are used and understood (Marasovic, Kenney, Elliott, &

Sindhusake, 1997; Saba & McCormick, 1986). That is, depend on nurses' computer knowledge, attitudes and skills.

Nurses' computer knowledge

Knowledge is defined as the fact or condition of knowing something gained through experience; having information by learning; acquaintance with or understanding of a science, art, or technique; or the sum of what is known, the body of truth, information, and principles acquired by mankind (Mish, et al., 1995). That is, knowledge encompasses the facts and understanding how to use those facts (Miller, 1965). Knowledge categories in general range from simple to complex, from the concrete to abstract (Krathwohl, Bloom, & Masia, 1974).

In 1988, the National League for Nursing (NLN) published Preparing Nurses For Using Information Systems: Recommended Informatic Competencies (Grobe, 1988). NLN suggested that the practicing nurses should have four informatic competencies, including (1) documenting nursing practice; (2) accessing information; (3) using data and information of a system; and (4) coordinating information flow. At the moment, based on computer knowledge and skills levels of nurses, nurses are divided into three level users

of computers: informed user, proficient user, and developer. At the informed user level, nurses are users of information systems and have an awareness of, understand, use, and interact with those systems in their practice. At the proficient user level, nurses modify and evaluate information systems. At the developer level, nurses are system innovators and are responsible for designing and developing new information systems for nursing. NLN expected that all nurses should be at least at the informed user level, most professional nurses should reach the proficient user level, and only those nurses with advanced preparation will become developers. Therefore, the three level computer users have different requires, for example, the competencies requires for documenting nursing practice: Level I: knows the type of system in use; Levels II: analyses the system in use; Levels III: participates in designing and developing systems serving as an innovator of systems.

Knowledge about computer, therefore, can be defined as the understanding of a computer system's purpose, functions, and interaction with nursing staff, included general, hospital information system, and nursing information system (Burkes, 1991). Bryson (1991), Ronald and Skiba (1987), as well as Saranto and Leino-Kilpi (1997) also

mentioned that the computer knowledge of nurses should include a basic understanding of computer hardware and software, the concept of computer program, and the relationship among various components of the computer; how to develop a computer vocabulary; how a computer system operates, how to use the computer for word processing purposes; computer applications in nursing, and how to use computer-assisted instruction programs for continuing education. Nurses must also be aware of system security, and limitations of the computer. The nursing work environment would be heavily computer-based in future, nursing educators expect that the nurses should be knowledgeable in computer (Bryson, 1991).

Literature have shown that nurses' computer knowledge generally were influenced by nurses' computer training opportunity, computer attitudes, computer use experience, and computer use frequency. It was necessary to provide a computer training opportunity for nurses to obtain computer knowledge (Ngin, Simms, & Erbin-Roesemann, 1993; Sullivan & Decker, 1985). Computer training have been suggested as the most effective means of increasing nurses' computer knowledge (Ball, Snelbecher, & Schechter, 1985; Lange, 1988; Marr, 1988). Several authors have identified appropriate content for computer training courses, they

agreed that computer knowledge training should include the basic computer knowledge, a overview of computer applications in nursing, and focus on the current available computer system (Allen, 1991; Ford, 1990; Lange, 1988; Marr, 1988; Ronald & Skiba, 1987). The time of computer training depends on the complexity of the system and nurses' background or experience of computer use. In general, it ranges from as brief as a two-hour orientation to two weeks for more complex system (Allen, 1991; Ford, 1990; Marr, 1988).

It was demonstrated that previous computer use experience of nurses could generate a positive or negative response to a specific computer system, and influence an individual's motivation to acquire new computer knowledge (Krampf & Robinson, 1984). So, both nurses' computer use experience and computer attitudes influenced learning of computer knowledge (Scarpa, Smeltzer, & Jasion, 1992).

Measurement of nurses' computer knowledge

According to literature, there is no universally accepted measurement instrument for computer knowledge. Most authors used self-developed instruments. Staggers (1994) developed a 32-item computer knowledge questionnaire to measure nurses' self-perceived knowledge of general and hospital informal system computer applications. The subjects

were asked to rate them perceived computer application knowledge as none to extensive, with higher score reflecting higher computer knowledge level. Birx, Castleberry and Perry (1996) developed a 10-item multiple choice tests based on the computer orientation content to measure the computer knowledge of students. The test questions focused on students' understanding of basic computer terminology.

In summary, as the increased use of computers in health care systems, there has been an accompanying need to increase nurses' computer knowledge. All nurses are expected to have basic computer knowledge in informed users level. The factors affecting nurses' computer knowledge includes the opportunity of computer training, computer use experience, and computer attitudes.

Nurses' attitudes toward computer

Attitudes were universally viewed as complex systems. According to Vroom (1964, cited in Burkes, 1991), an attitude had three constructs: satisfaction, beliefs and motivation. The person expects or believes that in performing a certain act, the preferred outcome or reward will follow the act. Satisfaction combined with beliefs can produce motivation to perform the act. The another common view was

that an attitude consisted of the individual's cognitive (beliefs), affective (feelings), and behavioral (behavior) components (Ajzen & Fishbein, 1980). The beliefs represent the individual's own direct or indirect intellectual evaluation of the object, based on facts collected or acquired. The feelings represent the individual's likes and dislikes, they are influenced by his or her values about how things ought to be, and serve as the standards of assessing things. The behavioral aspect is a predisposition to act (Ajzen & Fishbein, 1980).

The concept of nurses' computer attitudes has emerged in nursing as one of the major variables that affects computerized system implementation. Furthermore, it was reported that many studies have approached computer attitudes from a broad and multidimensional perspective (Murphy, Maynard, & Morgan, 1994).

Stronge and Brodt (1985) considered that the nurses' computer attitudes as complex internal states of nurses that affect their choice or behavior toward computer use. Burkes (1991) based on an adaptation of Vroom's expectancy theory, considered that nurses' computer attitudes are nurses' feelings regarding satisfaction for a computerized system, and their beliefs that using computerized system will lead to preferred outcome, therefore, they will produce motivation to

use computerized system. Satisfaction is defined as an attitude of preference for a certain computer-use outcome; Beliefs is an expectation that using computerized nursing systems will lead to preferred outcome; Motivation is the force or willingness to use computerized nursing systems. Murphy, Maynard and Morgan (1994) based on Fishbein and Ajzen (1975), defined nurses' computer attitudes as nurses' evaluation toward the characteristics of a specific computerized system, include efficiency, flexibility, accuracy of computer system and so on.

According to the literature, in the United States, some earlier studies found that nurses had negative attitudes even skepticism toward computer use. The concerns of nurses about the introduction of computers included many aspects: perceived threats to their ability to provide traditional hands-on nursing care to their clients, anxiety related to returning to the role of student during the process of learning how to use the computer, fear of failure in mastering a new skills, the perception that computers were a threat to job security, anticipation of excessive paper output, slow response of the computer system, inability to accommodate updated or changed orders, and a lack of manual backup (Dowling, 1980; Gibson & Rose, 1986; Packer, 1986 cited in Scarpa, Smeltzer & Jasion, 1992). Dowling (1980

cited in Scarpa, Smeltzer & Jasion, 1992) also identified eight organizational and computer technical factors that may contribute to interference with acceptance of computer systems: preexisting organizational problems, failure of the change process, insufficient resource support for the implementation of the computer system, problems with hardware and software, concomitant organizational change, lack of user involvement in introduction and use of the computer system, absence of staff reward systems, and failure of the computer system to meet expectations of the users. However, in general most of more recent studies found that nurses had positive attitudes toward computers, and nurses overwhelmingly considered that the computer technology is capable of making their work easier (Abbott, 1993; Ngin, Simms & Erbin, 1993; Rapko & Adaskin, 1993).

A study described the successful implementation experience of HIS in New York University Medical Center. It reported that nurses' negative attitudes toward computer use were replaced in approximately two months, and after six months, the nurses felt comfortable using the system, and using computer had become a part of their routine work (Marr, 1988). Murphy, Maynard and Morgan (1994) conducted a pretest and post-test study to assess 224 nurses' attitudes toward a patient care information system before and three years after

its implementation. The results showed the positive attitudes before computer use. However, the nurse users' attitudes became less positive during the actual start-up of the system. The researcher explained the main reason that computerized system might be unable to meet nurse user expectations. Newton (1995) also examined staff nurses' attitudes toward a new computerized care planning system before, three months after and one year after its implementation at the Royal Hampshire Country Hospital in Canada. The results showed that the understanding of nurses before computer use was inadequate. Most nurses were ambivalent about paper care planning and the proposed computer care plans. Three months after implementation, attitudes became more unfavorable; and after a year, attitudes showed a significant shift toward the positive attitudes, and the overall quality-of-care planning improved significantly. All above the three studies indicated that nurses' computer attitudes might change as the time of computer system implementation. Since as the time going, the increased experience of computer use, and the computer skills will contribute to increase nurses' positive attitudes toward computer use.

In addition, individual characteristics and demographic variables related that nurses' computer-use

attitudes were reviewed. Several studies have shown that nurses' attitudes toward computer generally were influenced by age, education level, previous computer use, present frequency of computer use, computer knowledge and skills, and years of work in nursing (Axford & Carter, 1996; Brodt & Stronge, 1986; Scarpa, Smeltzer, & Jasion, 1992). However, the results varied from study to study. Most studies produced no significant correlation of age with computer-use attitudes, while Chang (1984, cited in Burkes, 1991) found a significant correlation between younger age and more computer-use willingness. Krampf and Robinson (1984) found a greater percentage of older nurses, with a higher educational level and greater computer experience, to perceive a computer problem as a challenge rather than a frustration. The study of Brodt and Stronge (1986) also revealed that the greater the nurses' educational preparation and length of service in nursing profession, the more favorable attitudes toward computers.

Bongartz (1988) reported that higher frequency of computer use and greater computer experience significantly positive correlation with computer-use attitudes (Chang, 1984 cited in Burkes, 1991; MacBride & Nagle, 1996; Scarpa, Semeltzer, & Jasion, 1992). Scarpa, Smeltzer and Jasion (1992) suggested that positive attitudes toward computer use

could be enhanced by using as tutor nurses with previous computer experience. This may imply that increase computer knowledge and skills will increase nurses' positive attitudes toward compute use.

Several other studies showed that the problems with computer hardware and software also affected nurses' attitudes toward computer use. If the computer systems were perceived as ineffective or did not meet expectations of nurses, they could be contributing to nurses' negative attitudes (Bongartz, 1988; Dowling, 1980). Burkes (1991) also found that nurses with more computer use experience may initiate the critical response toward a specific computerized system. That is, the more familiar with a computer program the more knowledge of its inadequacies, and the more critical response toward a computer system.

Measurement of nurses' computer attitudes

Most instruments to measure nurses' computer attitudes have been developed in the United States (Jayasuriya & Caputi, 1996). There are two common instruments used to measure nurses' attitudes toward computers.

The first instrument was a 20-item Nurses' Attitudes toward Computers Questionnaire developed by Stronge and Brodt in 1985. The content of this instrument asked about (1) job

security, (2) legal ramifications, (3) quality of patient care, (4) capabilities of the computer, (5) employees' computer-use willingness, and (6) computer benefit to the institution. This questionnaire measures

computer-use beliefs/concerns and willingness in general, not toward a specific computer system use. It was also reported that this instrument is more suitable for assessing nurses' attitudes toward computer use in the beginning of introducing a computer system into a hospital setting for nurses' use.

The second common instrument was Burkes' Nurses' Computer-use Attitude Questionnaire, developed by Burkes in 1991. Burkes (1991) used this instrument to conduct a study identifying and relating nurses' attitudes toward computer use. Nurses' computer attitude was measured by three components: satisfaction, beliefs, and motivation. In this study, nurses' computer knowledge and demographic data were regarded as variables affecting nurse's computer attitudes. Therefore, the whole questionnaire contained five sections to measure (1) knowledge, (2) satisfaction, (3) beliefs, (4) motivation, and (5) individual characteristics relating to computer-use in nursing among nurses. The author designed the knowledge, satisfaction, and motivation survey sections based on the literature review, and adaptation Vroom's expectancy

theory. The beliefs and part of the individual demographic data sections consisted of a questionnaire by modified Stronge and Brodt' Nurses' Computer Attitude Questionnaire. This instrument was adapted and regarded as more sophisticated than Strong and Brodt's instrument by many recent researchers. Because it was adapted from Vroom's expectancy theory, and identified nurses' individual characteristics related to computer-use satisfaction, beliefs, and motivation, so, the three sections of measure nurses' computer attitudes in Burkes' Nurses' Computer-use Attitude Questionnaire were modified and used to measure nurses' computer attitudes in this study.

In conclusion, as the computer technology advanced, attitudes toward computers of nurses was positive with respect to the computer's efficiency and importance in society and least positive concerning their willingness to use the computers. However, many individual characteristic factors may affect nurses' computer attitudes, including age, education level, previous computer use, present frequency of computer use, the computer knowledge and skills, and years of work in nursing.

Nurses' computer skills

Skills imply the translating of knowledge into behavior (Miller, 1965). The most general operational definition of skills is that the individual can find appropriate information and techniques in his previous experience to bring to bear on new problems and situations. This requires some analysis or understanding of the new situation; it requires a background of knowledge or methods that can be readily utilized (Krathwohl, Bloom & Masia, 1974). Therefore, nurses' computer skills are regarded as the ability to operate computers, and to use the computer as a problem-solving tool.

A study investigated the expectation of nursing educators about what computer skills should be mastered for nursing students. The survey found that nursing educators expected the nursing graduates to have skills in using the computer as a tool in nursing, using a word processing for writing nursing care plans, using a hospital information system, using computer-aided instruction as a learning tool, using a computerized library database, and using software of statistical computations (Bryson, 1991).

According to literature, there were several primary factors affecting nurses' computer skills, including computer

training for hands-on experience, computer knowledge, the frequency of computer use, and computer attitudes. It was reported that in computer training sessions, it was necessary to provide a hands-on experience for a nurse to translate computer knowledge into a basic computer skills, and it was very helpful for her to obtain individual instruction and assistance in gaining proficiency computer skills (Ngin, Simms, & Erbin-Roesemann, 1993; Sullivan & Decker, 1985; Sweeney, 1985). In addition, Strength and Keen-Payne (1991) reported that increasing exposure to different information systems could enhance computer skills. This may imply that increased computer knowledge and the experience of computer use will increase computer skills level.

Ngin and Simms (1996) conducted a study to examine the computer use among 528 nurse administrators and staff nurses in three urban teaching hospitals. The results showed that computer skills level is most highly correlated with computer use for both nurse administrators and staff nurses, and the former had better computer skills than the later. This might be because that nurse administrators had longer time of using computers for work, greater opportunity access to computers, more than twice the amount of time using computers, and wider range of using variety computer systems than staff nurses. Therefore, computer skills level was

highly correlated with frequency, length and varieties of using computer systems. Furthermore, the result also suggested that multiple factors might have effects on actual computer use, such as: attitudes toward computer use, computer skills, previous experience with computers, access to computers and unit norms toward computer use, as well as the integration between information systems capability and nurses' work needs. The authors considered that computer skills could not be mastered in an environment that does not support staff nurses' use of computers. This was a managerial barrier for learning computer skills (Ngin, Simms, & Erbin-Roesemann, 1993). Gagne, Briggs and Wager (1988) reported that a broadly computer knowledge and frequency of computer use could improve computer skills.

Measurement of nurses' computer skills

According to literature, different computer systems needed different computer skills, each measurement of computer skills was focus on its computer training content. Therefore, there was no universally accepted measure instrument of computer skills. Several authors used self-developed computer skills scale or checklists (Birx, Castleberry, & Perry, 1996; Lange, 1988). Lange (1988) developed a 7-item scale to evaluate the skills level of

undergraduate students in learning about computers before and after a computer course. The subjects were asked to rate their present self-perceived level of skills as very low, low, moderate, high, or very high skills in using microcomputers, HIS, and various microcomputer software programs. Scores range from 0 to 28, with higher score reflecting higher perceived skills in using computers.

Birx, Castleberry and Perry (1996) conducted an evaluative study to determine the effects of computer use on baccalaureate nursing students' computer skills. Students in the experimental group (n=20) received 9 hours of computer instruction, they were encouraged to use computers for electronic mail, library searches, and work processing. The comparison group (n=18) completed the same assignments in the usual manner. They self-developed a computer skills checklists to measure students' self-reported skills in using electronic mail, word processing, and library searches via modem. Each of the three skill checklists consisted of 10 to 12 tasks. Students indicated whether they were able to complete each task independently, with minimal assistance, or with the assistance of a classmate or instructor answering three or more questions.

In summary, the usefulness of computer technology is becoming increasingly evident to nurses. Nurses are expected

to have skills in using computers as a useful tool in nursing. The factors affecting nurses' computer skills include computer training for hands-on experience, computer knowledge, the frequency of computer use, and computer attitudes.

Relationships among nurses' computer knowledge, attitudes and skills

From the literature, many studies focused on nurses' computer knowledge, attitudes, or skills as three key variables affecting computer use. Even though the relationship among the three variables has seldom been tested directly, there were some general findings, which imply relationships among three concepts (Birx, Castleberry, & Perry, 1996; Burkes, 1991; Ngin & Simms, 1996).

Burkes (1991) adaptated Vroom's expectancy model, measured computer attitudes of 56 ICU staff nurses who had computerized charting experience, and identified variables that may correlated with computer attitudes. The results showed that nurses' computer knowledge significantly related to computer-use beliefs, and beliefs were significantly related to satisfaction and motivation. So, the author explained that this might imply the higher level of computer

knowledge, the stronger beliefs that using computer systems will yield positive outcome to nursing and patient care, then, nurses will produce motivation to use computer system. That is, nurses' computer knowledge should have a relationship with computer attitudes.

Thomas, Delaney and Weiler (1992) designed a course of computer in nursing for undergraduate students, included spreadsheet, word processing, electronic mail, orientation to hospital and nursing information systems, computerized literature searches, computer-assisted instruction, and ethical issues. The study found that the computer course had a positive impact on nursing students' computer attitudes ($t=3.61$, $p < .05$) and there was a significant relationship ($r=.407$, $p < .05$) between computer attitudes and computer skills.

Ngin and Simms (1996) conducted a study to examine the computer use of 528 nurses in three urban teaching hospitals. They compared nurse administrators' time spent with staff nurses' at the frequency and variety of using computer systems, computer attitudes, and computer skills. The findings showed that nurse administrators had greater computer skills and more positive attitudes toward computers than staff nurses did. These findings may indicate that a positive relationship between the computer attitudes and

computer skills.

According to Sullivan and Decker (1985), before a nurse could effectively use computer, she had to understand the capabilities and advantages of computer. This indicated that computer knowledge was basis of computer skills. Therefore, a relationship among nurses' computer knowledge, attitudes and skills is expected, and it is necessary to examine the relationships among these three variables.

In conclusion, nurses' computer knowledge, attitudes, and skills are three key variables affecting computer use, and there are some general findings, which imply relationships among three variables (Birx, Castleberry, & Perry, 1996; Burkes, 1991; Ngin & Simms, 1996). However, there was a lack of reports in the literature found regarding directly relationship among these three variables.

Conceptual framework

The conceptual framework for this study was derived from the learning theory (Festinger, 1957 cited in Krathwohl, Bloom, & Masia, 1974; Reilly, 1975) and literature review. According to learning theory, cognitive, affective, and psychomotor domains are interdependent, and equitable important. In general, there is a causal chain linking

knowledge, attitudes, and skills. Knowledge can be used to build attitudes and develop skills; Attitudes can develop interest or motivation to learn knowledge and skills; and as the increased skills, the knowledge and more positive attitudes will be increased by practice (Festinger, 1957 cited in Krathwohl, Bloom, & Masia, 1974; Reilly, 1975).

From literature review, nurses' computer knowledge, attitudes, and skills were three important variables of affecting the implementation of computer systems, and they were influenced by each other. The conceptual framework of this study is shown in Figure 1.

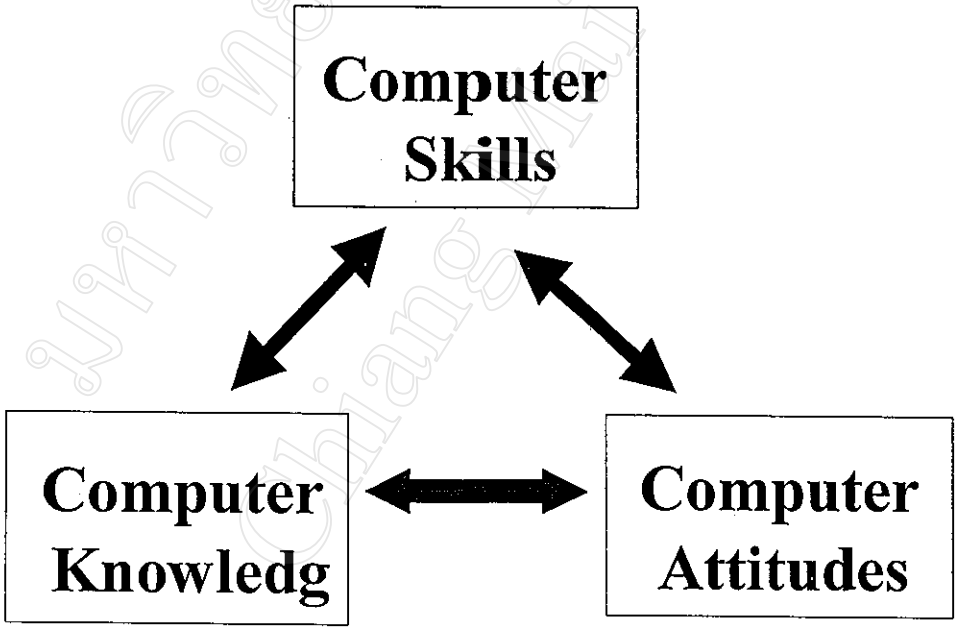

Figure 1. Conceptual framework for this study