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ABSTRACT

This report describes instructional uses of computers, interactive videodisks, and related technologies in undergraduate and graduate nursing education and in continuing education and faculty development. Its principal aims are to document ongoing activities, to identify factors that inhibit technological applications in nursing education, and to suggest measures that might increase such applications. The report begins with a discussion of faculty and student involvement in computer-based education (CBE). This is followed by sections on the development, implementation, and evaluation of CBE materials; commercially available instructional software and hardware; and facilities. Miscellaneous resources such as organizations, consortia, and journals are noted. Glimpses of the near future of nursing education and the potential influences of educational technologies in that future are offered. The report concludes with a listing of constraints associated with CBE technologies and potential responses to alleviate or eliminate them. An annotated bibliography of frequently-cited publications is included. (49 references) (GL)

Computer-Based Education In Nursing

The Learning Center For Interactive Technology

Lister Hill National Center for Biomedical Communications
Educational Technology Branch

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
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COMPUTER-BASED EDUCATION IN NURSING

by
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Foreword

In keeping with a long-standing commitment of the Lister Hill National Center for Biomedical Communications at the National Library of Medicine to develop and support innovative methods for training health care professionals, the Educational Technology Branch conducts research and development in applying computer, audiovisual and multimedia technologies to health professions education. Much of this research and development has focused on interactive educational technology – the delivery of health science education through the compined use of microcomputer technology and videodisc-based images.

The Learning Center for Interactive Technology (TLC), part of the Educational Technology Branch, is a "hands-on" laboratory where visiting health science educators and scientists can explore the use and application of interactive technology to health science education. TLC staff provide tutorials in the set-up and use of the required hardware and in the alternatives that are available for the design of interactive courseware. It is our hope to capture the essence of these tutorials in this series of TLC monographs and thereby create a series of "hands-on" handbooks which will guide the reader into the new world of interactive educational technology.

Michael J. Ackerman, PhD
Chief, Educational Technology Branch

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Introduction

This report describes instructional uses of computers, interactive videodiscs and related technologies in nursing education. Its principal aims are to document ongoing activities, to identify factors that inhibit technological applications in nursing education, and to suggest measures that might increase such applications.

The report examines computer-based education (CBE) use in undergraduate and graduate nursing education and in continuing education and faculty development. It describes CBE applications in academic and health care settings. Most widely discussed is CBE in undergraduate nursing because more information has been published about the 1,469 R.N. programs in state-approved schools of nursing (National League for Nursing [NLN], 1988) than is available about any other level.

Data sources for the report include recently published articles and books, personal communications with nurse experts in CBE and videodisc applications, and one unpublished doctoral dissertation. Two reports were especially useful. the "Nursing Data Review 1987" (NLN, 1988) and "Computer Use in Undergraduate Nursing Education Programs: A Study of 550 Programs" (Aiken, 1988a).

The nurse experts in CBE whose personal communications contributed much to the substance and currency of this report were:

Dr. Eula Aiken, Project Director, Continuing Nursing Education in Computer Technology (D10NU24198), Southern Regional Education Board, Atlanta, Georgia.

Christine Bolwell, Independent consultant and Editor, "*Nursing Educators MicroWorld*" and *19XX Directory of Educational Software for Nursing*, Saratoga, California.

Dr. Donna Larson, Associate Professor, Kirkhoff School of Nursing, Grand Valley State University, Allandale, Michigan.

Dr. Kathleen J. Mikan, Professor and Director, Learning Resources Center, School of Nursing, University of Alabama at Birmingham, Birmingham, Alabama.

Dr. Mary Anne Rizzolo, Program Director, Interactive Videodisc Project, Educational Services Division, American Journal of Nursing Company, New York.

While there has been more written about CBE in undergraduate nursing than about CBE in other nursing areas, information about CBE in nursing is decidedly lacking, as is reportage of instructional research. The one review of experimental studies that was found, Chang's (1986) "Computer-aided instruction in nursing education," included research reported from 1966 to 1983 and, therefore, was not used because the data were judged to be too old to characterize the present situation. Another information deficiency is represented by the limited data available regarding CBE in care facilities, such as hospitals, where most nurses practice and for which the Joint Commission on Accreditation of Health Care Organizations (JCAHCO) has established standards for inservice or staff development.

The report begins with a discussion of faculty and student involvement in CBE and related issues. This is followed by a section about the instructional development of CBE materials. Next, is a look at commercial software, followed by a section about hardware, including limited comment about facilities. Then, miscellaneous resources such as organizations, consortia, journals, etc. are discussed. Glimpses of the near future of nursing education and the potential influences of educational technologies in that future are offered. The report concludes with a listing of constraints associated with CBE technologies and potential responses to alleviate or eliminate them. An annotated bibliography, "Brief Descriptions of Publications Cited Frequently and Their Use in Report", is followed, finally, by a listing of references.

Faculty, Curricula, Students and Computer-Based Nursing Education

Faculty are the key to implementing computer-based education (CBE) in schools of nursing. Faculty, ultimately, will determine whether CBE in any of its forms – computer-assisted instruction (CAI), computer-managed instruction (CMI), or interactive videodisc instruction – is used and used to advantage in the education of nurses. Unless faculty are attracted to and convinced of the value of CBE, incorporation of these technologies in nursing education will continue to progress slowly.

In general, most nursing faculty have had limited personal experience with educational applications of computers. The current generation of faculty did not experience CBE in their own educational process. At this time, many nursing faculty may not have even seen an interactive videodisc, no less a well-designed one (K. J. Mikan, personal communication, September 27, 1988). In some instances, nursing students are much more experienced, and comfortable, with using these educational technologies than are the nursing faculty.

Thomas (1986) surveyed faculty computing skills at 305 National League for Nursing (NLN)-accredited baccalaureate and associate degree programs. Responding deans and program directors estimated that most of their faculty were novices. The next largest group of faculty was estimated to be unskilled. The smallest faculty group was estimated to be expert. According to Thomas, the findings "reaffirm that faculty development is a major concern, and that extreme variability among programs exists" (p. 225).

Faculty Development Programs for CBE – Faculty development programs; i.e., continuing education for faculty, have been conducted to increase faculty competence and comfort with CBE technologies. Tailored for nurses, these programs have been available for, perhaps, eight to ten years and have been offered by many organizations, schools, and companies. The largest and most aggressive nursing faculty development programs have been initiated by the Southern Regional Education Board (SREB), through offerings at university sites, and, more recently, by the Fuld Institute for Technology in Nursing Education (FITNE). The SREB programs emphasize "computer-supported education", while the FITNE programs cover both CAI and videodisc technologies.

In 1986, Thomas' (1986) survey found that 65% of the responding deans and directors were assisting faculty to develop computing skills. As shown in Table 1, the greatest percentage of faculty were learning computing skills for use in instruction. Other applications being learned by faculty were, in descending order: statistical analysis; word processing; and information retrieval.

Table 1: Faculty Learning of Computing Skills for Specific Applications

Application	Percent of Programs
Instruction	46%
Statistical analysis	43%
Word processing	36%
Information retrieval	25%

Note. Adapted from Thomas (1986).

According to the NLN (1988), there was a substantial increase in interest in computer technology and applications in nursing education between 1984 and 1986. During the 1985-86 academic year, this survey found that 87.5% of the nursing programs had at least some faculty attendance at conferences or seminars about computers. As shown in Table 2, more generic baccalaureate, than any other type program, had faculty attending continuing education programs about computers. Associate degree programs had the next highest faculty attendance, followed by diploma programs.

Table 2: Faculty Attendance at Conferences about Computers by Type Nursing Program During 1985-1986

Type program	Percent
Diploma	82.6%
Associate	87%
Generic baccalaureate	91.9%
All programs	87.5%

Note. Adapted from NLN (1988).

Faculty Development of CBE - Not one of five nurse experts in personal communication (E. Aiken, October 7, 1988; C. Bolwell, October 13, 1988; D. Larson, September 29, 1988; K. J. Mikan, September 27, 1988; M. A. Rizzolo, October 11, 1988) disagreed with the statement, "Most of the CBE that's produced could be improved." This was particularly true when applied to software developed for local consumption. Much local consumption software is prepared solo, by nurses who are primarily content specialists. Often the poor quality of the resulting software is due to lack of quality instructional design and production.

Both the SREB survey (Aiken, 1988a) of 550 nursing programs and the response of the 151 schools using CAI that Hebda (1988) surveyed, found about 40% of nursing faculty developing CAI software. It cannot be determined from the survey data whether these efforts are high quality in content, design, and production or not. According to E. Aiken (personal communication, October 7, 1988), local development of CAI is increasing.

The few interactive videodiscs now available for use in nursing education have, with one notable exception, thus far been produced by nurses within schools of nursing or within their institutions' setting. These have been developed by teams composed of experts from within the institutions. Team members represented the diverse kinds of expertise desirable to achieve high quality in content, instruction, and production. While they may have been developed to meet their institutions' needs, the resulting videodiscs can be used by others and are commercially available.

The notable exception mentioned is the American Journal of Nursing (AJN) Company's interactive videodisc on care of the elderly with chronic obstructive pulmonary disease, the first of a series. This videodisc was developed for commercial distribution by a team of experts whose professional services were purchased from a variety of sources, such as schools, professional organizations, computer services companies, etc. It is intended for use by a wide audience in a variety of settings.

Given the quality of much CBE and the amount of effort and expense to produce it, especially in interactive videodisc format, nurse experts feel that its development should be performed by a team of experts. C. Bolwell (personal communication, October 13, 1988) recommends that nursing faculty participate in development in the role of content expert. To promote the development and use of interactive audio visual learning, Rizzolo (1988) proposes the preparation of a new nursing specialist, the "nurse/instructional designer" (p. 2). These experts support Hannah's (1988) call for CBE development by a team of experts, including the content expert (presumably, the nurse faculty member), a lesson designer, a systems analyst, a programmer, and a graphics specialist. Design and development experts with strong educational or experiential qualifications in more than one area; e.g., nurse/computer systems analysts, nurse/television producers, etc., are highly desirable.

Computer Technology in the Curriculum - Whether or not nursing subjects can or should be taught by CBE, there is agreement that nursing students need to know about computer technology itself. But there is little agreement about what they need to know about computers. A survey conducted by Heller, Romano, Damrosch, and McCarthy (1988) of selected hospitals accredited by the Joint Commission on the Accreditation of Hospitals of 200 beds or more found that 84% of the 128 responding institutions currently use computers in nursing practice and/or administration. All remaining hospitals had plans to adopt computer technology. Therefore, the likelihood that nurses, as students and later as practicing professionals, with need to know or do "something" related to computers is quite high.

Students and faculty encounter computers in the various agencies they use for student clinical learning experiences. According to more than 230 programs in the SREB study of 550 nursing programs (Aiken, 1988a), "more than 50 percent of the clinical agencies affiliated with the school of nursing expected staff nurses to use computers" (p.12). While the SREB study reported that students used computers at most of the agencies, according to K. J. Mikan (personal communication, September 27, 1988), where sophisticated Nursing Information Systems are in place, in many instances students are not permitted to use them. When they are permitted, usually clinical agency staff, not faculty, instruct students in use of the agency's computers as required by the students' learning experiences in caring for patients.

Various factors influence faculty to use or not to use CBE. These include faculty competence and comfort with the technology, availability of appropriate hardware and quality software, plus other internal and external motivators toward or away from CBE. The SREB study (Aiken, 1988a) found that incentives (financial, promotions, tenure, merit raises, release time) were provided nursing faculty to use computers within the curriculum in about 40% of the schools responding.

Instruction About Computers - Currently there seems to be somewhat limited attention to teaching about computers in nursing curricula. According to the NLN (1988), only 13.2% of all nursing programs require computer courses (see Table 3). Not surprisingly, the program type with the least percentage requiring computer technology courses was the diploma level. Again, not surprisingly, the program type with the greatest percentage requiring computer courses was the graduate level. What is surprising are the percentages across program types, nearly one-third of all, in which computer courses are not even available. Unfortunately the most remarkable findings are at the graduate level. Although more graduate level programs than any other type required computer courses, more than one-third of the graduate programs do not even have computer courses available.

Table 3: Courses in Computer Technology by Type Nursing Program

Type Program	Required	Available	Unavailable
Diploma	5.0%	8.3%	73.9%
Associate	11.0%	52.4%	28.8%
Generic baccalaureate	18.6%	52.0%	19.6%
Graduate	31.3%	17.4%	39.1%
All programs	13.2%	45.7%	31.8%

Note. Adapted from NLN (1988).

There is apt to be more emphasis on computers in nursing curricula in the future. While currently no state law or board of nursing mandates teaching about computers or computer competence, there is apt to be more consideration of computer-related instruction in future laws or regulations.

While no computer competencies are currently included in the NLN criteria for accrediting undergraduate programs, there is speculation within the nursing profession that there soon will be. A resolution promoting instruction about computer technology was passed by the NLN in 1987. Members at a 1989 meeting of the NLN Computer Forum resolved that "nursing school administrators explore the learning needs of the faculty and students with respect to technology and nursing informatics and identify ways in which these needs can be met. And [resolved that] the committee on accreditation of the National League for Nursing be requested to examine the issue of technology in nursing informatics education and make recommendations about its inclusion in nursing curricula to all nursing education councils" (NLN, 1989, p. 12).

The next generation of nursing faculty is being educated in doctoral and masters level programs now. While many have assumed that these future faculty will be prepared to cope effectively with interactive learning technologies, the percentage of graduate programs in which computer courses are not even available suggests otherwise. This unfortunate circumstance is further supported by Rizzolo's (1988) finding lack of agreement of respondents with the statement, "Time will take care of the problem of faculty lack of computer expertise (younger faculty will have experience)" (p. 235).

Some nursing faculty are capable of teaching about computers. "Sixteen percent of all nursing education programs employed at least one nurse faculty member to teach computer technology/applications" (NLN, 1988, p. 149).

Considering only generic baccalaureate programs, 28% employed at least one nurse faculty to teach computer/technology applications (NLN, 1988). Some programs had as many as three or more nurse faculty who taught these applications.

In 1988 (too recently to be included in the NLN (1988) survey), the University of Maryland, School of Nursing initiated a Master of Science in Nursing Administration/Informatics which graduates a Nursing Information Systems Specialist. The three semester course prepares graduates to "analyze nursing information requirements; design system alternatives; manage information technology, identify and implement user training strategies, and evaluate the effectiveness of clinical and/or management information systems in patient care" (University of Maryland, 1988). This program, the only one of its kind in the U.S., represents the closest approximation of a nursing educational program preparing a graduate with competencies in advanced interactive technologies which can be applied for educational purposes.

In contrast to programs in medical informatics, there are no nursing programs preparing nurse computer scientists, nurse information scientists, or nurse educators at the doctoral level. However, a relatively few individuals have educated themselves in nursing and then undertaken doctoral level preparation in computer science, informatics, or educational technology.

The lack of advanced educational programs that address interactive instructional and information technologies in nursing may perpetuate the tendency of nursing faculty to be hampered by inexperience and lack of competence with these potentially powerful educational devices. On the other hand, the situation may promote the emergence of new roles in instructional development as suggested above.

Instruction by CBE - Personal communications with nurse experts in CBE identified broader issues relevant to the use of CBE than were addressed in the literature reviewed. A very thought-provoking possibility offered by K. J. Mikan (personal communication, September 27, 1988), is that CBE is not being used as widely as it could be perhaps because most faculty do not use audiovisuals at all in their teaching.

In personal communication, C. Bolwell (October 13, 1988), K. J. Mikan (September 27, 1988), and M. A. Rizzolo (October 11, 1988) indicated that when CBE was implemented, it tended to be as an "add on", as "homework", rather than being an integral component of a learning experience. Further, the CBE tended to be "stand-alone" instruction, not discussed, explored, or addressed in the classroom and, therefore, not appropriately integrated into the curriculum.

Rizzolo's (1988) proposed new specialist, the nurse/instructional designer, could directly promote instruction by CBE. By providing faculty education and consultation, this specialist could lead the integration of this technology, especially in the format of interactive videodisc, into nursing curricula and the entire health field.

Preparation of Graduates for Use of Computers in Nursing Practice - The NLN (1988) survey asked about preparation of current students to apply computer technology in practice upon graduation. Given the relatively low percentages of required and available computer courses, the data about current students' projected capability to apply computer technology in practice as graduates are quite surprising.

Most surprising is that, "Twenty-five percent of all nursing education programs reported that most of their current students will be prepared, upon graduation, to use computer technology in their nursing practice. This is double the percentage reported in the 1984 survey" (NLN, 1988, p. 153). However, in 1987 (NLN, 1988), more programs (28) said that none of their students, as graduates, would be able to use computers in practice (see Table 4).

Table 4: Preparation to Use Computers in Practice by Program Type

	As Graduates			
Program type	Most	Some	A few	None
Diploma	27.5%	8.3%	15.1%	44.5%
Associate	20.8%	15.1%	29.5%	33.0%
Generic baccalaureate	31.4%	23.5%	26.2%	16.4%
Graduate	39.4%	27.7%	24.1%	8.8%
All programs	25.1%	17.2%	26.3%	28.4%

Note. Adapted from NLN (1988).

There are other bleak projections in these data (NLN, 1988). Particularly disturbing are the high percentages of diploma and associate degree students who will not be prepared to use computers in practice. The findings about graduate students are also distressing. While more graduate students appeared to be prepared to use computers in future practice than would graduates of any other program type, the percentages so prepared are dismally low.

Constraints

There are many constraints to CBE in schools of nursing. Some pertain uniquely to certain schools, while others are common to many. A major common constraint is lack of knowledge. Many faculty are not knowledgeable about CBE. In addition, because there have been few controlled studies of CBE in nursing, there is little factual evidence to direct or guide decisions about it. Other relatively common constraints include personal characteristics of faculty and curriculum factors.

Lack of Knowledge About Development as a Constraint – According to K. J. Mikan (personal communication, September 27, 1988), most faculty do not have the knowledge, skills, or ability to create or adapt CBE materials. Mikan's comment is supported by the results of several surveys.

Murphy (1986), Hebda (1988), and Rizzolo (1988) identified lack of knowledge about CBE or its development as inhibiting its application in nursing schools. Murphy (1986) found that lack of computing expertise was a major reason why instructional applications lagged behind the use of computers for documentation and evaluation. Hebda's survey (1988) found that lack of capability to design their own programs was a reason for nonuse of CAI by 32.7% of the respondents.

Rizzolo (1988) found that respondents strongly supported the statement that, "Lack of knowledge of potential power and use of IAVL [Interactive Audio-Visual Learning]" is a factor impeding the development of new interactive videodisc programs (p. 233). The respondents also strongly agreed that "Lack of competent developers and/or lack of resources to assemble a multidisciplinary team" was a factor impeding the development of new interactive video programs (p. 233). Lack of a pool of useful software contributes to restraining the growth of CBE.

Highly qualified design and development experts are probably not readily available. According to D. Larson (personal communication, September 29, 1988), there is a significant and growing shortage of nurses with competence in CBE instructional design.

Lack of Knowledge About Implementation as a Constraint – Appropriate integration of CBE into the curriculum is difficult for many faculty. Frequently a CBE activity is assigned to students without adequately preparing them for the experience. Often faculty do not follow-up on CBE with students to determine how effective or meaningful these experiences have been or to relate the CBE activity to other learning experiences.

M. A. Rizzolo (personal communication, January 30, 1989) believes that "many faculty are technophobes, or just haven't had the time and opportunity to learn how to use the hardware or even preview software." This, unfortunately, tends to perpetuate inappropriate or no use of CBE.

M. A. Rizzolo sees faculty's lack of knowledge as, perhaps, the single most important barrier to the implementation of CBE. She believes that "faculty's lack of knowledge about how to use the hardware and software and integrate it into the curriculum" is more of a barrier to CBE than is the cost of hardware (personal communication, October 11, 1988).

Lack of Research as a Constraint - There is considerable documentation that research on CBE is needed. In 1986, Thomas' (1986) survey identified "lack of evidence of worth; i.e. that CAI is cost effective" (p. 226) as tenth in importance in a list of barriers to growth of instructional computing. In 1988, 6.3% of Hebda's (1988) survey respondents cited the unsuitability of CAI for education as a reason for not using it. There is little nursing research evidence to support or refute the findings of either survey. In addition, there is little research evidence to encourage and guide the continued development or implementation of CBE.

In 1986, Thomas (1986) called for results of "sound evaluation research" (p. 228) to replace beliefs and rationales about the superiority of CAI. The need for research results persists. According to personal communication with E. Aiken (October 7, 1988), D. Larson (September 29, 1988), and K. J. Mikan (September 27, 1988), controlled studies of the effect of CBI or characteristics of CBE on learning are needed.

While there has been limited research on CAI, there has been even less research attention devoted to study of the newer, even more resource-consuming and more potentially educationally powerful interactive videodisc. In fact, Rizzolo's respondents agreed that "Lack of research proving educational value and cost effectiveness" was a factor impeding the development of new videodiscs (1988, p. 234).

Lack of Faculty Incentives as a Constraint - CBE efforts tend not to be highly valued by nursing administrators. Surveys by Thomas in 1985 and 1986 asked deans and directors to rank the importance of selected faculty accomplishments in making promotion, tenure, and salary decisions. "Of 12 types of accomplishments, development of CAI or interactive video was rated dead last, behind all sorts of publications including nonresearch articles in nonrefereed journals, development of programmed learning modules, and even service activities" (Thomas, 1988, p. 303).

In 1986, Thomas found "Lack of incentives, rewards" (p. 228) rated thirteenth in importance as a barrier to growth of instructional computing by survey respondents (1986, p. 228). However, this situation may be changing. In 1988, the SREB study (Aiken, 1988a) found that about 40% of the responding schools provided incentives for nursing faculty use of computers within the curriculum.

Another incentive for faculty involvement with CBE may be commercial distribution of the software they develop. These faculty may be motivated to develop computer-based materials by income generated by sales or licensing. However, since this income is generally a paltry amount, it would seem that intrinsic motivation is a significant factor promoting the development or use of CBE.

Other Faculty-related Constraints - Thomas (1986) found other faculty related barriers to growth of CBE. From most to least important, these were: lack of faculty interest in computer applications, costs of training faculty and staff, and lack of technical assistance for faculty.

Curriculum-related Constraint - Thomas (1986) found lack of "space" in the curriculum to be a barrier to growth of CBE.

In summary, this chapter has examined CBE in nursing from the perspectives of nursing faculty, curricula, and students. Instruction about and by computers was reviewed. Constraints, especially those related to faculty knowledge, were identified. It should be noted that although there are many constraining forces, CBE in schools of nursing seems to be expanding.

Development of Computer-Based Education

Recent surveys indicate that considerable computer-based education (CBE) program development is now underway for nursing. Most of this development is of computer-assisted instruction (CAI) for undergraduate nursing students but some software is being developed as CAI for practicing nurses. A few CBE programs have been developed as interactive videotapes and a small, but growing, number of videodiscs has been developed for various nursing audiences. Future development of CBE in nursing is expected to increase most rapidly in the videodisc format, promoting the gradual extinction of interactive videotape.

Extent of CAI Development – In undergraduate nursing programs, of the 151 CAI-using schools surveyed by Hebda (1988) and according to the Southern Regional Education Board (SREB) survey of 550 nursing programs (Aiken, 1988a), about 40% of the faculties were involved in developing CAI. Further, E. Aiken (personal communication, October 7, 1988) reports that local development of CAI for undergraduate nursing education is on the increase.

CBE is also being developed for continuing nursing education. At least two nursing specialty organizations, the American Association of Critical-Care Nurses (AACN) and the American Nephrology Nurses' Association (ANNA), develop CBE programs for their members. AACN has developed several successful CAI programs. ANNA has developed two renal-related CAI programs as a pilot project. According to the president, if the pilot is successful, the Association plans to pursue other topics for CAI development for continuing education credit and possibly for certification review (P. Jordan, personal communication, August 2, 1988).

Extent of Interactive Videodisc Development – Presently, several schools of nursing and various consortia, professional and commercial organizations are developing interactive videodiscs for nursing education. The videodiscs are being developed for a variety of nursing audience levels, but most are for undergraduate students.

Perhaps the most widely-known commercially available interactive videodiscs developed in school settings are those produced at the University of Cincinnati, by Elizabeth E. Weiner, and at the University of Texas at Galveston, by Mary Anne Sweeney. Weiner's credits consist of a videodisc series about care of diabetics and one videodisc about care during labor and delivery. Sweeney's credits, in addition to a videodisc for patient education, include a videodisc on aging and nursing care of the elderly.

Two especially notable consortium development efforts are by Fuld Institute for Technology in Nursing Education (FITNE) and the IBM-supported Healthcare Interactive Video Consortium (HIVC). Because FITNE, a growing consortium of nursing schools and individuals includes many members who are or will be developing videodiscs, it is anticipated that its efforts will eventually result in significantly increasing the number of available videodiscs. FITNE, itself, will produce five new nursing programs in the next two and a half years (D. Burke, personal communication, November 7, 1988). The HIVC involves 18 U.S. and Canadian nursing and medical schools, at least three of which are schools of nursing. A consortium goal is to produce a grand total of 75 videodisc programs for nursing, medicine, and other biomedical professions.

The American Journal of Nursing (AJN) Company, Educational Services Division, with financial support from the Division of Nursing (DN), Department of Health and Human Services (DHHS), is developing a series of videodiscs on aging and chronic illness (M. S. Hill, personal communication, July 19, 1988). The first of the series, on care of the elderly patient with chronic obstructive pulmonary disease was released in 1988. Another project, supported by the National Center for Nursing Research (NCNR), will develop an interactive videodisc to enable perinatal nurses to attain/maintain electronic fetal heart monitoring skills (Andicore, 1988). When commercially-available, the videodisc will be for use by students of nursing and other health professions at a variety of levels.

Two other significant computer-based development efforts are being conducted. Both are by the National Council of State Boards of Nursing (NCSBN) and are designed to investigate the feasibility of implementing: (1) computerized adaptive testing (CAT) and (2) computerized clinical simulation testing (CST). The CAT project is in its second year. According to the Director of Research Services of the NCSBN, C. Yocom (personal communication, September 15, 1988), "The first year was devoted to the development of computer software that, using Item Response Theory, ... will tailor individual tests for every licensure candidate. The remaining three years of this project will address the multiple psychometric, legal, security, scheduling, and administrative questions and issues that must be addressed prior to a final decision, tentatively scheduled for 1991, as to whether to begin implementation." The CST project is a three-year feasibility study funded by the W.K. Kellogg Foundation designed to address: "(1) whether the software developed by the National Board of Medical Examiners...can be modified to support nursing practice simulations, (2) to develope [sic] and explore the validity and reliability of 20 nursing simulation cases, and (3) to disseminate information about the project." According to Yocom, "We will also be exploring the use of a video disk to supplement or support narrative descriptions of client status" (personal communication, September 15, 1988).

How CAI Is Being Developed - How CBE software for nursing, in CAI format, is developed was not well described in the literature. Thomas (1988) mentions the availability of several authoring tools which can be used in developing CBE, including the Nurse Education Module Authoring System (NEMAS). The *1988 Directory of Educational Software for Nursing* (Bolwell, 1988) describes three systems for authoring on Apple II family and on IBM/IBM compatible hardware: MICROINSTRUCTOR, SIMU-WRITER: SIMULATION AUTHORING SYSTEM, and NEMAS: NURSING EDUCATION AUTHORING SYSTEM. An additional program only for IBM and compatibles, AUTHOR/QUIZ, is also described. It is not known to what extent any of these, or other, authoring tools are being used to develop CAI for nursing.

NEMAS, the only authoring system based on a formal nursing process, was developed by Grobe in 1982 and then distributed by Lippincott Company. NEMAS, according to Thomas (1988), is "complex in its ability to produce a wide variety of simulations; the system is actually quite easy to use. Nurse educators can use this system to design nurse-patient encounters in a variety of settings to teach protocols, decision making, and the consequences of one's decisions" (p. 309). However, according to S. J. Grobe (personal communication, November 7, 1988), the Lippincott Company has discontinued its sale of NEMAS.

How Interactive Videodiscs Are Being Developed - While CAI development techniques are not well described in the literature, there are several excellent descriptions of processes used to develop interactive video. Three "case studies" of interactive video development for nursing education were found in the literature. Fishman (1984), in her description of the development of what was probably the first interactive videotape, worked from a storyboard and seems not to have used authoring tools. Redland and Kilmon (1986) used the Whitney Authoring System to develop an interactive videotape on nonverbal communication. Weiner et al. (1988) seem to have written all their own programming and not to have used an authoring tool to develop a videodisc on nursing care of the diabetic patient. Another published 'case study", developing and implementing an interactive videodisc for patient use, describes planning based on a videodisc map or program flowchart and use of the QUEST authoring system (Sweeney & Gulino, 1988).

The FITNE consortium recommends that its members author using the QUEST system. Because the FITNE members' development efforts are anticipated to be extensive, there will probably be a significant number of videodiscs developed using that system. However, it is not known to what extent NEMAS, QUEST, or any other authoring system is being used for videodisc development.

Content needs for future CBE development - D. Larson (personal communication, September 29, 1988) listed top priority content needs which are common to all nursing undergraduate curricula and which are problematic to teach as: psychomotor skills development, clinical decision-making skills, communication skills development, and rare or high-risk learning experiences. She feels that development of these as CBE software is a high priority.

Constraints

There are probably many constraints that act both individually and synergistically to impede development of CBE. Some impediments are unique to a specific setting or to a specific instructional problem. Others apply or could apply to nearly all development efforts. Due to the greater complexity of developing a videodisc, compared to a CAI program, one would anticipate more varieties and intensities of constraints bearing on videodisc development.

Foremost of the impediments might be lack of knowledge, skills, or interest in developing software. Hebda's (1988) survey found that 32.7% of the responding programs did not use CAI in any form because of "lack of capability to design own programs" (p. 27).

Another significant barrier is the circuitous problem of inadequacy of available software. Rizzolo (1988) found some agreement that "Lack of software discourages purchase of equipment. Conversely, the lack of hardware discourages software development efforts" (p. 233).

Maybe the paucity of useful, affordable, commercially-distributed software is serving as a stimulus to the relatively extensive local development efforts. Some, finding the available software inadequate, are perhaps stimulated to develop their own tailor-made, quality software.

Dearth of Models As a Constraint - However, several authors suggest that the low quality and quantity of available software may serve as an impediment to development of CBE in any form. Some of these inadequacies may be related to deficiencies in the instructional design of the software. Design deficiencies may be related to a dearth of models of various kinds. These include: insufficient numbers of available, suitable CBE programs to serve as models to emulate; scarcity of adequate, easy to use, powerful authoring tools providing appropriate models of nursing or of the learning process; and lack of research results to suggest models and guide design.

M. A. Rizzolo (personal communication, October 11, 1988) cites the lack of good instructional design models, to use as templates in development, as contributing to extensive time requirements for developing videodiscs. Rizzolo (1988) also found some agreement of her respondents that a lack of good authoring systems was a factor impeding the development of new interactive video programs.

K. J. Mikan (personal communication, September 27, 1988) feels that lack of research on benefits of simulation, on "interaction", and on "intelligent" systems is a hindrance to CBE development. Further, the lack of research findings to direct and guide development, especially about the effects of simulation and interaction, two characteristics basic to the essence of quality CBE itself, is handicapping. While posing formidable barriers to development of CAI, this lack of research-based findings is especially deleterious to the development of videodiscs.

Other significant constraints to the development of software, especially in interactive videodisc format, are: lack of time required for development; cost of production and development hardware; lack of standardization or incompatibility of equipment and components; and an insufficient supply of competent developers.

Time as a Constraint - Murphy (1986) cites the amount of time required to develop instructional programs as a major restraint to computer use. Hannah and Osis (1988) still accept Kearsley's 1982 projection of 100 to 400 hours of development time possibly required to produce one hour of CAI. M. A. Rizzolo (personal communication, October 11, 1988) feels that more time is required to develop interactive videodiscs than to develop other educational materials. She feels this is due to the tremendous number of instructional possibilities and alternatives available with the videodisc. Taking design possibilities and alternatives into consideration and exploration may push the development time for one hour of videodisc instruction far beyond the projected 100 to 400 hours for one hour of CAI.

Cost Factors as Constraints - The time required to develop software translates into a major factor in the cost of development. But there are other cost factors, too, and, thus, cost has become a major barrier to all development and use of CBE, particularly in videodisc format. Rizzolo (1983) found strong agreement of her respondents that the cost of developing programs was a factor impeding the development of new interactive videodiscs. In videodisc development, the most costly component is the video production. Unfortunately, according to M. A. Rizzolo (personal communication, October 11, 1988), the costs of producing the video component will probably not decrease significantly in the future.

Schools of nursing no longer have the video production capability they once enjoyed. With Federal funds in the 1960's and early 1970's, many schools of nursing purchased considerable video production equipment. While this equipment, when maintained and used appropriately, is capable of producing tapes adequate for local consumption, many schools now find their equipment and facilities unable to produce the quality and format of tape required for videodisc mastering (K. J. Mikan, personal communication, September 27, 1988).

Lack of Standardization and Incompatibilities as Constraints - D. Larson (personal communication, September 29, 1988) feels lack of standardization is a barrier to CAI development and even more of a hindrance to videodisc development. Rizzolo (1988) found strong agreement of her respondents that hardware/software incompatibility is a factor impeding the development of new interactive videodisc programs. In addition, her respondents agreed that a limited market with limited funds cannot insure a return on investing in developing videodiscs. There probably would be more development if there were more certainty of the compatibility of proposed software with the hardware market.

Insufficient Supply of Competent Developers as a Constraint - Having knowledgeable, capable people to form an instructional team is a problem in many development efforts. Due to the various tasks required in development, talents of several people are usually required, in addition to one or a few "interested or invested" nurses. This constraint is especially deleterious to videodisc development. Rizzolo's (1988) respondents agreed that "Lack of competent developers and/or lack of resources to assemble a multidisciplinary team" was a factor impeding the development of new videodisc programs (p. 233).

In summary, the constraints to the development of interactive learning materials are: lack of knowledge, skills, or interest in developing software; inadequacy of software to serve as models; insufficiency of suitable authoring tools; dearth of research on the characteristics, effects, and quality of CBE; lack of time required for development; cost of production and development hardware; lack of standardization or incompatibility of equipment and components; and an insufficient supply of competent developers. These constraints apply to all CBE, but especially to the interactive videodisc format.

Implementation of Computer-Based Education

Nearly all schools of nursing use computers (M. S. Hill, personal communication, July 19, 1988). According to the surveys summarized in this section, computer implementation by nursing programs has varied over time and amongst schools. The surveys have been of slightly different nursing program populations and of different facets of computer-based education (CBE) implementation, making comparisons among and between surveys difficult. However, since some comparisons are possible, Table 5 is presented.

How Nursing Schools Have Implemented Computers - A 1983-84 survey by Thomas (1986) found nursing faculty, staff, and students of NLN-accredited baccalaureate and higher degree programs using computers as follows, in descending order of usage: word processing; statistical packages; information retrieval; computer-assisted instruction (CAI) and computer-managed instruction (CMI); and retrieval of patient data. As shown in Table 5, Thomas' respondents reported the lowest, of all the surveys, usage of computers for CAI (14%).

In 1984, Walker (1986) surveyed dean and chairperson members of the American Association of Colleges of Nursing about computer use in their programs. Respondents indicated that computers were being used primarily for word processing and administrative applications, with limited use for research and instruction. Only 29.6% were using computers for CAI (see Table 5).

There were two surveys of nursing school computer use in 1986 (see Table 5). The 1986 survey by Hebda (1988) of all National League for Nursing (NLN)-accredited baccalaureate programs, found a much higher usage of computers

Table 5: Uses of Computers by Nursing Programs

Uses	1984[a]	1984[b]	1986[c]	1986[d]	1987[e]
CAI/CMI	14%	29.6%	48%	57%	39.9%
Word processing	30%	36.8%		14%	
Research/statistical	27%	36.7%		59%	35.5%
Information retrieval	19%			53%	
School/program management		31.2%			
Academic services		28.8%			
Student services		25.5%			
Testing				42%	12%
Patient data retrieval				10%	

[a]Adapted from Thomas (1986). Population: NLN-accredited baccalaureate and higher degree programs.

[b]Adapted from Walker (1986). Population: members of the American Association of Colleges of Nursing.

[c]Adapted from Hebda (1988). Population: NLN-accredited baccalaureate nursing programs.

[d]Adapted from Bolwell & Thomas (1986). Population: NLN-accredited baccalaureate and higher degree programs. Survey of microcomputer use only.

[e]Adapted from NLN (1988). Population: all nursing education programs.

for CAI than earlier studies did. Hebda found 48% of the programs using CAI in the curriculum. For nursing courses only, 44.5% of the programs were using CAI. Also in 1986, Bolwell and Thomas (1986) surveyed NLN-accredited baccalaureate and higher degree programs. Even though the latter survey was limited to microcomputer use only, it found the highest, of all the surveys, usage of any size computers for CAI (57%).

In 1987, the NLN (1988) survey of all diploma, associate degree, baccalaureate and higher degree programs found that about 40% of these programs were using computers for CAI (see Table 5). The purpose of the highest computer usage, about 50% of all programs, was for grading and test analysis. However, student testing by computers was found in only 12% of all programs. Statistical analysis for research was another frequently used application of computers.

In 1987, the NLN (1988) survey of all nursing programs found that more than one third of the programs reported that no faculty integrate computer applications into their instruction (see Table 6). While the greatest percentages having no integration of computer applications were of faculty of diploma and associate degree programs, a greater percentage of associate degree programs reported more faculty integration of computers than did any other program type. Only about 10% of all programs reported that most faculty included computer applications.

In spite of what appears to be a low level of individual faculty involvement in CBE, the NLN (1988) survey found that about 40% of all nursing programs offered CAI. At about the same time, the Southern Regional Education Board (SREB) study of 550 nursing programs (Aiken, 1988a) found that microcomputers delivered some nursing instruction in most of the programs. However, "In most cases, less than 25 percent of the undergraduate nursing curriculum was taught with microcomputers" (p. 1).

In 1987 and early 1988, the American Journal of Nursing (AJN) Company (1989) surveyed approximately 3,000 professionals interested in interactive videodiscs for nursing education. Surveys were returned by 661 respondents (see Table 7). Relatively low, but nearly equal, numbers of respondents used interactive videodisc or interactive videotape. Only 6 respondents used both interactive video formats. However, the vast majority of respondents, 516, reported that they would like to use interactive videodisc instruction.

Table 6: Faculty Integration of Computers in Nursing Courses

	Proportion of faculty integrating			
Program type	Most	Some	A few	None
Diploma	9.6%	9.2%	20.2%	56.0%
Associate	11.3%	12.9%	32.1%	42.5%
Generic baccalaureate and higher degree	7.1%	19.6%	50.2%	21.3%
All programs	9.9%	14.7%	36.0%	37.2%

Note. Adapted from NLN (1988).

Table 7: Usage of Interactive Video Formats

Format	Respondents
Videodisc	29
Videotape	23
Videodisc and videotape	6

Note. N=661. *Adapted from AJN (1989).*

Although the surveys summarized above are not directly comparable with each other, they indicate an increase, over the period 1986 through 1988, in implementation of computers for CAI by schools of nursing. The newest CBE technology, the interactive videodisc, seems to be desirable and is expected to be adopted and implemented by schools of nursing.

How Nursing Practice Settings Have Implemented Computers – It appears that hospitals and other facilities where nurses practice have computers that are used mostly for noninstructional purposes. While these computers could be used to provide staff development or continuing education, only two indications of such implementation were found in the nursing literature. Bolwell and Thomas (1986) surveyed a random sample of 5% of community hospitals listed by the American Hospital Association and found that 23% were using microcomputers, primarily for noninstructional purposes. Cost was cited as the major reason for nonuse of microcomputers for instruction by the hospitals.

The other indicator of possible care facility use of computers for instruction is inferred from the 1987 NLN (1988) survey. That survey found computerized nursing care plans available in the clinical areas used by 14.4% of all nursing education programs. While the primary purpose of such care plans is for care rather than instruction, the plans may be used by faculty for instructional purposes, as students learn to nurse patients, and by clinical staff, for inservice or continuing education. Other than these two studies, there were no indications of the use of computers in hospitals and other health care facilities for instructional purposes.

While there are currently no data about implementation of videodiscs in nursing practice settings, at least one interactive videodisc was developed specifically for prenatal outpatient education (Sweeney & Gulino, 1988). Availability in clinical settings of the hardware required for interactive videodisc implementation may promote development of videodiscs for practicing nurses.

Computer Implementation for Education

Hannah (1988) says that nurse educators are using the computer to manage the educational environment to: teach, assess. identify students' learning problems, gather data on the learning process, manipulate research data, and direct continuing education. The SREB study of 550 nursing programs (Aiken, 1988a) found that "The major purposes and uses of computers in nursing were to supplement and enrich learning" (p. 1). Most of the programs reported teaching nursing with microcomputers "less than 5 percent" (p. 10). According to the NLN (1988) survey, as shown in Table 8, CAI was available in about 40% of all nursing programs. The greatest availability of CAI was in baccalaureate and higher degree programs with generic students. The least availability was in diploma programs. According to the SREB (Aiken, 1988a) study, where computers were implemented, their instructional purposes, in descending order, were as follows (see Table 9): enrichment; required basic learning; optional basic learning; remediation; testing; self help; and diagnosis.

Table 8: CAI Applications by Program Type

Program type	CAI
Diploma	22.5%
Associate	38.9%
Baccalaureate and higher:	
generic students	50.0%
RN students	46.7%
All programs	39.9%

Note. *Adapted from NLN (1988).*

Table 9: Instructional Purposes of Computers

Purpose	Programs
Enrichment	57%
Basic learning, required	41%
Basic learning, optional	41%
Remediation	37%
Testing	28%
Self help	27%
Diagnosis	9%

Note. Adapted from Aiken (1988a).

Instructional Methods and Activities Implemented - Various instructional methods can be implemented in CBE formats to deliver, manage, and direct learning, self-assessment, and testing activities. Where CAI was used, Hebda's (1988) respondents identified instructional methods employed, in descending order, according to the following (see Table 10): problem solving; didactic instruction; deductive reasoning; inductive reasoning; guided discovery; and discovery/inquiry.

Table 10: Instructional Methods Used in CAI

Method	Programs
Problem solving	60.1%
Didactic instruction	55.9%
Deductive reasoning	54.9%
Inductive reasoning	46.5%
Guided discovery	32.9%
Discovery/inquiry	11.9%

Note. Adapted from Aiken (1988a).

The SREB study of 550 programs (Aiken, 1988a) and the AJN (1989) survey both found the same rank order of CBE instructional activities. In descending order, these were: simulations, tutorials, and drill and practice. In addition, the SREB study found these activities followed by testing and word processing instructional applications, in that order.

The 1987 NLN (1988) survey found applications of simulations available in 31.2% of all nursing programs. The greatest availability of simulations was in baccalaureate and higher degree programs for RN students only (see Table 11). The least availability was in diploma programs.

Table 11: Computerized Simulations and Testing Applications by Program Type

Program type	Simulations	Testing
Diploma	15.1%	6.0%
Associate	33.0%	10.7%
Baccalaureate and higher:		
generic students	35.8%	17.6%
RN students	37.1%	11.4%
All programs	31.2%	12.0%

Note. Adapted from NLN (1988).

As shown in Table 11, testing of students at computers was most available in generic baccalaureate programs and least available in diploma programs (NLN, 1988). Consistent with this relatively high implementation of computerized testing, Hebda's (1988) survey revealed that the single commercial computer program most frequently used was NURSESTAR, a testing rather than a CAI program.

While there were no data available about the instructional design of interactive videodiscs in use, this format can deliver the same instructional methods and activities as CAI, with the added bonus of video images. The videodisc seems to be an ideal format for the delivering simulations of clinical applications, the learning activity most frequently used in CAI.

Sources of CAI Programs Implemented - Hebda's survey (1988) identified the source of CAI programs used. Where CAI was implemented, nearly all of the nursing programs used commercially available software (see Table 12). This usage ranged from one package per school to a maximum of 55 per school. Locally-developed CAI usage was reported by about 40% of the respondents who were implementing CAI. Locally-developed software usage ranged from one to six per school. Locally-developed CAI "tended to coexist with commercial CAI" (Hebda, 1988, p. 25).

Table 12: CAI Package Usage and Sources

Source	Nursing programs using	Range of packages used
Commercial	91.7%	1-55
Local	39.1%	1-6

Note. *Adapted from Hebda (1988).*

Table 13: Commercial Programs Used by More Than 20% of Nursing Schools

Program Name	Users
Computerized Simulations in Clinical Nursing	32.4%
Simulation Calculating & Adjusting IV Flow Rates	25.2%
CAI Nursing Research	23.0%
Simulation Calculating & Preparing Fractional Medication Dosages	23.0%
Calculate with Care	22.3%
Nursing Skills Simulation	22.3%
Psychiatric Nursing Simulation	20.1%

Note. *Adapted from Hebda (1988).*

Table 14: Commercial CAI Program Content Areas Having Ten or More Programs

Content areas	Number of CAI Programs
Pharmacology/Medication Administration	29
Medical	23
Emergency Care	20
Nursing and the Nursing Process	12
Nutrition	10
Pediatric Nursing	10

Note. *Adapted from Hebda (1988).*

Table 13 shows the sources of commercial CAI programs used by more than 20% of the CAI implementing schools.

Content of CAI programs implemented - Hebda (1988) found that only six content areas were represented by ten or more commercial CAI programs being used by respondents to her survey (see Table 14).

Using different content descriptors than Hebda's, the SREB study of 550 nursing programs (Aiken, 1988a) also gathered data on content areas taught by microcomputer. No distinction was made as to whether the software was commercially or locally developed. Table 15 lists the nursing-related content areas taught by microcomputers in more than 20% of the CAI implementing programs.

According to K. J. Mikan (personal communication, September 27, 1988), where computers are available to students, word processing and statistical packages are usually available too.

The SREB study of 550 programs (Aiken, 1988a) found some ways that computers were not being implemented. Nearly 70% of all respondents were not using computers in conjunction with other new technologies, such as interactive videodiscs, to enhance learning. And, nearly 55% did not apply the computer to "other" administrative uses, such as online information, database searches, electronic mail, electronic bulletin boards, etc.

Table 15: Content Areas Taught by Microcomputer in More Than 20% of Nursing Programs

Content	Nursing Programs
Calculations (drugs/solutions)	61.7%
Clinical case studies	55.0%
Adult nursing	53.4%
Clinical decision-making	50.4%
Nursing process	46.2%
Basic mathematics	44.1%
Pediatric nursing	39.4%
Maternal nursing	37.8%
Mental health nursing	34.4%
Clinical topics	31.7%
Computer literacy	27.7%
Pharmacology	24.6%
Literature searches	22.5%
Nutrition	21.2%

Note. Adapted from Aiken (1988a)

Computer Bulletin Boards for Nursing Education

Some schools have expanded their implementation of computers into other, more unconventional, educational areas. An SREB newsletter (1988) describes bulletin board systems at three schools, ones within the SREB region known to be capable of routing mail out of their local areas. These are at the University of Southwestern Louisiana College of Nursing, the University of Texas at Austin School of Nursing, and at the University of Texas School of Nursing at Galveston. The Southwestern Louisiana system, established in 1986 as a means of sharing information within the nursing profession, also makes nursing education programs available for downloading. The bulletin board at Austin intends to be international and, in addition to facilitating communication, seems to emphasize announcements of continuing education events, research symposia, and other conferences. The Galveston system, in addition to offering mail, announcements, and other administrative communications, is used to implement long distance education for nursing students.

Constraints

Many factors have been cited as constraints or barriers potentially limiting implementation of CBE in any of its current formats. The same factors that impede the implementation of CAI also constrain the implementation of interactive videodiscs However, the newness, greater complexity, and additional resource requirements for implementing videodiscs increase the magnitude of these constraints.

Costs as Constraints - Experts mentioned four types of costs as constraints: the cost of hardware, the cost of software, the cost of developing software, and the cost of maintaining the hardware. These various costs may operate individually or in combination to deter implementation of CAI or interactive videodiscs.

The cost of acquiring hardware, especially for large student bodies (Thomas, 1986), is the major or most important barrier to the implementation of CAI (Murphy, 1984, 1986; Thomas, 1986) and to the implementation of interactive videodiscs (E. Aiken, personal communication, October 7, 1988; K. J. Mikan, personal communication, September 27, 1988). However, M. A. Rizzolo (personal communication, January 30, 1989), referring to both CAI and interactive videodisc technology, believes that "cost of hardware is not as much a barrier as the problem of faculty's lack of knowledge about how to use the hardware and software and integrate it into the curriculum. Often institutions are willing to come up with the money for a computer lab, complete with hardware, but are unwilling to hire someone to staff it, or give faculty time to learn to use it."

According to Murphy (1986), "While costs of obtaining and maintaining equipment (referring to computer-only configurations) cannot be ignored - especially during this time of finite resources for nursing education - the cost factor apparently does not have sufficient weight to restrain the use of computers. If cost was [sic] major restraint, one would not expect schools to begin to use or to expand their use of computers in the future. On the basis of available results, nursing educators did project just that" (p. 113).

Likewise, the AJN interactive videodisc survey (1989) found a substantial number of respondents whose institutions planned to purchase hardware to implement interactive videodiscs . Seven respondents indicated that these purchases would be in the next year; 195 indicated that these purchases would be in the future.

Another major cost constraint, the second most important barrier according to the Thomas (1986) survey, is the cost of the computer software to be implemented. The degree to which the cost of CBE software poses a barrier is proportional to the number of students being served. The more students who are to receive individualized CBE instruction, the more software copies required for implementation. Considering that interactive videodiscs tend to be more expensive than CAI programs, their cost would seem to pose even more of a constraint to implementation.

The cost of developing software was perceived as a major constraint to CBE implementation. Apparently the low quality and quantity of available software makes local development desirable or necessary, especially in the CAI format, to meet curricular needs or to use the equipment available. This kind of cost was seen as a major constraint limiting the implementation of CAI (Murphy, 1984, 1986) and the implementation of interactive videodiscs (E. Aiken, personal communication, October 7, 1988; K. J. Mikan, personal communication, September 27, 1988).

Murphy (1984, 1986) found the cost of maintaining computer equipment to be a major limitation to implementing CAI. For videodisc implementation, because the computer is only one of several items of equipment involved, it is anticipated that the cost of maintenance may be even more of a barrier than it is to implementing computer-only CBE.

Faculty Characteristics as Constraints - Another barrier Thomas (1986) identified was "computing in nursing too new" (p. 226). If "computing" was too new to nurses in 1986, it is not hard to imagine that the interactive videodisc is "too new" to nurses in 1989. In fact, the videodisc format of CBE may be so new that nursing faculty may not yet have seen any videodisc, no less a well-designed one (K. J. Mikan, personal communication, September 27, 1988).

In personal communication E. Aiken (October 7, 1988), K. J. Mikan (September 27, 1988), and M. A. Rizzolo (January 30, 1989) cited formidable barriers in other faculty-related aspects of implementation, especially the lack of faculty capability to appropriately integrate CBE in the curriculum. In fact, M. A. Rizzolo (personal communication, January 30, 1989) believes that the faculty's lack of knowledge about CBE is more of a barrier to implementation than is the cost of hardware. In addition, according to personal communication with E. Aiken (October 7, 1988), K. J. Mikan (September 27, 1988), and M. A. Rizzolo (January 30, 1989), lack of faculty acceptance of the technology itself is a limitation.

Other faculty-related constraints to implementation include a lack of peer support of those who become involved in videodisc technology (E. Aiken, personal communication, October 7, 1988; K. J. Mikan, personal communication, September 27, 1988) and a lack of advocates for CBE (K. J. Mikan, personal communication, September 27, 1988).

Curriculum Factors as Constraints - According to K. J. Mikan (personal communication, September 27, 1988), additional hindrances to implementation of CBE include the lack of assessment of the curriculum for the content and instruction most suited to CBE. She further speculated that "real" integration of CBE in nursing may require curricula that are very different from those presently in place.

Insufficient Technical Support as a Constraint - One of the barriers to growth of instructional computing deemed important by Thomas' (1986) respondents was lack of technical assistance for faculty. K. J. Mikan (personal communication, September 27, 1988) says that lack of technical support is even more of a barrier to implementing videodisc learning than it is to computer-only delivered instruction. Adequate specialized technical support would seem to be essential to the success of any CBE implementation effort.

Low Quality and Quantity of Available Software as Constraints - Surveys by Murphy (1986), Thomas (1986), and Walker (1986) revealed that the low quality and quantity of available software limited implementation of CAI. Obviously, since there are currently few interactive videodiscs available, implementation of that format is also hampered.

Lack of Information About Software as a Constraint - Thomas' (1986) survey found "Lack of information about software" (p. 226) to be an important barrier to growth of instructional computing. Since there is no central "clearing house" of information about available videodiscs, even less is known about their availability than is known about CAI software.

Lack of Standardization as a Constraint - Another barrier to implementation of CBE in nursing education has been the lack of hardware standards. This barrier has been overcome to some extent in computer-only implementation in that, from an initially large number of microcomputer formats, there have emerged two major formats, IBM/IBM compatible and the Apple II family. The standardization of software has followed, ensuring compatibility with one or both these major formats.

The recently introduced Macintosh microcomputer, with its relatively easy-to-use software, may emerge as another major format. The impact of this and other new developments on CBE in nursing, such as the authoring software, Hypercard, is yet to be determined.

Since standardization has not occurred in interactive videodisc technology, it poses a significant barrier to implementation. Weiner et al. (1988) say the lack of standards makes marketing any videodisc difficult. Their team developed a videodisc for "a Pioneer 6000 videodisc player interfaced via RS232 port to an IBM personal computer" (p. 108). Although this is not an exotic equipment configuration, they report, "There have been positive responses after demonstrations of our program, but most schools of nursing do not have the set of hardware needed to run our program" (p. 112).

In summary, the use of computers for learning purposes in nursing education seems to be progressively increasing. The videodisc has only recently been introduced. Implementation of interactive videodiscs is expected to increase. Constraints to the implementation of both CAI and videodiscs are: costs, faculty characteristics, curriculum factors, insufficient technical support, low quality and quantity of available software, lack of information about software, and lack of standardization.

Harnessing the instructional power of both the computer and video, particularly if motion video is required for learning, makes the videodisc, conceptually, the most useful individualized learning technology yet available. It would seem that the pattern of implementation of this technology would follow roughly the same pattern that the computer has in nursing education. In fact, the computer(s) already implemented by a school should facilitate progression to a videodisc configuration both philosophically and physically. The "proper place" of this technology — in educating nursing students (undergraduate, graduate, or continuing education), in the nursing curriculum, and among the instructional alternatives available — is a fundamental question that nursing faculty and educational program administrators must answer.

Evaluation of Computer-Based Education

Computer-based education (CBE) may be evaluated on several dimensions depending on the evaluation's purpose. CBE may be evaluated to make decisions about software development or implementation, or to determine its effect on students, regarding objective factors, such as student learning or achievement; subjective values, such as the ability of the software to maintain student interest; and technical aspects, such as ease of student use. CBE may be evaluated directly, by assessing accomplishment of its objectives with target audience students, or indirectly, by using information provided about a CBE item. Further, CBE may be evaluated on a total instructional system-wide level or on an individual unit level.

Evaluation on a System-wide Level - Hannah and Osis (1988) state that there are three models for analyzing costs and benefits of educational computing on a system-wide level: cost-benefit analysis, cost-utility analysis, cost-effectiveness analysis. They suggest that a cost-effectiveness analysis include hardware and software longevity, usage data, and effectiveness in achieving instructional objectives. In addition, this analysis should address content, learning strategies, format, ergonomics, style and documentation.

The only report found which included system-wide evaluation was the Southern Regional Education Board (SREB) study of 550 nursing programs (Aiken, 1988a). While usage of a specific model for analysis is not reported, this survey did find that 44% of the nursing programs were conducting evaluation of the benefits "(time, productivity, learning, better use of resources)" (p. 15) of computerized instruction.

Instruments to Evaluate Individual CBE Items - There are at le[a]st two instruments which can be used to evaluate individual software items for use in nursing education. The instrument which forms the basis of the ratings of software in the *19XX Directory of Educational Software for Nursing* is included in the directory . The other instrument, developed as a SREB seminar activity by Speranza et al., is available through SREB. Although the reliability and validity of neither instrument is given, both have face validity.

Bolwell's Rating Form Used to Evaluate Computer-Assisted Instruction Software (1988, p. 6) can be used to describe an item and rate it on ease-of-use factors, incorporation of microcomputer attributes, interest maintenance, and overall (global subjective) rating on a scale of 1 (low) to 4 (high). Each factor has a place for rater comments. There is a prompt which asks the rater to specify in what ways the program could be used.

The Speranza et al. Computer Software Evaluation instrument (Speranza & Aiken, 1989; Aiken, 1988b, pp. 9-10) can be used to record operating characteristics and reviewer comments. This instrument, using "Yes", "No", and "Not Applicable" as response options, has the evaluator examine specific facets of content, learning process support, user appeal, technical features, and purchase considerations.

Evaluation on an Individual Item Level - Only limited information about the evaluation of CBE on an individual item level was found. The SREB study of 550 nursing education programs (Aiken, 1988a) found that only 34% were evaluating the cost-effectiveness of already-produced computerized instruction. It is not known if, or how, the majority of faculty locate and use the information that is available for assessing CBE directly or indirectly.

Other Sources of Information for Evaluation - Certainly a source of evaluation data should be the source of the CBE itself. According to Thomas (1986) "If a program is available for purchase, the potential buyer has a right to ask for evidence of its effectiveness" (p. 227). Currently these data are either not available or CBE buyers are not insisting on them prior to purchase.

The most current and comprehensive source of information about software for nursing education seems to be the directory published annually by the NLN, compiled by Bolwell, titled the *19XX Directory of Educational Software for Nursing*. Its more than 300 entries, in the 1988 edition, provide information about computer programs which can be used as an initial screen or evaluation by the potential user/purchaser. The directory includes descriptions of programs, audience, and purpose; specification of style of instruction (tutorial, simulation, etc.); and, as implied above, ratings of quality, interest, ease of use, and use of microcomputer attributes. The 1989 edition will also include videodisc entries (Bolwell, 1988).

Many nursing journals and newsletters contain software reviews which could be used as indicators, or indirect assessments, of materials. Certainly networking with counterparts, face-to-face or via bulletin boards, etc., could provide useful evaluative information.

Another potential source of indirect evaluation data is AVLINE®, one of the many databases of the National Library of Medicine's (NLM) MEDLARS® system. AVLINE search citations that have a "CONT. ED. CREDIT NOTE Approved for continuing nursing education credit by...." statement, indicate that the material has been assessed and passed standards of the reviewing/approving body. Obviously, this statement indicates the applicability of the software to continuing nursing education, but it does not necessarily indicate anything about its applicability to other audiences.

Constraints

There are many potential constraints to evaluation. Some of these may be unique to specific settings. Many constraints are common to most settings. Cost seems to be a universal constraint. Also hampering both implementation and evaluation of CBE are lack of information about software items and from findings of research studies. In addition, there may be faculty-related impediments to evaluation.

Cost of Evaluation as a Constraint - Accumulating evaluation data can be an expensive undertaking. For system-wide evaluation of CBE, it can be very expensive.

Evaluation would likely be less costly for individual software items than for system-wide evaluation. Many CBE developers do conduct formative evaluations; few conduct summative assessments. The practice of conducting both formative (alpha testing) and summative evaluations (beta testing) is becoming more common in the interactive videodisc format of CBE than it has been for CAI.

Lack of Information as a Constraint - Thomas (1986) found that "Lack of information about software" (p. 226) was rated fourteenth in importance in a listing of barriers to instructional computing. In light of this finding, it is interesting to note that 30.4% of Hebda's (1988) respondents cited "Lack of Suitable Commercial Programs" (p. 27) as a reason for nonuse of CAI. One wonders how respondents decided suitable commercial programs were lacking if there is, in fact, a lack of information. Perhaps, more specifically, it is lack of evaluative information or lack of comprehensive information about software that is a barrier.

Lack of Research Results as a Constraint - Only 6.3 of Hebda's (1988) respondents cited "Unsuitability of CAI as an Educational Tool" (p. 27) as a reason for nonuse of CAI. However, Rizzolo's (1988) survey about interactive videodiscs, found agreement among her respondents that "Lack of research proving educational value and cost effectiveness" was a factor impeding videodisc development.

Faculty-related Constraints - According to K. J. Mikan (personal communication, September 27, 1988), there is no systematic process being used by most faculty to select either software or hardware. Therefore, according to D. Larson (personal communication, September 29, 1988), educating faculty and nursing program administrators in how to make choices about acquiring software is a major problem in faculty development.

Lack of capability to evaluate software is further compromised by the absence of a systematic method for integrating CBE into the curriculum. Therefore, evaluating the benefits of CBE by comparison against established standards is nearly impossible.

In summary, while it seems that some evaluation of CBE in nursing is taking place, little else is known about the process. Instruments to use in evaluating CBE have been developed. There are limited data available about the performance of individual software items. However, these data are becoming more available, especially for interactive videodisc performance. Common constraints to evaluation include cost, lack of information, and faculty characteristics.

Software

Although commercially available software is thought to be of less than the highest quality, Hebda (1988) found that more than 90% of the nursing programs implementing computer-assisted instruction (CAI) in 1986 used it. This use ranged from one package per school to a maximum of 55 per school. Findings of the Southern Regional Education Board (SREB) study of 550 nursing programs (Aiken, 1988a) suggest that about 60% of them are purchasing or leasing educational software, most likely from commercial vendors or consortia.

Many faculty are not trained to develop their own quality software; still, the SREB survey of 550 nursing programs (Aiken, 1988a) found about 40% of them developing CAI for local consumption.

Sources of Information about Software - There seem now to be many available sources of information about software. The most extensive source is probably Bolwell's *19XX Directory of Educational Software for Nursing*, published annually by the NLN.

The *1988 Directory of Educational Software for Nursing* (Bolwell, 1988) describes more than 340 items for microcomputers, representing about 85% of the microcomputer software for nursing education available for purchase in July 1987. The items include CAI, tests, authoring systems, etc. Individual entries about each item include: title, author or developer, address, hardware, type (instructional model), number of disks, date of publication, intended users, suggested uses, Continuing Education Units, price, preview policy, warranty, citation of published software reviews, support after purchase (telephone number), description, and educators' comments.

Each CAI item in the directory was rated by educators and administrators from schools of nursing, hospitals, and community health agencies on ease of use, interest, micro attributes, and overall impression. The "ease of use" rating was based on the reviewers' judgement of how easy the item was to start, the degree of user control of pace and sequence, and how easy on-screen instructions were to follow. "Interest level" was based on the reviewers' judgement about the item's ability to interest the learner and was composed of assessments of whether it would hold the viewer's attention and be motivating. Other interest level assessments "were based on three strategies that CAI program authors can use to attract and hold the student's attention and stimulate motivation to learn: personalizing the program, individualizing the program by the use of branching, and individualizing the program by the use of individualized feedback" (p. 8). The "micro attributes" rating was based on the reviewer's judgement of the item's use of the following attributes: interactivity, immediate feedback, use of graphics or animation, and use of the calculation capabilities of the computer. "The overall rating represents the reviewer's subjective judgement about the program as a whole" (p. 8). A mean rating was calculated from the ease of use, interest, micro attributes, and overall ratings.

AVLINE, the database listing audiovisual materials of the MEDLARS family of databases produced by the National Library of Medicine, is also a potential source of information about software. This constantly expanding database has recently started to list "computer files" and "videodiscs" along with other audiovisual materials for audiences of nursing and other health sciences.

Information about and demonstrations of software are also available at conventions of many nursing organizations. Professional journal advertisements, announcements of new releases sent to individual nurses, and discussions with professional counterparts are also sources of information. Consortia such as the Fuld Institute for Technology in Nursing Education (FITNE) and the Health Sciences Consortium, based in Chapel Hill, NC, also share information about software.

Commercially Available Instructional Software

Number and Content of Items - The *1988 Directory of Educational Software for Nursing* (Bolwell, 1988) lists 169 items of CAI software. Of these, 45 are for use only on the Apple II family format microcomputers; 31 are for use only on IBM format microcomputers; and 93 are for use on either the Apple II family or IBM microcomputers. Software developed for use on Macintosh microcomputers is too new to have been included in the *1988 Directory*. . . .

As shown in Table 16, more CAI items have been developed for nursing practice than for any other content area. The vast majority of nursing practice items were for use on either the Apple II family or IBM format microcomputers. Nursing theory and research had the least number of CAI items.

Table 16: Major Nursing Content Areas of CAI By Major Kind of Hardware

Content	Apple only	IBM only	Apple/IBM	Total
Basic science	13	9	11	33
Basic skills	19	12	23	54
Nursing practice	9	9	51	69
Nursing theory & research	4	1	8	13

Grand total of CAI items summarized = 169

Note. Apple hardware refers to the Apple II family of microcomputers. These data are summarized from 1988 Directory of Educational Software for Nursing by C. Bolwell, 1988, New York: National League for Nursing.

Table 17: Mean Rating of CAI for Major Kinds of Microcomputer Hardware

	Mean rating					
Hardware	Not rated	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9
Apple only	1	3	7	11	23	1
IBM only	6	1	4	4	9	7
Apple/IBM[a]	5	3	11	37	30	5
Total	12	7	22	52	62	13

Grand total of CAI items summarized = 168

Note. Apple hardware refers to the Apple II family of microcomputers. These data are summarized from 1988 Directory of Educational Software for Nursing by C. Bolwell, 1988, New York. National League for Nursing. Possible mean ratings ranged from 1 (low) to 4 (high); however, no item was rated 4.0.

[a]One software item which could be used on either kind of hardware received a different mean rating for Apple II family (2.8) than for IBM (2.1). This item is not included in the table.

As shown in Table 16, with the exception of basic science, more items were for use on either Apple II family or IBM than were for use on one format exclusively. In basic science, more items were for use only on the Apple II family format than were for use on IBM exclusively or for either of the two formats.

Mean Ratings of Items – Table 17 shows the mean ratings of software for CAI in the 1988 Directory of Educational Software for Nursing (Bolwell, 1988). *The mean ratings were calculated from the means of ratings of ease of use, interest, employment of microcomputer attributes, and overall impression.*

Although many find that software items could be improved, there were no items rated in the lowest possible range. However, not one item received the highest possible rating, 4.0. The highest rating range included about twice as many software items as the lowest ratings assigned received. More items for use on IBM exclusively or for use on the Apple II family or IBM microcomputers received high ratings than did those for use exclusively on Apple II family microcomputers. The vast majority of items were rated in middle ranges, consistent with expert opinion that many items could be improved.

Year of Publication of Items – Table 18 shows the year of publication, through July 1987, of CAI items listed in the 1988 Directory of Educational Software for Nursing (Bolwell, 1988). Not many items were published before 1983. The peak year was 1985, during which almost twice as many items were published as in the preceding year. However, if the publishing trend in the first half of 1987 continued, that will have been the peak year. While Apple II family-only items were more common than IBM-only or Apple II family or IBM in the early years, in the first half of 1987 there was a definite shift to publication of items for the IBM-only or for Apple II family or IBM. In fact, only one item was published exclusively for the Apple II family format during the first half of 1987. However, the recent introduction of the Macintosh microcomputer and software for instructional development may influence development of CBE in nursing in the near future.

Table 18: Year of Software Publication By Major Kind of Hardware

Hardware	No year	Pre-1983	1983	1984	1985	1986	1987[a]
Apple only		4	8	15	10	7	1
IBM only	2			2	8	7	12
Apple/IBM[b]		2	5	11	32	24	17
Total	2	6	13	28	50	38	30

Grand total of instructional software items summarized=167

Note. *Apple hardware refers to the Apple II family of microcomputers. These data are summarized from 1988 Directory of Educational Software for Nursing by C Bolwell, 1988, New York: National League for Nursing.*

[a]To July, 1987.

[b]Two software items which could be used on either kind of hardware were published in different years for Apple II (1985 and 1987) than for IBM (1986 and 1986, respectively). These items are not included in the table.

Constraints

There probably are many constraints to the selection and acquisition of published CBE items. Some may apply to specific CBE items or to certain settings. Others may be common to many items or settings. Some common constraints include cost, lack of useful software, lack of faculty's ability to develop CBE, and lack of information.

Cost as a Constraint – The cost of quality software is a significant factor limiting the implementation of CBE in nursing education. Cost has been a constraint when computer-only software was considered. Thomas' (1986) survey respondents ranked cost of software as the second most important barrier, of eighteen, to instructional computing. Walker (1986) also cited paucity and high cost of useful software as constraints to computer implementation in schools of nursing.

The cost of well-designed videodiscs will probably be even more prohibitive than the cost of computer software has been. Rizzolo (1988), not surprisingly, found the cost of developing videodiscs to be a factor impeding the development of new videodiscs. It seems reasonable to expect that those producing and selling videodiscs will attempt to recover, at a minimum, the costs of developing videodiscs in their pricing and sales policies. FITNE, as a technical resource to its member institutions, plans to offer assistance in negotiating discounts on software purchases (Fuld, 1988).

Lack of Useful Software as a Constraint – Murphy (1986) and Walker (1986) cited lack of useful or appropriate software as constraints to implementation of CBE. Thomas (1986) found "Lack of useful software" (p. 226) rated as ninth, of eighteen, in importance as a barrier to instructional computing.

Lack of Capability of Faculty to Develop CBE as a Constraint – While many find commercially-available software to be of inadequate quality, a further problem is the lack of capability of most faculty and schools to develop their own quality software. This was cited as a constraint in personal communications with E. Aiken (October 7, 1988), C. Bolwell (October 13, 1988), K. J. Mikan (September 27, 1988), and M. A. Rizzolo (October 11, 1988) and also by Hebda (1988). Apparently lack of development capability is an impediment to implementing CBE in any format, regardless of the size or quality of the pool of published software.

Lack of Information About Available Software as a Constraint – Insufficient information about available software has also been a constraint. Thomas' (1986) survey respondents rated "Lack of information about software" (p. 226) as fourteenth in importance as a barrier to instructional computing. Perhaps lack of information was a greater problem in the mid-1980's than more recently.

It may well be that current information about software, although available from many sources, is insufficient for faculty needs. While no studies identify needs for specific software documentation, most software descriptions do not include data on performance, achievement, or learning outcomes. These data would be particularly helpful in considering acquisitions of software. Until these data are available, faculty considering acquisitions will need to rely on other indicators of software instructional quality. And, unless faculty demand such data from producers, they will always have to rely on indirect indicators of instructional quality.

In summary, there are several sources of information about published software items. The pool of available software is spread across nursing content areas and tends to be rated as less than the highest quality. Current trends suggest that more CBE, either as microcomputer items or interactive videodiscs, will be developed for use on IBM-only format than for the Apple II family-only format. However, the recently introduced Macintosh with its easy-to-use software, such as Hypercard, may soon emerge as another major format. Although four powerful constraints were mentioned, they are probably only sufficient to hamper, but not halt, acquisition of published software.

Hardware and Facilities

According to M. S. Hill (personal communication, July 19, 1988), every school of nursing has computers. These are distributed among three general sizes: mainframes, minis, and micros. They may be used by administrative and other staff, faculty, and students and for various purposes, including the delivery of computer-based education (CBE). Their location may be decentralized, within the school of nursing, or centralized, in a university-wide computer facility.

In 1986, Thomas (1986) found that nursing faculty, staff and students used computers primarily for word processing and statistical purposes (see Table 19). Only 14% of the nursing programs used computers to deliver instruction. The only usage not surpassing computer-assisted instruction (CAI) or computer-managed instruction (CMI) was patient data retrieval.

As shown in Table 20, Thomas (1986), found that most nursing faculty used mainframe computers and microcomputers. Graduate nursing students used primarily mainframe computers, followed by microcomputers. Undergraduate nursing students made most use of microcomputers, followed by use of mainframe computers. While no faculty reported using minicomputers, graduate and undergraduate students used them. However, the mini was the size computer least used. According to Thomas (1986), "These results probably reflect faculty and graduate student's use of mainframes and minicomputers for analyzing data and faculty and undergraduate students' use of microcomputers for instructional applications" (p. 224).

Table 19: Uses of Computers by Schools of Nursing in 1986

Use	Percent
Word processing	30%
Statistical packages	27%
Information retrieval	19%
CAI or CMI	14%
Patient data retrieval	10%

Note. *Adapted from Thomas (1986).*

Table 20: Size of Computer by Kind of User in 1986

	Computer Size		
User	Mainframe	Mini	Micro
Faculty	63%		62%
Grad. Student	39%	10%	22%
Undergrad. Student	20%	7%	31%

Note. *Adapted from Thomas (1986).*

More recently, the Southern Regional Education Board (SREB) study of 550 nursing programs (Aiken, 1988a) found that most used microcomputers, although many used terminals of mainframe computers (see Table 21). However, for instructional use, microcomputers were used by the majority of the programs, while mainframes were used by relatively few. No usage of minicomputers was reported.

There have been four surveys that included microcomputer brand use. Data gathered in three of these studies are shown in Table 22. In 1986, Thomas (1986) found that most survey respondents used Apple II family microcomputers, while a substantial number used IBM-type. The 36 users of "other" brands of microcomputer were all using Radio Shack TRS-80s.

Only two years later, the data indicated a trend toward increased use of IBM and compatible microcomputers. In 1988, the SREB study (Aiken, 1988a) found that both Apple II family and IBM microcomputers were being used by the greatest percentage of the nursing programs. However, exclusive use of IBM PCs accounted for the next greatest percent, while Apple II family microcomputers were being used exclusively by the smallest percent of programs.

More recently, the American Journal of Nursing (AJN) Company (1989) found that about twice as many respondents used IBM and compatible microcomputers as used Apple II family or other brand hardware to deliver CAI. And most recently, Bolwell (1989a, December/January) found that IBM and compatible microcomputers were used by many more schools and hospitals than used Apple II family microcomputers.

Table 21: Size of Computer and Kind of Use in 1988

	Computer Size		
Use	Mainframe	Mini	Micro
Instructional	9.7%		65%
All Other	20.1%		66.8%

Note. Adapted from Aiken (1988a).

Table 22: Brands of Microcomputers Used in Schools of Nursing by Selected Years

	Brand			
Year	Apple only	IBM only	Apple & IBM	Other
1986[a]	148 (40.5%)	85 (23.3%)		36 (9.9%)
1988[b]	44 (22%)	47 (28.2%)	69 (34.9%)	
1989[c]	300	607		44

Note. Apple refers to the Apple II family of microcomputers. The 1989 data describe microcomputer brand use specifically for CAI.

[a]Source Thomas, 1986

[b]Source Aiken, 1988a

[c]Source AJN, 1989

It is probable that recent activities of Fuld Institute for Technology in Nursing Education (FITNE) may not be reflected in these surveys. Because these may have a great impact on CBE in schools of nursing, it should be noted that since February, 1988, FITNE has assisted nursing schools in purchasing nearly 50 computer systems (FITNE, 1989, Winter). Because FITNE encourages purchase of IBM or IBM-compatible hardware, it is assumed that the computer systems are of this kind.

In addition, the Macintosh microcomputer was introduced too recently to be considered in the surveys described in this report.

Videodisc Hardware – Only one study reported any usage of videodisc hardware. The SREB study (Aiken, 1988a) found that 68.7% of the 550 nursing programs *did not* use computers with videodisc or other new technologies to enhance learning. This implies, then, that 31.3% of the programs *did* use computers in combination with other technologies.

Since February 1988, FITNE has assisted nursing schools in purchasing nearly 50 interactive video systems (FITNE, 1989, Winter). Because FITNE encourages purchase of IBM or IBM-compatible equipment, these systems are assumed to be of that type. In fact, these schools may have purchased the package FITNE has assembled. The FITNE package consists of a computer, graphics/overlay, monitor, touchscreen, and laser videodisc player. The package is IBM-compatible and, if assembled after March 1989, probably emulates the IBM InfoWindow (FITNE, 1989, Winter).

Plans for Microcomputer Acquisition – The SREB study of 550 nursing programs found that, "Collectively, programs without available microcomputers for instruction in nursing planned to purchase 226 microcomputers; those with microcomputers expected to expand the number available for nursing instruction with 768 additional computers" (Aiken, 1988a, p. 8).

The pool of compatible software available for different kinds of microcomputers may influence the kind of hardware purchased. If this is so, considering raw data for the numbers of published CAI items only, the Apple II family format would be the kind of microcomputer purchased. According to the *1988 Directory of Educational Software for Nursing* (Bolwell, 1988), of the 169 items of CAI software, 45 are for use on Apple II family format exclusively, 31 are for use on IBM format only, and 93 are for use on either Apple II family or IBM formats.

When the year of publication of the items is taken into account (see Table 18), the predominant software format is not as clear. In early years, more items were published for the Apple II family format than for the IBM format. Starting in 1985, the vast majority of items were published for use on either the Apple II family or IBM formats. In 1985 and 1986, nearly equal numbers of items were published for Apple II family-only and for IBM-only. In the first half of 1987, many more items were published for IBM-only than for Apple II family-only. However, the introduction of the Macintosh computer, too recent to have been included in the *1988 Directory*. . . ., may soon influence these trends.

Institutions or nursing programs planning to implement interactive videodiscs may also be influenced in their selection of microcomputers by compatibilities of hardware and pools of software available for both microcomputer and videodisc formats of CBE.

Plans for Interactive Videodisc Acquisition – The AJN Company (1989) found 124 respondents' institutions planning to buy interactive videodisc hardware. Seven respondents indicated purchase in the next year, while 195 indicated plans to buy this hardware at some time in the future.

Available evidence suggests that schools of nursing will tend to buy IBM or IBM-compatible hardware. AJN Company (1989) survey respondents indicated that if they were to buy interactive videodisc hardware now, 148 would buy IBM InfoWindow hardware, 167 would purchase "other" hardware. FITNE's Interactive Video Demonstration Center Project is expected to result in "77 interactive video systems being distributed to 46 schools" (FITNE, 1989, Winter, p.1). These are expected to be either IBM InfoWindow hardware or compatible.

Further supporting the tendency for schools of nursing to buy IBM-type hardware is the pool of compatible videodisc software available. The two major emerging consortia developing videodiscs, the Healthcare Interactive Video Consortium (HIVC) and FITNE, will produce software for IBM and IBM-compatible microcomputers. The AJN Company is currently developing a series of videodiscs requiring IBM InfoWindow capability. Both the HIVC and FITNE videodiscs will be for Pioneer players, while the AJN Company videodisc can use either Pioneer or Sony players.

Facilities for CBE - Some schools place CBE hardware in learning centers for nursing, while others make use of large university computer centers. At large schools that own considerable hardware, faculty have computers or terminals in their offices, in addition to those used by administrative staff and students, which are located elsewhere. In some schools, computers have been set aside specifically for student use in preparing their own materials and course assignments. These terminals or microcomputers tend to be loaded with word-processing and/or statistical packages that students use to prepare their papers and research reports.

As shown in Table 23, Thomas (1986) found that most respondents used microcomputers at other departments of health centers. The other sites of microcomputer usage were, in descending order: at their institutions' computer center; in faculty offices; and at libraries. The smallest percentage had microcomputer usage under unspecified arrangements.

There is no consensus, or even identification, in the literature of model or outstanding examples of arrangements for computer usage. However, according to E. Aiken (personal communication, October 7, 1988), there are two schools that could serve as demonstration centers for placement and utilization of CBE hardware. The University of California at San Francisco could be a model for the implementation of a computer center within a school of nursing, while the University of Tennessee at Memphis could serve as an outstanding example of nursing use of a university-wide computer science laboratory.

Some students have computers too. While no school requires nursing students to have their own microcomputers, apparently growing numbers of students do have them, either in their dormitories or homes. These students routinely ask to borrow software, as one would a library book, forcing schools to develop policies regarding such practices (K. J. Mikan, personal communication, September 27, 1988).

The actual situation in the schools of nursing is not as favorable for educational applications of computers as the above might suggest. As recently as 1988, Hebda (1988) found 55.4% of her respondents citing lack of computer facilities as a reason for nonuse of CAI.

Most of the computers in nursing schools are used for administrative purposes only. Some schools do not have any student use of computers. Computers dedicated to word processing and administrative functions or those in faculty offices are often not available to students even after "office hours". Students express an interest in this type of learning but are hindered by lack of hardware and lack of access time. Where there is educational computer use, most schools have extremely limited hardware configurations. Most students, therefore, must use CBE in groups. Thus, a primary advantage of CBE, "individualized" teaching/learning, is not possible in most situations. Unfortunately, this situation prevails nearly as widely for computer-only use as it does for applications that use a computer with a videodisc player and monitor.

Table 23: Location of Microcomputers Used by Schools of Nursing

Site	Percent
Other department of health center	35%
Institution's computer center	30%
Faculty offices	13%
Library	12%
Unspecified	8%

Note. Adapted from Thomas, 1986.

Maintenance of Hardware - While a few schools use technicians to keep the various CBE systems operating and maintained, the vast majority are unable to afford such a person (K. J. Mikan, personal communication, September 27, 1988). Schools that are unable to support technical services tend to be the same schools having little equipment redundancy. Thus, these schools and their students are greatly disadvantaged when the systems fail.

FITNE (FITNE, 1989, Winter) offers technical resources to member institutions: a telephone support service, providing immediate assistance; an electronic bulletin board, FITNET; and on-site consultations, which may provide some relief of technical problems at some schools of nursing.

Constraints

There are a number of factors and issues which constrain the growth of CBE use in nursing schools. Some of these are unique to specific schools and some are common to most or all schools. Most constraints apply to both computer and videodisc based CBE. However, because of the greater expense, complexity, and newness of the videodisc, forces inhibiting its growth in schools of nursing may be more intense and difficult to overcome.

Cost of Hardware as a Constraint - Cost of hardware is an important barrier to the proliferation of CBE in nursing. Surveys by Murphy (1986) and Walker (1986) found the cost of computer hardware to be constraining. According to Thomas'(1986) survey respondents, "Cost of [computer] hardware excessive for instructional applications with large student bodies" (p. 226) was the most important of eighteen barriers to the growth of instructional computing. Yet, according to Murphy (1986), the cost factor was not sufficient to hamper plans for expansion of the use of computers in the future.

Because of the greater expense involved with interactive videodisc hardware, this format of CBE may be even more inaccessible to schools of nursing than computers have been. Hebda (1988) and Rizzolo (1988) found agreement of respondents that the cost of equipment was a factor impeding the development of videodiscs. In personal communications, D. Larson (September 29, 1988), and K. J. Mikan (September 27, 1988), also mentioned videodisc hardware cost as a major barrier. However, while recognizing that cost is a limiting factor, M. A. Rizzolo (personal communication, October 11, 1988) believes that "faculty's lack of knowledge about how to use the hardware and software and integrate it into the curriculum" is more of a barrier to CBE in all formats than is the cost of hardware.

Lack of Standardization as a Constraint - There are two types of standardization which can constrain growth of both computer and videodisc based CBE, hardware/software standardization or compatibility and standardization of hardware components. Currently two major microcomputer formats have evolved: the Apple II family format and the IBM and IBM compatible format. Similarly, software development has provided useful pools in each format. The recently introduced Macintosh microcomputer shows promise of spawning rapid development of CBE in nursing and of becoming a major microcomputer format.

Videodisc system applications for CBE are more recent, more complicated, and more expensive than are microcomputer applications. Therefore, lack of standardization of videodisc elements is more of a constraint. Rizzolo (1988) found strong agreement with "hardware/software incompatibility" (p. 233) as a factor impeding the development of videodiscs. Weiner et al. (1988) say that, "Because no hardware standard currently exists, marketing any interactive video product is difficult. There have been positive responses after demonstrations of our program, but most schools of nursing do not have the set of hardware needed to run our program" (p. 112). The equipment required to run the Weiner et al. videodisc is: IBM PC or compatible (minimum 256K), color monitor, and Pioneer LDV-6000. This is not a particularly unusual or exotic combination of hardware components.

The incompatibility of hardware components between videodisc configurations looms as an even greater constraint. D. Larson (personal communication, September 29, 1988) said that there are very few schools with any one hardware configuration and this lack of standardization is a major impediment to development and use of videodisc technology. Rizzolo's (1988) survey results provide some indication of who respondents feel should resolve compatibility constraints. Her respondents agreed with the statement "Hardware standards should be set in education and/or nursing by establishing a consortium, or through computer councils of ANA, NLN" (p. 234).

Lack of Software as a Constraint - Lack of software has been named as a constraint for both computer and videodisc based CBE. Since there is so little software currently available for interactive videodisc instruction, this is more of a barrier than when applied to computer-only instruction. Rizzolo's (1988) respondents agreed that, "Lack of software discourages purchase of equipment. Conversely, the lack of hardware discourages software development efforts" (p. 233). Therefore, the availability of a pool of quality software for these systems is apt to promote purchase of the hardware required for play.

Lack of Facilities as a Constraint - Thomas (1986) found "Lack of space; costs in building renovations" (p. 226) rated eighth, of eighteen, in importance as a barrier to instructional computing. Even as recently as 1988, lack of facilities continued to be constraining. More than half of Hebda's (1988) respondents cited lack of computer facilities as a reason for nonuse of CAI.

Even when there are facilities, their location may be inconvenient. Thomas (1986) found that the "Policy of supporting a central computing facility inhibits ready access for nursing faculty and students" (p. 226) was rated sixteenth in importance as a barrier.

Cost of Maintenance of Operating Hardware as a Constraint - Murphy (1986) found the cost of maintaining equipment to be a major restraint to instructional computing. Considering the additional hardware required for interactive videodisc instruction, their maintenance costs must be even more of a constraint.

This chapter has examined nursing school use of computer and interactive videodisc hardware, plans to acquire hardware for CBE formats, facilities for delivery of CBE, and maintenance of hardware. Constraints to the growth of CBE in nursing related to hardware were identified as the cost of hardware, lack of standardization, lack of software, lack of facilities, and cost of maintenance. These constraints, while formidable, do not seem to be sufficient to keep schools of nursing from pursuing a course toward greater use of both computer and videodisc based CBE.

Miscellaneous Resources and Computer-Based Education

The literature clearly documents a need for a variety of resources to support computer-based education (CBE) in nursing. In 1984, Thomas (1986) found that lack of information about software and hardware and lack of technical assistance were barriers to the growth of instructional computing in nursing. Also in 1984, Walker (1986) found the "need for computer experts for consultation" (p. 169) to be a constraint to adoption and use of computers in nursing education. And, in 1986, Hebda (1988) found that lack of knowledge about appropriate computer-assisted instruction (CAI) programs was a reason for nonuse of CAI by 24.8% of her survey respondents.

Since these reports were published, many new developments have contributed to the growth of a variety of resources for CBE in nursing. Consequently, where earlier there were no resources, today there are many, and there probably will be even more in the future.

Because there is no central clearinghouse of information about potential resources, however, the task of finding those that are available is somewhat difficult. This chapter attempts only to provide a general overview of some of the resources available for consultation, for sharing interests and networking, for rewarding and promoting CBE efforts, and for learning about CBE.

Expert Consultation About CBE – More people are becoming qualified as computer experts and identifying and gaining access to them seems to be easier now than it was earlier. Such experts are available through a variety of sources. Since 1986, national nursing organizations have prepared lists of computer experts. The American Nurses' Association (ANA) compiles a "Computer Nurse Directory" organized alphabetically by name, state, and functional area. The National League for Nursing (NLN) operates a Computer Consultation Bureau.

For both interactive videodisc and computer formats of CBE, the Healthcare Interactive Video Consortium (HIVC) Project and the Fuld Institute for Technology in Nursing Education (FITNE) offer computer expertise and technical support to their members. FITNE offers several approaches to serving as a technical resource to member institutions: as a clearinghouse for current information and reviews of software and hardware, as a telephone support service, via a quarterly newsletter, and through an electronic bulletin board (Fuld, 1988).

National Nursing Organizations and CBE - Major national nursing organizations have formalized internal interest groups focused on computers. The ANA has its Council on Computer Applications in Nursing and the NLN has its National Forum for Computer Professionals in Health Care. Purposes of these special interest groups are to share expertise, to share solutions to problems, and to develop common interest networkings. Rizzolo (1988) found that respondents agreed with networking as an approach to overcoming obstacles to videodisc development. Perhaps these organizations and networks will be able to solve many and varied computer-related problems and issues.

ANA and NLN both hold biennial conventions, during which computer interest meetings and CBE presentations are held. Exhibitors demonstrate hardware and software, and software exchanges are conducted.

Many other organizations that are involved with media such as computers and/or videodiscs and education, instruction, or training have special interest groups or other membership elements concerned with nursing. For example, nurses are among the members of the MDR (Medical Disc Reporter) Videodisc Consortium, "an educational publishing cooperative dedicated to the development and distribution of interactive videodisc courseware in the health sciences" (Stewart Publishing, undated). In addition, there are elite academies or societies, such as the American College of Medical Informatics, which has inducted its first nurse members in 1989.

Awards for CBE Efforts - Recognition and awards have been suggested as incentives to the development and implementation of CBE. In 1987, Sigma Theta Tau, the international honor society of nursing, initiated an award to recognize and honor outstanding people and projects involving the development or application of information technology. There is a national award biennially and, in the "off" years, there are regional awards.

Printed Sources of Information About CBE - The primary printed sources of computer information within the nursing profession are *Computers in Nursing*, which is published by the American Journal of Nursing (AJN) Company and is the first professional, refereed journal dedicated to computers, and *Nursing Educators MicroWorld*, a newsletter published by Bolwell for nurse educators who are using or planning to use microcomputers. *Computers in Nursing* publishes an annual software exchange issue.

There are several other newsletters of use, especially for those involved with videodiscs. These include newsletters published by FITNE, IBM, and the MDR Videodisc Consortium.

Although CBE in nursing is not the primary subject focus, there are many other nursing and educational journals which publish articles on aspects of CBE in nursing.

Educational Activities and CBE - There are many sources of educational activities about CBE in nursing. These sources include regional compacts, such as the Southern Regional Education Board, and consortia, such as FITNE. The Clinical Center of the National Institutes of Health and Rutgers, The State University College of Nursing, hold annual computer conferences. Some conferences are sponsored by professional societies, like the annual Symposium on Computer Applications in Medical Care, which has a large number of cosponsors, and the international nursing conferences sponsored by the International Medical Informatics Association. There are other major computer-oriented and videodisc organizations within health sciences and education which have presentations or whole sections of programs devoted to computers in nursing or nursing education.

Faculty development activities can be used to promote CBE in nursing. Murphy (1986) outlines a multifaceted approach that includes identifying resources, emphasizing current CBE usage, and collaborating with others.

For those seeking formal training in the fields of medical informatics and biotechnology information, the National Library of Medicine (NLM) currently supports predoctoral and postdoctoral training through grantee institutions. These institutions are responsible for the selection of trainees. "Alternatively, a qualified individual (doctorate only) may apply directly to NLM for an individual fellowship" (NLM, 1989, April, p. 2).

Self-Directed Learning and CBE - Another possibility for learning about CBE is self-instruction. Armstrong (1986) suggests and presents a model for self-directed learning about computer technology. The model includes an Action Plan for exploration, development of a plan, implementation of the plan, and formative evaluation. The self-directed learning skills related to the elements of the action plan are organized according to attitudinal, cognitive, self-teaching, and interpersonal skills.

The Educational Technology Branch, Lister Hill National Center for Biomedical Communications (LHNCBC), NLM, offers opportunities for nurses and other health professional educators to become familiar with software and hardware of interactive educational technologies through The Learning Center (TLC). Visitors to the TLC can take advantage of hands-on operation of hardware and software systems. Staff are available to provide explanations and answer questions.

Bulletin Boards and CBE - As mentioned earlier, there are at least three Bulletin Board Systems available to nurse educators capable of routing communications out of their local areas. These are at the University of Southwestern Louisiana College of Nursing, the University of Texas at Austin School of Nursing, and the University of Texas School of Nursing at Galveston. Each of these, while having unique emphases, has an information sharing and communication vision within the profession.

FITNE also operates an electronic bulletin board, providing information about educational technology and nursing (Fuld, 1988).

There are at least two other bulletin board systems functional in nursing. Nurse Link of Denver and Nightingale Nursing BBS of San Francisco (Rankin, 1988). The extent to which these systems concentrate on issues related to interactive learning technologies in nursing education is not known.

In 1989, the Educational Technology Branch initiated E.T.Net. "E.T.Net is an online computer conference whose purpose is to electronically link together developers and users of interactive technology in health care education" (NLM, 1989, May). Nurses and other health professionals developing or using interactive technology in education may participate in the conference at no cost.

A Need in Search of a Resource - There is a major category of needs for which no specific resource seems to exist. Rizzolo (1988) found that many respondents agreed that major resources could be instrumental in overcoming obstacles to marketing and developing videodiscs. Respondents agreed that "Someone (ANA, NLN, publishers) must assume marketing leadership and insure quality programs" (p. 235) as means of overcoming obstacles to development of videodiscs. Respondents also agreed with the statements: "Hardware standards should be set in education and/or nursing by establishing a consortium, or through computer councils of ANA, NLN" (p. 234) and "The publishing industry needs to get involved" (p. 234).

Nurse educators have many formal and informal opportunities to take advantage of a wide range of miscellaneous resources available to them as they adopt CBE technologies or adapt them to their needs. There are formal and self-directed learning activities, formal and informal computer interest groups, national and regional awards, journals and newsletters, and bulletin boards available. Exploitive or exhaustive use of these resources by nurse educators has yet to be realized.

Glimpes of the Future of Nursing Education and Technology

There are several social and economic influences profoundly affecting health professionals and health care in the United States. These influences have great implications for nursing education in the near future. Our nation is in the midst of a nursing care shortage, the length and depth of which cannot be determined at this time. The present supply of nurses cannot meet current care needs and young, intelligent, caring people are increasingly choosing other professions and jobs. Consequently, fewer people are selecting nursing careers. Those that do are not as academically qualified as they have been in the past.

Current Trends in Basic Education and Practice

Fewer Students - Table 24 shows the trends in basic nursing programs for five years, 1982-1986, and for ten years, 1977-1986 [National League for Nursing (NLN), 1988]. In general, these data show large numbers of diploma programs closing and increases in the numbers of associate and baccalaureate programs, with an overall increase of 8.3% in the number of programs for the ten-year period. Trends in these programs are consistent with the professional movement toward two levels of nursing clinician: one whose basic academic preparation is the associate degree; the other whose basic preparation is the baccalaureate degree.

Table 24: Five- and Ten-Year Trends in Numbers of Basic RN Programs

Program type	1982-1986	1977-1986
Diploma	−50	−129
Associate	+34	+131
Baccalaureate	+53	+111
All basic programs		+8.3%

Note. *Adapted from NLN (1988).*

Program trends are not necessarily reliable indicators of the numbers or levels of clinicians actually being prepared. Table 25 shows the ten-year, 1977-1986, trends in the preparation of nurses. It is not surprising to find that over the period, diploma programs have had heavy attrition in admissions, enrollments, and graduations. Only associate degree programs have experienced any student growth, but even these have had a modest decrease in enrollment. It may be that the increase in admissions to and graduations from associate degree programs is due in part to the opening of new programs. However, although there were increases in the number of baccalaureate programs over the period, there were disturbing declines in the numbers of students. Especially alarming is the drop in baccalaureate program enrollments.

Considering all basic programs, there has been an overall decrease in admissions, a tremendous fall in enrollments, and a minute increase in graduations over the ten years. Obviously, if these trends continue, the number of graduates entering the profession will soon show a dramatic decrease. And, if current trends in the need for care continue, decreases in the numbers of graduates will be seriously felt at about the same time as the need for them escalates tremendously.

Less Qualified Graduates – According to The American Nurse, more candidates for Registered Nurse licensure failed the July 1988 examination than failed the July 1987 examination (Candidate failure, 1988, November/December). Although changes in the exam itself may account for the lower passing rate, according to the article, evaluation of the candidates found their average ability level to be substantially lower than for previous July exams. "The 16.4 percent failure rate is the highest in the seven years that the National Council of State Boards of Nursing has been administering the exam" (p. 4). Since July 1983, the failure rate had been 10 percent or less.

Less Nursing Care – There is some debate about whether there is a shortage of nurses or a shortage of nursing. The core of this debate centers around the fact that the number of nurses in the workforce has never been greater. It seems, however, that the demand for Registered Nurses has never been greater either. The general trend is that the number of professional nurses is relatively stable, but may begin to shrink as fewer people enter the profession. However, the need for skilled, competent, compassionate care for greater numbers of sicker patients is increasing.

Detailing the "pervasive" shortage of nurses, Rich (1988, December 13) cites data furnished by Carolyne K. Davis, head of the Commission on Nursing, and the commission's report itself. "There are about 1.9 million registered nurses, 80 percent working full or part-time. Two thirds work in hospitals and 7 percent in nursing homes....Hospitals and nursing homes list job vacancies of about 137,000. The hospital job vacancy rate was 11.3 percent in December 1987...."(p. A3). And, according to Selby (1988, November/December), "The U.S. Department of Health and Human Services estimates that nursing homes currently need an additional 20,800 RNs" (p. 1).

Table 25: Ten-Year Trends (1977 - 1986) in Basic RN Program Admissions, Enrollments, and Graduations By Program Type

Program type	Admissions	Enrollments	Graduations
Diploma	−56.0%	−57.0%	−42.0%
Associate	+5.6%	−2.2%	+14.0%
Baccalaureate	−6.0%	−19.0%	−7.0%
All basic programs	−10.4%	−21.0%	1.0%

Note. Adapted from NLN (1988).

Demographic changes, technological advances, and alterations in patterns of health and disease are among the forces changing nursing. The nation's population, including nurses (Young, 1989) is growing older. More Americans are living longer, many are chronically ill and infirm. More than ever before, people are dependent on technology or genetic engineering to perform certain functions they are unable to perform for themselves. The specter of acquired immune deficiency syndrome looms as a high resource-consuming, long-term problem, the projected dimensions of which will pose heavy, perhaps impossible, burdens on care-givers, health care systems, and the economy. In addition to these forces, another major agent changing nursing is the prospective payment system.

Impact of Prospective Payment Systems

In a prospective payment system of reimbursement, hospitals are paid a preset amount based on a patient's diagnostic category, or diagnostic-related group (DRG). This system, commonly and generically referred to as "DRG", is used to pay for the care of each Medicare and many privately insured inpatients. As a cost containment effort, its effect is far reaching. And it is changing health care delivery and impacting nursing in various ways.

In 1987, the Midwest Alliance in Nursing (MAIN), the Mid-Atlantic Regional Nursing Association (MARNA), the Southern Regional Education Board (SREB), and the Western Institute for Nursing (WIN) were funded by the DN to gather data on the impact and implications of DRGs on undergraduate nursing courses and curricula. Because each region, within broad guidelines applicable to all, developed its own approach to the problem, it is difficult to determine whether the data are limited in applicability to the gathering regional compact or are generalizable to other regions. However, since nursing students are prepared for practice anywhere in the nation and are not limited to one region, this report where it seems reasonable to do so, considers the findings of the regional compacts applicable to the nation.

DRGs and Practice - DRGs appear to affect clinical nursing practice in three major ways. One is to increase scope of responsibility and activities of Registered Nurse staff. Another is to increase the accountability of nurses. The third, and perhaps most profound, impact is the result of the "quicker/sicker" syndrome.

Nurses are being asked to be more responsible and more accountable than ever before. Their level of performance, knowledge, dependability, (and especially their, frequently, lower salary level) make nurses quite suitable, from an administrative perspective, to taking on the roles of clerical and administrative staff as well as those of technical support staff and other less-qualified care providers. At the same time, nurses and other care providers are being held more accountable for their expenditure of resources, their level of productivity, and the quality of care they provide.

To conserve resources, procedures and treatments which would have been done only on inpatients before DRGs are now being routinely on an outpatient basis. Only those requiring the most care are hospitalized. These patients are being moved through care facilities as quickly as possible, being discharged earlier and sicker than they would have been before DRGs (hence, the "quicker/sicker" syndrome). Hospitalized patients are, therefore, requiring more intensive, extensive, scientifically-based, competent nursing care than ever before. To enable patients and their families to care for the patient adequately at home, they require more teaching over a shorter period than before.

Advances in technology are allowing many sicker patients to be discharged earlier. Devices, technologies, and procedures seen previously only in hospitals are now becoming commonplace in patient homes. As homes become more sophisticated care facilities, patients and families have more to learn to manage properly.

DRGs and Continuing Education - Changes in the type and intensity of nursing care required in the DRG environment are creating a tremendous need for continuing and inservice education of hospital and community nurses and nursing home staff. Because nursing shortage problems, which are to some extent a result of DRGs, are impacting hospitals and other care organizations now, they can least afford to provide nurses relief from care responsibilities to enable them to attend educational sessions. Many are also unable or unwilling to financially support nurses' continuing education.

Impact of DRGs on Undergraduate Nursing Education

The impact of DRGs on nursing practice also has tremendous implications for undergraduate nursing education. WIN was the only regional compact reporting specifically on the current effects of DRGs on associate degree and baccalaureate nursing programs. While the present effects of DRGs on both types of programs were perceived as "slight to none" in the WIN region (WIN, 1988, July, p. 116), the anticipated effects of DRGs warranted recommendations for changes in undergraduate education in each regional compact's report (MAIN, 1988, July; MARNA, 1988, July; SREB, 1988, July; WIN, 1988, July).

The effect of DRGs in increasing the responsibility and accountability of nurses, will need to be considered for undergraduate education. There will likely be a need to redefine the nature and scope of nursing practice. This redefinition will influence the courses, content, and objectives constituting undergraduate curricula.

In addition, increased accountability may inhibit the use of "real" clinical learning experiences in terms of supplies expended as a result of mistakes happening in the learning process (e.g., who will pay for replacing sterile supplies contaminated while learning how to perform a procedure?). Increased accountability will influence other aspects of undergraduate education as well.

The most profound effects of DRGs on undergraduate education will likely be the result of the combined effects of the "quicker/sicker" syndrome, the requirement for high quality patient care, and the safety of the learning environment. Since patients are discharged earlier (quicker), this "limits opportunities for students to provide continuity of care or to evaluate results of care and teaching" (Yeaworth & Crutchfield, 1988, July, p. 79). "For example, how does one teach wound healing in today's hospital setting? If a student cares for the patient only during the time they are hospitalized, the student will never see wound healing" (Lindeman, 1988, July, p. 88).

Because only those that are the most ill are admitted, "the acuity level of patients in the hospital give it the ppearance of one large intensive care unit. Beginning students are not prepared for the complex medical and nursing requireents of these patients" (Lindeman, 1988, July, p. 88). Further, "The increasingly acute and complex conditions of patients mean that some patients may be too ill to be cared for by students or that students will have to care for fewer patients" (Yeaworth & Crutchfield, 1988, July, p. 79). "They will require clinical learning experiences in settings with less acutely ill patients" (Lindeman, 1988, July, p. 88).

Having students learn from experiences with patients who are in the community, because they may be less acutely ill and, therefore, more suitable for learning, is not a viable alternative to learning in the hospital environment. "Clients of community and home health agencies are sicker, older and more complex, so that many agencies are reluctant to arrange for student experiences with them, yet these agencies want graduates with this preparation" (Yeaworth & Crutchfield, 1988, July, p. 80).

DRGs and Undergraduate Nursing Curricula Related to CBE - In anticipation of the impact of DRGs, new approaches to the process and content of undergraduate education are needed to prepare graduates "for the complexities of current nursing practice in a variety of settings" (SREB, 1988, July, p. 5). Recommendations of ways to adapt the educational process to the DRG environment included individualizing the curriculum to attract and retain students (MAIN, 1988, July) and implementing a systems orientation "to stimulate risk taking among students and to encourage intrapreneurship [*sic*] potential in the practice setting" (MARNA, 1988, July, p. 3).

Increased educational emphases were seen necessary for many content areas. Included among these were client teaching (WIN, 1988, July) and "computer literacy" (MARNA, 1988, July). Computer science was even suggested as one of the non-nursing courses (SREB, 1988, July). Specifically for the baccalaureate curriculum, the following was recommended: "Include nursing informatics and management information systems (MIS) [with the rationale that] A[a]gencies are utilizing computers for statistics, billing, quality assurance, documentation and research" (Harris, 1988, July, p. 29).

Approaches to expedite these, and other, curriculum changes were recommended. These included focusing on current models of excellence in education and practice which could serve as demonstration projects to study curriculum changes (MAIN, 1988, July; MARNA, 1988, July) and increasing "publications by nurse educators about innovative curricula modifications and strategies which respond to DRG implications...." (Henderson, 1988, July, p. 31).

DRGs and Undergraduate Learning Experiences - Each regional compact report mentioned simulation and computers (MAIN, 1988, July; MARNA, 1988, July; SREB, 1988, July; WIN, 1988, July). Simulation was suggested as an approach to prepare students for learning with real patients. "Trial and error learning in the clinical setting will have to be replaced by simulation and the real world setting used to perfect nursing practice" (Lindeman, 1988, July, p. 89). Simulation was even suggested as a replacement for some real clinical experiences (SREB, 1988, July).

Computer-assisted instruction (CAI) was the only type of computer-based education (CBE) specifically mentioned in the reports. And, while CAI and simulations were both suggested, CAI was not necessarily seen as the method to deliver clinical simulations. However, CAI was specifically mentioned as a replacement for "trial and error learning" in the clinical setting (Lindeman, 1988, July).

CBE in Nursing in the Future

The Influence of Practice on CBE in the Future - Current efforts to capture nursing care data locally and nationally will eventually develop into useful databases and clinical information systems. These systems will become the source of material for instructional content, especially for high fidelity simulations. Years of development and study will be required before nurse experts will regard these systems as sufficiently reliable to create instructional and clinical algorithms, especially when it is created by an "automatic" or "hidden" updating process, such as by computers or data links.

Continuing Education and CBE in the Future - The most "educationally disadvantaged" groups, given the near future milieu, would seem to be, in ascending order of magnitude, staff nurses of: large hospitals, moderate sized hospitals, large community/home care agencies, smaller hospitals and community/home care agencies, and (most of all) nursing homes. The continuing or inservice education provided these staff by employers will probably only meet the standards of the Joint Commission on the Accreditation of Health Care Organizations standards, which are very general and quite minimal, but will not extend much beyond them.

Hospitals and other care agencies will continue to struggle to pay for the registration, travel, compensatory time, etc. that nurses require to keep pace with professional practice demands. According to Bolwell (1988) "The biggest and most frequently overlooked expense of providing education to employed nurses is time off the job" (p. 9).

Continuing education will become even more important to maintain competence than it is now. Competency-based certification programs will expand at an accelerated pace. Based on longevity of learning, changes in knowledge, and changes in practice, intervals for recertification will be established.

For continuing education outside the employing facility, individual nurses will be expected to pay for their own educational maintenance. This will continue to be defined as part of the concept of "professionalism".

In the more distant future, greater numbers of nurses than are presently involved will enter the continuing education marketplace as entrepreneurs. They will establish teams which will evolve innovative approaches to educational design and development in interactive media. Delivery mechanisms, especially at the employing facility or practice site, will include "online or live" use of computer networks, cable, satellites, and microwaves in addition to soft and hardcopy packages. Learning sites, experts, information databases, and information and data processing devices will be linked with multi-directional audio, video, print, interactive and computerized devices, and information storage devices.

The current concept of "artificial intelligence" will mature and will be applied to individualize learning experiences to maintain nurses' clinical competence. Expert consultants, live or "canned" through "intelligent" packages, will be available to help diagnose and meet learning needs in the context of individual nursing practice demands. Data relevant to clinical nursing practice will automatically be gathered and used to update databases and clinical algorithms. The same or similar systems will be used to solve immediate problems in clinical practice.

Undergraduate Faculty and CBE in the Future - Now and for the very near future, schools of nursing will be pressed to more efficiently and effectively educate nursing students. In spite of the lack of agreement of Rizzolo's (1988) respondents with the statement that time will take care of the lack of faculty computer expertise (younger faculty will be experienced), video home entertainment and personal computer usage will rapidly bring about more competence and comfort with interactive technologies in both faculty and students. This increased acceptance may be as much the result of improvements in the human-machine interfaces as due to user familiarity and practice with the hardware.

In the distant future, faculty will effectively utilize computerized and other technologies to individualize instruction for students. The content to be learned will be a product of clinical practice databases updated continuously by clinical algorithms. Student learning needs will be diagnosed and learning experiences will be prescribed by educational algorithms. Entire curricula will be individualized. Faculty will be managers of the learning environment.

Undergraduate Curricula and CBE in the Future - In the near future, both inductive and deductive processes will be used to determine curricula. Faculties will spend much time reassessing their philosophies of education and definitions of nursing. At the same time, individual faculty will set educational and practice competencies and expectations based on real world requirements.

Eventually, nursing program accreditation criteria and licensure requirements will mandate competence with many technologies and devices, the computer being only one of many. For some time, there will be an obvious increase in the "gap between education and practice", causing stress in students, faculty, and clinical nursing practitioners.

In the distant future, clinical algorithms will determine the curricula. The gap between education and practice will close. Faculty will be practitioners. In fact, to be an educator will require that one be a highly skilled clinician.

Learning Experiences and CBE in the Future - Rizzolo (1988) asked respondents about ways that interactive video learning (IAVL) might change the process of nurse education in the future. She presented 19 statements, two with subparts, upon which respondents based their predictions by agreement. Rizzolo found their predictions "conservative". There was agreement with only three statements: "Learning will be more flexible in terms of time and space" (p. 241); "More efficient use will be made of learning labs" (p. 242); and "Function of teachers will change ... They will:... become facilitators of learning" (p. 242).

Rizzolo (1988) found lack of agreement with the remaining statements, which, given the reporting above, is somewhat surprising. Some of the statements not agreed with were: 'Learners will borrow programs and players for home use.... Entire courses or modules will be offered via IAVL.... Large classrooms could be equipped with response or interactive capabilities at each seat - more students could be taught in class, and students could respond from terminals in their seats.... New dimensions in telecommunication and remote classroom concepts may emerge" (p. 242) "Function of teachers will change. They will:...design IAVL.... IAVL programs will exist as databases and for reference.... IAVL will provide a new dimension in media assisted instruction, but it will not totally replace other A-V materials" (p. 242).

Circumstances now and in the very near future hold the potential for giving a very powerful impetus to the integration of CBE, especially in the interactive videodisc format, in all levels of nursing education. Leaders in nursing education recognize that changes in the learning and practice environment, to enhance student learning and to protect both students and patients during that formative time, are rapidly being necessitated. Theoretically, the technology is available and capable of delivering the educational experiences, especially high fidelity simulations, needed in all nursing education settings. The cost of hardware, equipment redundancy for groups of students, and the design expertise necessary to develop high quality instructional experiences will continue to be limiting factors.

In the future, extensive and expensive learning experiences will be developed for several audiences at the same time. Transportability and sharing of learning materials among and between users will be by both electronic and physical means. Some audiences will have a learning experience delivered in one mode, while another audience will have a different experience, yet learning the same content from the same instructional material.

Bolwell's (1988b, February/March) description of the LRC and nursing skills laboratory, circa 2001, seems most feasible. She envisions a highly automated, computerized, mediated, and individualized learning environment. Many models and learning devices will be simulations of real world patients and clinical events. Bolwell also includes robots and a variety of input devices, including voice recognition, among the technologies at the learner's disposal. Faculty are predicted to become learning diagnosticians, guides, and motivators.

Further into the future, nursing education will be managed by yet-to-be invented intelligent systems encompassing video, audio, print, and information storage devices as the primary delivery medium. Content will be derived from clinical practice databases and algorithms. Each student's learning will be individualized based upon background and goals for nursing practice.

Development of CBE and Learning Experiences in the Future - Now and in the very near future, formal and informal working groups, networks, and consortia will emerge to attempt to meet the learning needs most commonly expressed at all levels of nursing education. This process will reduce duplication of expensive effort and enhance the quality of learning experiences produced. Better materials will be developed, but the stockpile of really good programs will increase slowly.

In the near future, autonomy in design and production will be sacrificed for standardization, less of the "NIH" (Not Invented Here) syndrome will be seen. However, many opportunities to modify or adapt instructional materials for local needs, on meaningful or significant dimensions, will be built into courseware. There will be increased problems with ownership and rights to materials produced.

In the distant future, content derived from clinical databases and algorithms will be manipulated and developed for individualized learning experiences by technologies yet to be invented. Current accuracy of the learnings will be maintained by constant communication between the educational and clinical environments.

Technologies for Care and Student Learning in the Future - Patients will continue to have even more technologies in their lives and care than they do today. The general public has adopted the videocassette recorder more rapidly than most new technologies. According to Newsweek (Rogers, 1989, June 5), "almost 60 percent of American households already own one VCR [videocassette recorder]" (p. 68). Many people have microcomputers and other computerized devices in their homes and vehicles. Patients, in hospitals and in their homes, are being cared for and monitored by an increasing array of computerized technologies.

A tremendous, currently unexploited market exists for the development of health and patient education materials for videocassette, compact disc, and videodisc players and microcomputers. In the future, these technologies, when linked by cable, satellite, microwave, telephone or data lines, or local area network, offer tremendous interactive learning potentials to patients and their families, as well as to professional and student caregivers. For student and professional caregivers and patients and their families, there will be opportunities for, using "POC" (point of care) interactive technologies for immediate instruction, consultation, support, and supervision. There will be immediate access to a vast array of databases and sources of information. The future could bring immediate access to expert, decision support, or intelligent systems from the site of care by or for either patient or caregiver. For example, with today's technology, the caregiver or patient could receive transmission of a research article needed for care after performing her or his own literature search using technology available in the patient's home.

Unless nurses begin immediately to take advantage of the current market for health and patient education software, leadership in this important and profitable arena will be captured by non-nurses.

The near future of nursing, health, and patient education and technology poses major problems and opportunities. Some of the problems can be relieved and, perhaps, solved by applications of currently available technologies. Many nurse educators will master these technologies and make them their slaves; others will permit the opposite to gradually prevail.

Individuals and groups, formal and informal organizations, public and private agencies — all — will be needed to help set priorities, to take advantage of opportunities, and to further the appropriate application of interactive communication technologies to nursing education and health care. These concerted efforts, especially in this time of resource constraints, are required to promote the health and well-being of the people of our nation.

Constraints to the Integration of Computer-Based Education in Nursing and Potential Responses for Alleviation or Elimination

This report has identified many constraints to the integration of computer-based education (CBE) in nursing. Despite of these impediments, however CBE implementation in nursing programs is increasing. More CAI is being used and use of the interactive videodiscs has begun. Still, there is much that could and should be done to reduce or eliminate the constraints.

Action should be taken to foster more widespread adoption of and adaptation to CBE; to improve development, implementation and integration, and evaluation of locally- and commercially-produced materials; to expand the research base documenting the effects of CBE; and to enhance access to expert technical and professional consultation. Achieving these objectives will require the cooperative efforts, resources, and capabilities of individuals and groups.

Possible Federal Government Activities - Within the Department of Health and Human Services (DHHS), several organizations have legislated interests, objectives, and activities in nursing education, particularly as this education may affect the health of the nation. Two primary organizations are the Division of Nursing (DN) of the Health Resources and Services Administration (HRSA) and the Lister Hill National Center for Biomedical Communications (LHNCBC) of the National Library of Medicine (NLM).

HRSA has leadership responsibility in the U.S. Public Health Service for health service and resource issues and the DN serves as nursing's focal point within HRSA. It pursues its objectives in several ways. One is by providing leadership in improving health professions training, such as through the application of new educational technologies.

The LHNCBC, particularly through its Educational Technology Branch, conducts research and development in computer, audiovisual, and multimedia support of health professions education and information transfer. The Educational Technology Branch "identifies and demonstrates educational technologies and technology applications which meet identified needs in health science instruction and information transfer, evaluates the effectiveness of educational and information technologies, carries out educational research to identify and define technology applications, and investigates educational applications of computer systems, programs, authoring languages and collateral technologies" (NLM Fact Sheet, 1988, October).

"The Branch operates The Learning Center for Interactive Technology which serves as the focus for using, investigating, and displaying new and effective applications of educational technologies to faculties and staff of health sciences educational institutions and other visitors. Health professions educators and others are assisted in improving the use of educational technologies in health sciences education through training demonstration and consultation activities" (NLM Fact Sheet, 1988, October). The Educational Technology Branch also supports a national electronic bulletin board for the exchange of information about technologies used in health sciences education, E.T.Net.

A third DHHS organization with interest in nursing education is the National Center for Nursing Research (NCNR), National Institutes of Health. The NCNR's involvement, however, is limited to health professions training only as it applies to nursing care research.

Collaborative relationships among the DN, the LHNCBC, and the NCNR could: 1) promote awareness of the latest educational technologies, their potentials and problems; 2) provide information about current and proposed applications of interactive technologies in nursing education, practice, and research; 3) serve as a basis for sources of technical and professional consultation to each other and to the nursing profession; 4) encourage planning of an agenda to promote the integration of interactive learning technologies in various programs of nursing education, including undergraduate, graduate, continuing, and inservice education in traditional and non-traditional environments; 5) support the planning of an academically and practice-oriented research agenda documenting the effects of all forms of CBE technologies; 6) identify

the nursing education, practice, and research applications for which CBE is especially or uniquely suited.

To accomplish these objectives, there could be co-funding of projects which meet the research and/or demonstration agendas of the organizations. Conferences, symposia, seminars, and monographs could be co-sponsored. These could address both information-gathering, such as consensual validation from the nursing profession about CBE issues, needs, and problems; and information-giving, such as through experiential learning and "hands-on" experiences with hardware and software.

Possible Nursing Profession Activities – Nursing, the object and primary beneficiary of the above initiatives, must itself become involved with the promises and problems of CBE. To ensure that the promises can be met and the problems vercome, the profession must participate aggressively in identification of both the constraints and the application of appropriate treatments to relieve or eliminate them. Attention should be directed toward determining whether there are populations of nurses or nursing students with special or unique CBE-related needs.

Individual nursing entities, such as major organizations, specialty organizations, regional compacts, care provider institutions and agencies, and academic organizations and institutions, should determine what, if any, their involvement with interactive learning technologies will be. They should plan purposely and aggressively for the future envisioned, sharing problems, solutions, scarce resources, talent and expertise. Possible options include meetings, conferences, symposia, journal publications, and production, integration and evaluation of CBE materials.

Also, nursing entities should gather data documenting the state of CBE in their respective domains to be shared with other nursing entities, philanthropic foundations, private and public granting and contracting organizations, and major software designers and publishers. Sharing information can bring useful attention to and support for relieving or eliminating common or ubiquitous constraints to CBE in nursing. Ultimately, the relief or elimination of these constraints will lead to advances in nursing education at all levels and, thereby, improvements in patient care, disease prevention, and health promotion.

Constraints cited earlier have been categorized according to the following: developer/development, implementor/implementation, evaluator/evaluation, cost, technological, curriculum/education program, research deficiency/evaluation, and technical and expert consultation availability. These categories provide a basis for proposing responses, activities, and projects, and allocating resources which could reduce or eliminate constraints to CBE in nursing.

Developer/Development

Constraints

Lack of knowledge, skills, or opportunities to learn about CBE development and application

Lack of awareness of potential CBE development options and design alternatives

Dearth of instructional design models, templates for development, and useful authoring tools

Lack of research results upon which to base development decisions

Insufficient supply of competent developers

Lack of time to develop and conduct formative evaluation of CBE

Lack of incentives, rewards

Lack of standardization of equipment

Cost of CBE development and production, especially as interactive videodisc programs

Potential Responses to Alleviate or Eliminate Constraints – Increase publication and studies of development "success stories", especially case-studies that detail step-by-step processes and rationales.

Increase use of newsletters, electronic bulletin boards, exhibit materials, informative materials about media or software awards, etc. to exchange information about effective CBE development approaches and alternatives.

Increase use of support groups, faculty development activities, and inservice and continuing education activities focused on CBE development and implementation alternatives.

Critically review and analyze both locally-developed and commercial materials to adopt or adapt design and development alternatives.

Increase the number and visibility of awards and award recipients for meritorious accomplishments in CBE development.

Conduct comprehensive needs analysis as a basis for CBE development decisions. To be certain that development is necessary, consult sources such as the "19XX Directory of Educational Software for Nursing", the AVLINE database, and electronic bulletin boards to determine that no instructional program that will meet identified needs exists or is under development.

Develop or encourage and support development of low cost or public domain instructional design models, templates, and authoring tools which can be applied to CAI, CMI, or videodisc development. Ensure provision of documentation of tools developed. Where possible, tools should be "adaptable" and support several development "alternatives".

In the absence of suitable authoring or design tools, seek those which can be adapted to the project. Assess this capability prior to committing to its use in development. Use experts to adapt tools to development specifications.

Assemble expert development teams. Decide what expertise and talents are required and acquire these by hiring, borrowing, exchanging, etc. In academe or in a practice or research environment affiliated with a college or university, other department faculty, staff, and/or students may provide the necessary expertise and thereby get "real world" experience.

Take every meaningful opportunity to conduct formative evaluation of CBE, especially when developing an interactive videodisc. Confirm content with content peer experts, learning with representative learners, and instructional alternatives employed. Revise the CBE to conform with formative feedback. Include formative evaluation data to document the development process and provide it to others who acquire and implement the CBE material.

Develop or encourage and support development of low cost or public domain software systems or templates, applicable to formative evaluation processes and to learner assessment, which will automatically capture and analyze learner use data, patterns of learner interaction, paths through instructional events, learning outcomes, etc. This software is [illegible]rable for CBE involving simulations, hypertext, [illegible] interactions. The greater the complexity of [illegible]ractivity of the CBE, the more desirable, even [illegible], this software becomes. This genre of software has immed[illegible]e applicability to CBE development and to research on CBE.

Design and conduct research to determine and establish specifications for the design, development, and evaluation of interactive group instruction. Specifications should include: design and development techniques to be used; potential for "repurposing"; characteristics of appropriate group learning tasks (i.e., type of content, whether learning is skill, knowledge, or attitude oriented); etc.

Develop all CBE programs for widespread implementation. Learners are not constrained to one area and should not be taught for practice limited to the learning locale. By developing for broad use, both products of its development the CBE material and the learner will be much more widely marketable.

When developing videodisc-based programs, consider using "unpurposed" or generic videodiscs as visual and/or auditory databases from which to develop new CBE or other instructional events.

Consider any video, audio, or computer video production component as possible material for future CBE development. Record, store, maintain, index and catalog high quality material so that it can be used in future development.

Plan development of CBE for the best possible circumstances. determine development priorities, identify multiple uses of quality programming, visuals, sounds, etc.; especially for interactive videodisc development, plan for more than one audience or type of implementation wherever meaningful and possible.

Seek support for CBE development efforts from a variety of sources. For funding, collaboration, or exchange of services, contact: public and private academic and health care institutions, philanthropic foundations, software publishers, hardware manufacturers, nursing and medical supply companies, nursing service provider agencies, health and media consortia, health insurers, health maintenance organizations, voluntary health associations, disease-specific interest groups and organizations, etc., and government agencies at local, state, and federal levels.

Implementor/Implementation

Constraints

Cost of hardware, especially for individualized learning

Cost of software, especially for individualized learning

Cost of maintaining hardware

Lack of knowledge, skills, or opportunities to learn about CBE implementation and curriculum integration

Lack of interest in computer applications

Lack of incentives, rewards

Curriculum factors

Insufficient technical support

Low quality and quantity of available software

Lack of information about available software

Lack of standardization

Lack of documentation of learning from CBE, especially videodiscs, or other effects of CBE

Potential Responses to Alleviate or Eliminate Constraints - Publicize "success stories". Document case-studies and detail step-by-step processes and rationales about how to successfully integrate interactive learning technologies at all levels of nursing education and about how to provide continuity to learning experiences using a variety of technologies in the curriculum.

Increase use of newsletters, electronic bulletin boards, exhibit materials, informative materials about media or software awards, etc. to disseminate and gather information about effective CBE implementation approaches and alternatives.

Increase use of support groups, faculty development activities, and inservice and continuing education activities that address CBE implementation alternatives.

Critically review and analyze curricular integration options and processes.

Increase the number and visibility of awards and award recipients for meritorious accomplishments in innovative implementation of CBE.

Invite experts with demonstrated successes to provide consultation in the implementation and integration of CBE technologies. Visit successful sites and study their implementation methodologies. Give consideration to guest or adjunct faculty status or agency advisory status for such consultants.

Conduct comprehensive needs analysis as a basis for CBE implementation decisions. Use technical and professional experts for consultation and installation. Plan systematically for progressive implementation and corresponding curricular integration, especially where extensive and expensive hardware or software purchases are anticipated. Hardware and software compatibilities and standards should be primary considerations.

Seek out information about software. Use sources such as software publishers, faculty or peer counterparts, journals and monographs, electronic bulletin boards, the *19XX Directory of Educational Software for Nursing*, the AVLINE database, etc. Critically examine software listed in AVLINE in the Learning Resource Center of the NLM or borrow the software on interlibrary loan. Insist on documentation of the quality of the learning experience provided by the software. Where possible, offer to gather software performance data in exchange for funding, services, software, etc. Critically review and analyze software "demonstration" materials as content experts and by using with representative learners prior to acquisition.

Seek out information about hardware. Visit computer stores, visit The Learning Center for Interactive Technology of LHNCBC, invite demonstrations by hardware vendors, visit other comparable nursing settings with model implementation and curricular integration to assess the application of hardware and CBE systems.

Develop or encourage and support development of low cost or public domain software systems applicable to learner assessment, which will automatically capture and analyze learner use data, patterns of learner interaction, paths through instructional events, learning outcomes, etc. Development of this type of software is especially desirable for CBE involving simulations and hypertext or hypermedia interactions. The greater the complexity and interactivity of the CBE, the more valuable and necessary this software becomes.

Implement results of research on group learning from media, particularly from software designed for individualized instruction. Identify methods for maximizing group learning from CBE materials whether or not these have been designed for group learning. Implement these methods when using CBE in a group mode.

Conduct research studies to determine and establish specifications for the design, development, and evaluation of interactive instruction for groups, including advantageous implementation techniques and curricular integration strategies. Where mainframe and microcomputer hardware coexist or are networked, critical analysis should determine the use of either or both technologies to maximize or expand the implementation of CBE. Use appropriate software interfaces to up- and download CBE programs between the two computer types.

Cost

Constraints

Cost of "playback" hardware, especially for individualized learning application

Cost of software, especially for individualized learning

Cost of production and development hardware, especially for interactive videodisc development

Cost of training to develop, implement, and integrate CBE

Cost of building renovations to house CBE hardware and activities

Cost of development, implementation, and evaluation of CBE, especially as interactive videodisc

Cost of maintaining hardware

Potential Responses to Alleviate or Eliminate Constraints - Systematically plan acquisitions of hardware and software to ensure compatibility, feasibility of implementation and curricular integration, and capability to maintain. Where there are uncertainties about standards and capabilities desired, or where the technology is rapidly changing, rent or lease equipment and include maintenance provisions. Where there has been significant technology change, assess the efficacy of acquiring "older" (now less expensive) models.

Take advantage of training experiences offered by hardware vendors and make them available to all faculty and staff who will use the hardware. Likewise, take advantage of software demonstrations.

Exchange software development and content expertise. Exchange opportunities to be used as a hardware or software evaluation site and opportunities for further training in CBE.

Implement results of research on group learning from media, particularly from software designed for individualized instruction. Identify methods for maximizing group learning from CBE materials whether or not these have been designed for group learning.

Acquire, implement, and integrate interactive CBE designed for group learning. Schedule use of scarce resources as expeditiously as possible.

Where mainframe and microcomputer hardware coexist or are networked, critical analysis should determine the use of either or both technologies to maximize learner access to CBE. Use appropriate software interfaces to up and download CBE programs between the two computer types.

Seek public domain, free, or low-cost, software. "Advertise" needs for particular types of software through electronic bulletin boards, newsletters, journal publications, etc.

Share or exchange CBE materials with others free or at low cost. "Advertise" availability through electronic bulletin boards, newsletters, journal publications, etc.

Require learners to furnish their own "playback" equipment. Charge laboratory use fees.

Explore rental, leasing, or exchanging to obtain access to needed equipment and facilities. Nurses in practice or research settings could potentially use academic (nursing or non-nursing) computing/learning environments during "off-times", nonuse hours, academic vacations, etc. Similarly, academic programs could potentially use care agency computing/learning environments when not in use by the agency.

Invite experts with demonstrated successes to provide consultation in planning for the acquisition of CBE technologies. Consider guest or adjunct faculty status or agency advisory status for such consultants.

Seek the services of faculty, staff, or students of CBE-related areas. Where possible staff maintenance operations, library operations, programming and production operations with students, especially graduate students, of these subject areas and disciplines.

Consider any video, audio, or computer video production component as possible material for future CBE. Record, store, maintain, index, and catalog high quality material so that it can be used in future development.

Seek funding for CBE hardware and software acquisition from a variety of sources. For funding, collaboration, or exchange of services, contact: public and private academic and health care institutions, philanthropic foundations, software publishers, hardware manufacturers, nursing and medical supply companies, nursing service provider agencies, health and media consortia, health insurers, health maintenance organizations, voluntary health associations, disease-specific interest groups and organizations, and government agencies at local, state, and federal levels.

Technological

Constraints

Compatibility/transportability problems

CBE facility location inconvenience

Potential Responses for Alleviation or Elimination of Constraints - Organize or join a formal or informal consortium that can agree on desirable hardware and software features which are internally compatible and for which the consortium will produce CBE materials.

Review the hardware requirements for the teaching software to be used. Select hardware configurations based on compatibility with a pool of desirable software.

Acquire all hardware and software according to "major" industry standards and specifications.

Systematically plan hardware and software acquisitions to ensure compatibility of components with current and projected operational and instructional program requirements.

Maximize each use of the CBE facility. Make the facility efficient and comfortable to use.

Curriculum/Educational Program

Constraints

Lack of "space" in curriculum; CBE is "add-on"

CBE inconsistent with nursing program focus, philosophy of nursing, beliefs about learning

Changes in nursing practice and content too rapid for the CBE development time required

Lack of awareness of potential use of CBE

Potential Responses to Alleviate or Eliminate Constraints - Determine the organization's actual or possible involvement with CBE as developer, user, or both.

Establish criteria and systematic processes for integrating CBE into on-going educational activities. Consult with or visit others who have successfully integrated CBE in a similar milieu. Explore the applicability of their processes to the current setting. Adopt and adapt those that are useful. Obtain suggestions, advice, and feedback from learners. Model strategies, content, and format of CBE development and implementation to conform to nursing program focus, philosophy of nursing, beliefs about learning, etc. Acquire only CBE that contributes to and supports these professional, social, and philosophical bases.

Avoid developing CBE that will become obsolete rapidly. Anticipate areas of obsolescence and devise systems or methods for maintaining current accuracy or updating.

When purchasing CBE in rapidly changing practice or content area, review carefully to be certain of its current accuracy. Anticipate and negotiate updates or revisions upon initial purchase.

Obtain suggestions, advice, and feedback on development, implementation, and integration of CBE from learners.

Research Deficiency/Evaluation

Constraints

Lack of evidence of cost-effectiveness of CBE

Lack of evidence of learning from CBE, especially from interactive videodisc

Lack of awareness of potential of CBE

Lack of documentation of effects of specific instructional events delivered by CBE, of instructional effects of types of interactivity, of effects of various aspects of learner control of the CBE

Cost of evaluation

Lack of skills, knowledge, or opportunities to learn about CBE evaluation

Potential Responses to Alleviate or Eliminate Constraints - Develop and implement software, templates, or models to automatically capture CBE learner use data, including: learning outcomes, paths through materials, subjective feedback, importance and application of interactivity, etc. The software should be applicable to formative and summative processes.

Develop and share free, low cost, or public domain "generic" assessment systems to structure, gather, and analyze needs for CBE development and/or implementation.

Design, conduct, and publish studies of instructional and subjective effects of different: types and degrees of learner control of CBE; modes and levels of interactivity; instructional strategies and techniques using both audio tracks of interactive videodiscs.

Document both direct and indirect cost of all CBE developed, acquired, and implemented, especially as research and development projects.

Design, conduct, and publish studies to establish specifications for the design, development, and evaluation of interactive instruction for groups. Identify efficient design and development techniques, potential for repurposing, characteristics of the appropriate group learning tasks (i.e., type of content, whether learning is skill, knowledge, or attitude oriented); etc.

Design, conduct, and publish studies of group learning from CBE. Study materials designed for groups and for individual learning experiences but used in a group mode. Assess implementation strategies to incorporate or avoid, characteristics of the learning experience (i.e., type of content, whether learning is skill, knowledge, or attitude oriented, etc.), most and least suited to group learning, characteristics of the learners most suited to group learning, etc.

Design, conduct, and publish studies to determine the characteristics of highly-rated, high performance CBE learning experiences. Specify how these characteristics can be incorporated in future CBE development activities.

Seek support for CBE research and evaluation from a variety of sources. For funding, collaboration, or exchange of services, contact: public and private academic and health care institutions, philanthropic foundations, software publishers, hardware manufacturers, nursing and medical supply companies, nursing service provider agencies, health and media consortia, health insurers, health maintenance organizations, voluntary health associations, disease-specific interest groups and organizations, etc., and government agencies at local, state, and federal levels.

Expert Technical and Professional Consultation

Constraints

Lack of technical assistance in development, implementation, and evaluation of CBE, especially interactive videodisc

CBE in nursing is too new

Lack of information about software

Lack of information about hardware

Lack of centers for demonstration to serve as models of excellence

Potential Responses to Alleviate or Eliminate Constraints – Anticipate the nature and extent of technical and professional assistance desired or required. Seek assistance from hardware and software vendors, from other professional counterparts (such as through the ANA, NLN, consortia, etc.), from electronic bulletin boards (such as the educational technology-oriented bulletin board supported by the LHNCBC), from other departments within the school, university, hospital, or agency.

Seek out information about software. Use sources such as software publishers, faculty or peer counterparts, journals and monographs, electronic bulletin boards, the *19XX Directory of Educational Software for Nursing*, the AVLINE database, etc. Critically examine software listed in AVLINE in the Learning Resource Center of the NLM or borrow the software on interlibrary loan. Insist on documentation of the quality of the learning experience provided by the software. Where possible, offer to gather software performance data in exchange for funding, services, software, etc. Critically review and analyze software "demonstration" materials as content experts and by using with representative learners prior to acquisition.

Seek out information about hardware. Visit computer stores, visit The Learning Center for Interactive Technology of LHNCBC, invite demonstrations by hardware vendors, visit other comparable nursing settings with model implementation and curricular integration to assess the application of hardware and CBE systems.

Increase publication and presentation about characteristics of models of excellence in CBE development, implementation, and integration. Share approaches to achieving and maintaining those characteristics. Document and publish case studies of successes.

Nursing Populations with "Special" Needs with Respect to CBE

Earlier this report identified or implied that there may be nursing populations with special or unique needs regarding development and implementation of CBE. Nurses in many settings are experiencing the nursing shortage, while caring for more critically and more chronically ill patients. Also there are settings where applications of high technology are accelerating and demands are rapidly changing. It would seem that certain nursing populations should explore their potentially unique educational needs, the routes available and desirable for meeting these needs, and the possibilities offered by any or all formats of CBE to provide essential learning experiences. The applicability of CBE technologies to patient care, disease prevention, and health promotion should be considered.

The following are some of the questions that might be explored by each special nursing practice population:

What are the educational needs of the nurse on entry or re-entry to this type of nursing practice?

What are the current continuing education needs of the nurse in this type of nursing practice?

What are the projected continuing education needs of the nurse in this type of practice? What care technologies will require special education of the nurse? What illness characteristics or nursing care requirements will necessitate special education of the nurse?

What is the best approach to delivering this entry or continuing education? Is CBE, in the format of CAI, CMI, or interactive videodisc, appropriate and cost-effective for meeting these needs? Are there other interactive technologies that should be employed? How well accepted are the educational technologies that could be implemented?

Should these special populations establish "consortia" to systematically monitor educational needs and potential cost-effective solutions for the greatest professional economy and effect? Should these special populations create solutions or participate in the creation of solutions to educational needs and instructional delivery and implementation problems?

What are the sources of funding to support development and implementation of CBE-delivered continuing education for practice? What are the sources of expertise to develop the learning experiences necessary to economically and cost-effectively meet the needs?

What role or requirement do the developers of high technology care and new nursing approaches have in the preparation and education of nurses to safely and efficiently implement and integrate these technologies and approaches in their practice?

What role might CBE or other interactive technologies play in nursing care practice? Is CBE cost-effective for patient education? Could online, interactive technologies assist in nursing care delivery or patient monitoring? How might these technologies best be applied?

How might CBE technologies be effectively applied in disease prevention and health promotion efforts? What processes should be used to determine needs, development specifications, and implementation strategies and mechanisms? What funding sources are available?

Nurses conducting research in these settings should also address how the technology might be best applied to address the problems and/or methodologies of research. The following lists some of the questions that might be explored about the potential contributions of CBE to nursing research:

How might CBE contribute to and enhance patient education, disease prevention, and health promotion? What is the acceptability of CBE technology by patients or the public? Can CBE designed for another audience be adapted or "re-purposed" cost-effectively for patient or public education? What instructional strategies are most effective, for what subject matter, for what patient or public characteristics?

How might CBE or other interactive technologies be used in gathering research-related data?

How might CBE or other interactive technologies promote the dissemination of results of nursing research?

This chapter has listed constraints to the integration of CBE in nursing education at all levels. Potential responses for alleviation or elimination of the constraints were suggested. The possibility of nursing practice populations with special needs regarding CBE was explored through questions about the application of CBE to education, practice, and research in these areas. The relief or elimination of constraints to the integration of CBE and other interactive technologies in nursing education, practice, and research will ultimately improve nursing care, thus benefiting patients, their families, and the health of the nation.

Brief Descriptions of Publications Cited Frequently and Their Use in Report

Aiken, E. (1988a). *Computer use in undergraduate nursing education programs: A study of 550 programs*. Atlanta: Southern Regional Education Board.

Survey of 1,301 college-based nursing programs: demographics, use of microcomputers, faculty perceptions, general comments or major plans for use of computers in undergraduate programs. Response rate 42.3%, or 550 programs. The original SREB report cites percentages and other statistics by "SREB" states and "Non-SREB" states. For the purposes of the present report, these distinctions between groups are not useful and, therefore, the data were combined or reconstituted so that one datum or value describes all 550 programs, serving as a "national" datum.

American Journal of Nursing Company (AJN). (1989, February/March). AJN interactive videodisc survey results. *Nursing Educators MicroWorld*, p. 23.

A late 1987 and early 1988 survey of approximately 3,000 professionals interested in interactive videodiscs for nursing education. There were 661 respondents, a 22% return rate, who represented 522 schools, 70 hospitals and others.

Bolwell, C., & Thomas, B. (1986). The use of microcomputers for educating nurses in the United States. In R. Salmon, B. Blum, & M. Jorginsen (Eds.), *Proceedings from MedInfo '86* (pp. 955-959). Washington, D.C.: Elsevier Science Publishers.

Study of the educational use of microcomputers by both hospital and nursing school populations. This was the only study found in the literature that documented educational use of microcomputers, or other computers, in hospitals. The hospital study population was community hospitals in the U.S., ranging from 6 to more than 500 beds, as listed by the American Hospital Association. A 5% random sample (N=277) was obtained. The hospital response rate was 24% (n=65).

Hebda, T. (1988). A profile of the use of computer assisted instruction within baccalaureate nursing education. Computers in Nursing, 6(1), 22-29.

A 1986 survey of all 441 NLN-accredited baccalaureate nursing programs to determine extent of CAI use. Response rate 80.5%, or 355 programs. Surveyed: use prior to and in nursing courses, use of commercially and locally-developed CAI, types of instructional methods most used within CAI, and future plans for CAI.

Heller, B. R., Romano, C. A., Damrosch, S. P., & McCarthy, M. R. (1988) The need for an educational program in nursing informatics. In M. J. Ball, K. J. Hannah, U. G. Jelger, & H. Peterson (Eds.), Nursing informatics: Where caring and technology meet (pp. 331-343). New York: Springer-Verlag.

Mail survey of nursing directors of JCAH-accredited hospitals of 200 beds or more located in the metro-Washington area and other selected locations. A response rate of 76% was obtained.

Murphy, M. A. (1984). Computer-based education in nursing: Factors influencing its utilization. Computers in Nursing, 2(6), 218-223.

Review of factors influencing implementation of CAI, including the research on the effectiveness of CAI in nursing and in other subjects and problems with CAI research. Forces driving and restraining the use of CAI are discussed.

Murphy, M. A. (1986). Preparing faculty to use and develop computer-based instructional materials in nursing. Journal of Medical Systems, 10(2), 109-120.

A 1983 survey of a randomly selected group of 100 administrators of NLN-accredited baccalaureate programs about use of computers in nursing education. "Usable responses were received from 80 subjects; this sample was found to be representative of the total NLN population from which it was drawn" (p. 111). Discusses faculty development approaches and outlines components of a multifaceted approach to faculty development for implementing CBE.

National League for Nursing. (1988). Nursing data review 1987 (Publication No. 19-2213). New York: Author.

A report of two major surveys: the annual survey of state-approved schools of nursing (1985-86) and the biennial survey of nurse faculty (1986).

Rizzolo, M. A. (1988). Factors influencing the development and use of interactive video in nursing education. A Delphi study. Unpublished doctoral dissertation, Teachers College, Columbia University, New York.

A three round Delphi study to identify factors impeding the development and use of interactive videodiscs in nursing education "to formulate policies and priorities for planning and action to facilitate its development and use." There were 31 respondents: 18 from academia, 5 from continuing education, and 8 from "business" settings.

Thomas, B. S. (1986).Instructional computing in American nursing programs. International Journal of Nursing Studies, 23(3), 221-229.

Winter of 1983-84 survey of 305 NLN-accredited baccalaureate and higher degree programs. Usable responses received from 157, or 51%, of the programs. Purposes were to describe status of instructional computing, identify factors inhibiting its growth, and identify potential remedies for the identified problems.

Walker, M. B. (1986). Nursing education: Challenges of the computerized environment. Computers in Nursing, 4(4), 166-171.

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