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The new developments in computer technology are changing the way training professionals look at computer-assisted instruction (CAI). Nursing educators and practitioners can plan on CAI capabilities that will be both possible and economical as well as within the reach of most organizations. Health care delivery may not be in a position to forego multimedia training as part of its repertoire. In this article, we review interactive video instruction as a multimedia tool in nursing education with an emphasis on the new developments in hardware and software technology. In particular, we examine the changing role of CD-ROM technology and how it has become a tool to change the face of CAI. We define the current status and future trends in CAI and interactive video instruction for nursing education. Several key definitions are introduced to reflect the new direction of multimedia in nursing education.
Key words: Computer-assisted instruction, Computer-based training, CD-ROM, Interactive video instruction, Nursing, Training, Technology.

New developments in computer technology are changing the way nursing educators look at computer-assisted instruction (CAI) (Sittig et al, 1995; Thede, Taft, & Coeling, 1994). In the near future, economical CAI capabilities will be both available and affordable to most organizations. Unfortunately, many of the training and educational applications that have been used have done nothing more than automate manual processes. "Just as early computer technology did little more than automate manual methods of doing business, so, too, instructional technology, or computer based training, has provided scant improvement over printed books and standardized test forms" (Williamson, 1994, p. 74).

Health care educators will need to incorporate multimedia training techniques as part of a multidimensional educational process. Nursing education is a prime candidate for the integration of multimedia as a teaching tool because nurses must learn as well as communicate complex issues to their patients. In addition, the changing development of multimedia technology will make the production of multimedia presentations that are tailored to individual patient needs commonplace. Thus, multimedia is important not only for nursing education but also for patient education.

To discuss the role of multimedia in nursing education, three issues will be examined. First, the role of CAI in nursing education will be presented. Second, the role of CD-ROM in CAI and multimedia will be covered. Third, some of the pitfalls in implementing multimedia in nursing education will be discussed.

Computer-Assisted Instruction/Interactive Video Instruction—Multimedia

Studies have shown that 20% of nursing students have anxiety when using computers (Lowdermilk & Hopkins-Fishel, 1991). Thede et al (1994) further found that students often were reluctant to use CAI. Yet, CAI has been shown to enhance computer literacy, facilitate decision-making skills, and positively affect student achievement (Wilson, 1991). Educators "are convinced that the tools offered by multimedia technology will help students to be-

come more creative, more knowledgeable, and more curious about learning" (Athappilly, Durben, & Woods, 1994, p. 117). In addition to the intrinsic value and quality of the training itself, the use of "hands on" training is an excellent way to overcome the inherent computer anxiety. More importantly, research has found that people retain only 20% of what they hear; 40% of what they see and hear; and 75% of what they see, hear, and do (Fletcher, 1990).

Some nursing education programs make extensive use of interactive video instruction (IVI); however, students have not seen the value in many of these applications. This lack of interest often has been due to either the quality of the media or the way that the instructor has chosen to integrate it into the course (Thede et al, 1994). Yet, as the complexity of nursing education continues to increase, the need for alternative educational delivery mechanisms increases. Nursing faculty members are teaching concepts with shorter half-lives. Kay (1991) argued that, "In the past few decades the task before children—before all of us—has become harder. Change has accelerated so rapidly that what one generation learns in childhood no longer applies 20 years later in adulthood" (p. 140). As a result, instructors increasingly find the need to integrate the expertise of others into their teaching. Miller (1994) suggests that the use of multimedia instruction will further enhance both the quality and consistency of the instruction.

Unfortunately, hardware and software availability has not made this transition easy. Cambre and Castner (1993) cite the cost of hardware and software, technical problems, and procuring appropriate videodiscs as being barriers to the use of IVI in nursing education. However, these barriers are disappearing rapidly because CAI/IVI is being focused more under the umbrella of multimedia technology.

In nursing education, multimedia has shifted from overheads and slides as the primary visual aids to videotape, PC programs, and, most recently, videodisc technology. The latest advancements in PC technology, multimedia systems, and software hold the promise of making multimedia training tools more effective and available than ever before.

The benefits of integrating multimedia into the training/educational environment can be grouped into three categories (Athappilly et al, 1994). First, quality multimedia applications should reduce costs. Although the initial costs for hardware and software are significant, nursing departments should expect to realize substantial labor cost reductions from both instructor time and participant time. Second, the effectiveness of training will improve. Effectiveness is influenced by consistency of educational delivery, mastery of learning, improved retention, and increased student motivation (Miller, 1994). Third, productivity can be improved through increased satisfaction and enjoyment of learning. Jerram (1994) suggests that the use of multimedia in this context helps educators to develop knowledge management programs.

Nursing educators have numerous options for the use of multimedia technology in and out of the classroom. Yet, the use of multimedia often is limited on university campuses because of both cost and expertise considerations (Michelman, 1994). Nursing educators now can use new, user-friendly tools designed with multimedia, thus making computers both effective and affordable in supplementing traditional methods of nursing education. The key to success in these applications is integration of the technology rather than merely adding on to the previously designed instructional program (Thede et al, 1994).

Falk and Carlson (1992) suggest that the first step in this process is to "educate educators" on how multimedia can be integrated into the learning process. "The first step is to train the trainers—key educators—with current knowledge. This training should demonstrate the use of simulated interaction, structured observation, didactic presentations, exploration, and other models of instruction while employing multimedia as both a teaching and learning tool" (p. 101). As educators attempt to engage all students' senses and appeal to their ever-growing need to be stimulated by both audio and video media, multimedia through its use of video, audio, image, animation, and data images becomes an effective delivery tool for communicating educational objectives (Integrated Voice, 1991; Van Horn, 1991). More importantly, multimedia offers the opportunity to involve the student as an active participant in the learning process (Bruder, 1991). "Research and experience indicates that use of multimedia leads to enhanced learning of criteria such as acquisition of content, development of skills, efficiency of learning, and satisfaction with instruction" (Falk and Carlson 1992, p. 96).

Salomon, Perkins, and Globerson (1991) suggest the need to examine both technology as the *object* of instruction and, more significantly, as a *tool* for instruction as we attempt to enhance the way that people think. "Effects *with* technology can redefine and enhance performance as students work in partnership with intelligent technologies those that undertake a significant part of the cognitive processing that otherwise would have to be managed by the person" (p. 8). As a result, the student becomes a more active participant in the learning process. Salomon et al (1991) further argue that the "effects *of* technology can occur when a partnership *with* technology leaves a cognitive residue, equipping people with thinking skills and strategies that reorganize and enhance their performance even away from the technology in question" (p. 8). The concept of "cognitive residue" suggests that the impact of technology can be enhanced greatly if technology

is integrated into the learning process rather than merely into the curriculum (Michelman, 1994). The integration of technology throughout the nursing curriculum is consistent with what Ishida et al (1994) have described as a "multimodal teaching strategy." From this perspective, many different techniques are used to allow for variability in student and patient learning styles and methods of knowledge transfer (Ulrich, Teets, & Quinn, 1994).

Nursing educators also must remember who the ultimate audience is. As nurses work to educate patients in many aspects of their own care, the use of CAI becomes a powerful medium for visually communicating nursing care plans to the patient. As the cost of the technology continues to decrease, compact disks (CDs) that are tailored to a particular patient's needs can be prepared by the nurse and given to the patient to take home for additional learning or involvement of other caregivers. The creation of unique CAI for individual patients is possible and will become commonplace as the cost of production continues to decline and the availability of patient information databases continues to increase (Dataware Technologies, 1994a; 1994b).

CD-ROM Drives Multimedia

Multimedia has become a major focus for advancements in PC technology. Personal computers and peripherals continue to become more powerful and less expensive. Perhaps the greatest influence on multimedia have been the advancements in CD technology CD-ROM and CD-R (recordable). A CD-ROM disk is capable of storing 650 MB of data, equal to approximately 1,500 floppy disks, 250 pages of text, or 12,000 scanned images.

Today, IVI uses videodisc technology because it has the storage capacity to hold the large amounts of data required to handle full-motion video. Like videodiscs, CDs are an optical storage medium, whereby a disk of reflective material is "burned" by a high-power laser. The presence or lack of holes defines the data stored. CD-ROM can be looked upon as a natural evolution from videodisc, much like the change to cassette tape from 8-track tape in the 1970s. Like VCRs, CDs also incorporate virtually the same technology for recording and playback of data. Yet, unlike a tape that requires data access to be sequential, videodisc and CD-ROM allow random access to the data based on the needs of the user at that time.

To illustrate how much of an impact CD-ROM is having on the PC and multimedia industries, shipments of CD-ROM drives in 1993 jumped to 6.3 million from 1992's 2.5 million, with an expectation of 14 million drives to ship in 1995 and 18 million in 1996. By the end of 1994, nearly 23 million CD-ROM drives were expected to be attached to PCs (Fritz, 1994b). In addition, at the end of 1994, one of five PCs in use were considered "full-fledged" multimedia machines equipped with both a CD-ROM drive and sound card (Wilken, 1994).

Virtually all PC vendors offer CD-ROM drives as standard equipment on many product lines. Software vendors often ship their software on CD-ROM. Compact disk "jukeboxes" have been developed that allow for accessing and sharing multiple CDs through networks. Kodak's photographic CD technology and the many on-line encyclopedias are two examples of applications exploiting the massive storage capacity of the CD-ROM for text and video storage. Digital encyclopedias are outselling printed versions three to one, whereas an additional 2,500 CD-ROM titles are estimated to have been marketed in 1994 (Shaffer, 1994). The availability of these technologies must be exploited in the learning/training process.

In the health training and education field, multimedia has been adopted by many education programs on and off campus. For example, ADAM Software, Inc. (Marietta, GA), sells interactive software on CD-ROM that allows medical and nursing students to perform dissection on the computer screen with a scalpel-like cursor. Perhaps one of the most interesting aspects of this particular software product is that a modified version of this software is being marketed directly to consumers on CD-ROM. Students who before had to perform their dissections on cadavers now receive the same instruction and results by using interactive multimedia. With a decrease in available cadavers to medical schools, multimedia is filling a need in the education of medical students (Wiegner & Schlax, 1991).

To bring these capabilities to the desktop PC, "authoring" software has been developed that allows users to create their own multimedia/interactive training tools. Data from videodisc, VHS tape, existing computer files, or still images can be incorporated into one file for future use. This file can be modified by adding audio or overlay information, then recorded on a videotape/VCR or CD-ROM disk, or transmitted directly to a standard television for viewing by the student (English, 1993).

Most authoring systems come with vendor-provided training, documentation, and useful on-line help features. Consulting groups will provide high-quality, personalized training tools. These solutions will cost more than current vendor-supplied tape or videodisc titles; however, if they fit the organization's educational needs, they may facilitate enhanced learning. As equipment gets less expensive and technology makes the process easier, nursing programs and medical facilities should be able to create the majority of their own multimedia educational training tools in-house, rather than having to purchase them from vendors (Harden, 1994).

What will become of the videodisc courses currently being used by health care organizations on and off campus? Economics and ease of use are driving the market to

CD technology. Compact disks are easier to handle, and the hardware to record and play CDs as well as the CDs themselves are less expensive than videodiscs. The videodiscs that are in use can be incorporated into training programs as is, or they may be incorporated through available authoring software. It is important to point out here that the use of media from other sources has major copyright implications and should not be undertaken without first addressing these issues (Werbel, 1994).

Perhaps the biggest change in CD technology is the increasing availability and reduced cost of CD-R. The cost of recordable CD drives has dropped from $100,000 in 1990 to $2,000 in 1995, and is expected to drop below $1,000 sometime in 1996. In addition, the cost of a recordable CD in 1995 has dropped to about $12 when purchased in quantity (Ryan, 1995). These price changes suggest that the ability of both nursing educators and practitioners to make use of patient care plans and educational resources from central databases is just around the corner. As educators try to envision these opportunities, they should consider that future multimedia presentation development will become no more difficult than using desktop publishing that is present in 1995. Yet, the major advantage of CD-R technology is that once a disk has been recorded on, the contents are permanent (Dataware, 1994b).

Pitfalls to Overcome

Although the CD-R technology seems advantageous, there are still obstacles to overcome. Integration of many different hardware and software systems is being slowed by the lack of a standard on how data are transferred between devices and how the data are stored on CD-ROMs. Acknowledging this fact, the American National Standards Institute has formed a subcommittee to address this issue (Fox, 1994).

A second hurdle has been that the quality of full motion video on CD-ROM has not been as good as that on videodiscs. This problem is being addressed by vendors with some successes already being announced. The technology that was needed to create video CDs has been refined and will allow the distribution of full-length motion pictures on CD (Fritz, 1994a). In addition, Mammoth Micro Productions has announced hardware and software solutions to the cross-platform compatibility problem called "StudioXA" (Guenette, 1993). Also, the Moving Picture Experts Group developed the "MPEG-1" standard that reduced (by 1/150) the amount of data required to store full-motion video (Mannes, 1993). This standard will allow data transfer between the CD and the PC at a rate of 1.5 megabytes per second (Leek, 1994). Using this standard, JVC, Inc., and Phillips, Inc., have demonstrated

full-motion video from CD-ROM that is almost indistinguishable from VHS tape.

Even with some acceptance of CAI, there is a hesitancy to use its capabilities. Yet, with the population reading less, CAI is a method that can be used to improve the reading habits of adult learners (Van Horn, 1991). As we expand the role of nursing in the 1990s, it becomes imperative that we find new and innovative ways to communicate with students and patients. The need to reexamine the way technology is used in nursing education is illustrated by the paradox described by Tufte (1990) when he states, "The world is complex, dynamic, multidimensional; the paper is static, flat. How are we to represent the rich visual world of experience and measurement on mere flatland" (p. 9)?

Although nursing often is portrayed as a two-dimensional, static activity, is that the reality, or is it the way that has been chosen to simplify the description? This characterization of nursing in this two-dimensional world of papers, charts, and schedules is what often leads to confusion by students and more importantly to the ultimate user of nursing information—patients (Michelman, 1994).

Some question the relevance of CAI. The key may be to introduce CAI as a practical tool that is close to the traditional learning methods of the past. The hope is that learning styles will change based on the exposure to these new communication models. These changing needs suggest the importance of taking a critical look at how the concepts are communicated to both students and, more importantly, to patients. Falk and Carlson (1991; 1992) suggest that the need for change in all aspects of education often is hindered by the same forces that foster quality instruction. In a sense, what happens is that instructors continue to teach as they were taught rather than creating the radical change that is necessary by new technology. Although many instructors may feel more comfortable teaching in the way that they were taught, the technologies require courses to be both redefined and redesigned (Michelman, 1994).

As the role of technology in nursing education is examined, a new conceptualization of how to teach must be developed. Yet, a major hurdle for nurse educators may be to determine what is important in the educational setting and translate that learning to the students in the classroom (Falk & Carlson, 1992), to those in practice, and for future continuing education programming (i.e., telemedicine).

Computer-assisted instruction is a convenience for those at distant sites. The computer and its accessories can jump across time zones. Students determine their best time for learning. With fiber-optic multimedia networks becoming a reality in 1995, the cost of transmitting educational programs will drop, allowing us to reach out to ru-

ral sites and into inner cities (Nichols, Beeken, & Wilkerson, 1994). The cost of production is still high for some lower-funded organizations; however, that is on the decline (IBM, 1994).

Although the benefits of multimedia are vast, educators must be careful to use the technology with planning, care, and, most of all, caution. Caution is important because a poorly designed application can detract the focus from the instructor's educational objectives. Instructors should ensure that communication is clear, visible, and understandable. Amusing but uninformative presentations degrade rather than enhance the learning process. Faculty should consider time, place, and audience before designing any application.

Faculty also should recognize the cost of multimedia. Besides the cost of hardware and software, multimedia application development is very costly in terms of faculty time. Learning curves are steep and will require faculty members to make sacrifices in other areas. As a result, the incentive to develop these applications must be tied to both faculty teaching load and the promotion and tenure process. A failure to recognize these efforts in annual evaluations will prevent many faculty members from attempting to integrate multimedia applications until it is made available by others (Michelman, 1994).

Conclusion

Nurse educators need to evaluate changes being made in the use of multimedia technology as an education and training tool. They should construct a "wish list" of subjects that would be covered in multimedia presentations. Organizations should consider the unique clinical experiences that may be encountered at the facility that are not available on any videodisc titles. Organizations should look beyond the formal nursing school curriculum to in-service presentations and continuing education needs for both students and patients. Both of these areas offer opportunities for the type of tailor-made multimedia training presentations that are becoming possible through the advancements in technology and software products. As nurse educators begin to "train the trainers" (faculty) with these new and exciting technology applications, it should not be forgotten who the ultimate trainee (the patient) is and begin to consider these opportunities.

Nurse educators should consider internal and external alliances to share the resources required to implement multimedia solutions. Most hospitals and universities have PC expertise on staff, as well as on-going needs for creating state-of-the-art multimedia presentation materials. The same equipment and software required for multimedia training can be used to create and maintain excellent "camera-ready" slides/overheads, printed materials, graphics, and video for use in marketing or executive presentations.

Health care organizations and nurse educators should consider the requirements of multimedia when buying or upgrading multimedia components such as PCs, VCRs, camcorders, CRTs, and televisions, or other video display devices. A designation of "multimedia ready" does not ensure that a system will be able to handle the full-motion video requirements normally associated with nursing education courses (Riofrio, 1993). Table 1 identifies the key components of a multimedia system and current preferred specifications. Technological advancements are constantly changing both required specifications and the capabilities of equipment to meet or exceed them. Authoring systems and training

Table 1. Multimedia Configurations

To run current videodisc or CD-ROM titles the minimum preferred system would include:
- a 66 MHz 486DX or comparable PC with 8MB of RAM and a 540MB hard drive;
- a 15-inch SVGA card & monitor - 1,024 × 768 pixel resolution with one megabyte of video RAM;
- a CD-ROM drive meeting the minimum MPC (Multimedia PC Marketing Council's) standards: double speed is suggested;
- a sound board and earphones or speakers; and
- a computer-controllable laserdisc player.

To author multimedia titles yourself, the requirements will be dictated by the authoring system(s) you have chosen. However, for best results the minimum configuration will likely include:
- a 100 MHz Pentium or comparable PC with 16 MB of RAM, 1 gigabyte or greater hard drive and video compression capabilities;
- a 17-inch SVGA card & monitor - 1,024 × 1,024 pixel resolution with one megabyte of video RAM;
- a dual or quad speed CD-ROM drive that exceeds MPC spec's;
- a studio quality microphone, 16-bit sound board, and quality speakers or headphones;
- a color scanner; and
- a Super-VHS or Hi-8 VCR, a camcorder, a video capture/delivery board and a computer-controllable VCR.

Multimedia technology is changing rapidly. Requirements and capabilities will surely have changed by the time this article is published. Before purchasing any hardware or software, you should perform the following three steps:
1. Review current multimedia and educational publications for the status of multimedia hardware and software developments, particularly with respect to hardware integration, CD-ROM standards, and most importantly, what kind of video quality you can expect.
2. Confirm this information with experts in-house and through nursing education (FITNE) or multimedia trade groups.
3. Ask specific questions of vendors and existing users of their hardware and software relative to cost, ease of use, and performance. Observe the product first hand.

MPC = Multimedia PC Marketing Council; SVGA = super video graphics adapter.

courseware vendors should be able to provide specifications on the equipment required to use their products. Most PC publications run periodic reviews of multimedia systems and equipment, including recommended specifications for maximizing performances.

For now, there are almost daily breakthroughs in multimedia technology. One has only to glance at the PC section of the magazine rack at the local newsstand or grocery store to see a multitude of publications that explore the latest information on PCs, CD-ROM, and the growing field of multimedia technology. Some examples are *PC-World, CD-ROM World, CD ROM Professional, Training,* and *VIDEO Magazine.* In addition, the journals *New Media* and *T.H.E. Journal* are available free to any faculty member who is interested in better understanding the role of technology in education. Suppliers of training materials, particularly those selling VHS or videodisc courses, are available to provide direction as to where they are headed relative to titles going to CD-ROM. As educators, the challenge is to remain current on this advancing technology for it will have a major impact not just on nurse education and training, but also on health care education and ultimately the delivery of health care.

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