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Synopsis

Education

1. Introduction

The past two years, 1996 and 1997, may well be considered an important turning point for the discipline of medical informatics through the initiation of several activities that will substantially shape the nature of education in the field well into the next century. Several factors contribute to this perspective. What is new and exciting from past years is the renewed energies devoted to a wide variety of advances in education in medical informatics and the resulting promise of those advances. The papers selected for this section represent a sampling of that promise. For the purposes of this synopsis, education in medical informatics is defined as encompassing two areas of endeavor: (1) the training of professionals in the use of computers in health care, and (2) the use of computers in medical and allied health education [1].

With regard to education in medical informatics, this past year has seen a number of activities on several fronts that have sought to define more clearly what constitutes education for health care providers and career professionals in medical informatics. By the end of 1997, the Medical Informatics Advisory Panel of the Association of American Medical Colleges' Medical School Objectives Project will have published its final report on informatics content for medical schools in the United States and Canada. Also by late 1997, the Education Committee of the American Medical Informatics Association will have produced a preliminary report defining a mechanism to arrive at core competencies in medical informatics to be used as the basis for training and education in the field. Also in 1997, the Education Working Group (WG1) of IMIA will hold its 6th triennial meeting addressing the theme "Transformation of Healthcare through Innovative Use of Information Technology for the 21st Century." Topics at this meeting will include "Basic core requirements for health and medical informatics education for all levels of health care professionals" [2]. In addition to these initiatives, strident discussion has appeared in the literature regarding the nature of professionalism in the field of medical informatics and how training should be conducted [3-6], and the degree to which medical informatics is a science [7-8].

In reference to the role of computers in health education, Friedman and Dev [9] suggested a broader view of what "constitutes educational work in informatics" in a 1996 editorial. They identified four areas for the development of educational resources: (1) domain-specific courseware; (2) information resources for learners; (3) tools to support administration of educational programs; and (4) applications for testing and assessment. Advances have been made in all of these areas in the past year. Highlights from the year include the proliferation of Internet-based continuing education programs with CME credit available directly on the World Wide Web (WWW) [10]; initiation of live, interactive continuing education seminars [11]; expansion of the use of interactive, adaptive computer-based testing to specialty board licensure in nursing [12]. This shift presages greater use of technology in both testing and in the development of test materials in medical specialty licensure. Also worthy of review are reports in the 1996 special issue of the Journal of the American Medical Informatics Association devoted to education in medical informatics [13-16]. These initiatives, along with those described in the articles selected by the editors for this section of the Yearbook serve to illustrate how the medical informatics community is responding to the challenges for resource development set forth by Friedman and Dev [9].

Of course, these issues will not be resolved here. In fact, the papers in this section, while they address training in the use of computers indirectly, their primary focus is on the use of computers in education and training. Additionally, many of the issues raised above are not new; questions of curriculum content and basic versus applied science are as old as the field.

2. Computerized Problem-Based Learning

The first article, "*An electronic study guide for problem-based learning,*" by Mooney et al. [17] presents a fine example of the use of computers to assist education through domain specific courseware. The authors describe a prototype application, called LETSGO, for self-directed learning the topic of oncology. This prototype will form the basis of a general software application to provide computer-based, self-directed instruction for the four years of medical school in the United Kingdom. The approach is novel in its focus on problem-based learning (PBL).

Problem-based learning (PBL) has slowly gained acceptance in medical education since its introduction more than three decades ago. The technique, in contrast to traditional lecture presentations, relies on the development of problem solving skills through group interaction. Students work through problems (typically a clinical case scenario) as a group in the belief that the students are exposed to material equivalent to that presented in a didactic format, but in a manner that is more conducive to developing the problem solving skills required of a practicing physician. Ironically, the use of computers and computer-aided instruction are somewhat antithetical to PBL. Traditional models of computer-aided instruction focus on individualized, self-paced learning. PBL focuses on group interaction. Although case-based simulation systems have been in use for some time, the report by Mooney, et al. on the application of computer-aided instruction to PBL is one of the first to appear in the literature [18].

LETSGO, an Electronic Study Guide for Oncology, brings together a number of important features in support of problem-based learning: Brainstorming (group work), links to core knowledge, and user assessment. The authors describe a "brainstorm pad" as the fundamental point of interaction with the system. As the problem-based learning module unfolds, the users record their learning goals and the information gleaned from the problem case scenario presented by the system. The use of the brainstorm pad for recording ideas of both the individual and group provides a common point of reference for making explicit the learner's thoughts. In addition to the brainstorming pad, the software provides links to relevant study material and information on the problem scenario. Although such links have come to be expected in a computerized learning environment, they are essential in a PBL setting, as they form the corpus of material to be learned. Also, while largely undeveloped in this prototype, the software incorporates a variety of methods of automated assessment and provides feedback with peer comparisons.

The LETSGO project as reported is a prototype. Further extension of this model should lead to valuable information about the application of technology to problem-based learning. Based upon the model demonstrated by LETSGO, the components for more advanced PBL software currently are available. The increasing power of personal computer workstations and improvements in multimedia systems continue to lead to more sophisticated case simulations. The growth of the World Wide Web provides a seemingly ever-expanding base for portable links to core and supporting knowledge. Finally, as workgroup and collaborative software become more widespread, group-interactive software in support of PBL will also likely grow.

3. Hypermedia Instruction

In the second article, Okada and O'Brien [19] describe advantages of hypermedia for instruction in introductory biomedical statistics. This application addresses two of the areas identified by Friedman and Dev, domain-specific courseware and information resources for learners. In this descriptive paper, the authors present a "model electronic handbook (in distinction to a textbook) for learning and applying biomedical statistics." Long before the explosive growth of the World Wide Web (WWW), the appeal of hypermedia instruction has been demonstrated many times over using the venerable HyperCard software available on the Apple Macintosh [20].

Although programs like HyperCard are being supplanted by distributed hypertext and hypermedia over the Internet, the authors describe the useful integration of nonlinear instruction and interactive presentation of material that transcends any particular computer platform. In fact, the use of HyperCard may seem quite dated. However, previous to the advent of Java, server-side program for interactive WWW applications were limited and awkward. Only with the maturity of Java over the last year, have the tools become available to the same level of interactivity described by Okada and O'Brien. It is likely that 1997 will see reports in the literature of platform independent educational materials developed in Java for use on the Internet.

While interactive hypermedia systems for instruction have become generally accepted, their utility continues to require further assessment. The expansion of the Internet and growth of tools for the development of distributed, hypermedia content have already led to a flood of interactive instructional and resource material for medical education. This same growth raises several questions that must be addressed by further research. First is the assessment of the method of delivery. The low cost and seeming ubiquity of access to the Internet in educational settings does not necessarily mean the Internet is the best mechanism for delivery, nor even the most accessible. Second is the assessment of the educational quality of Internet software. The culture of the Internet tends to lead to the production of free or low-cost software that is widely available in academic settings. At the same time, software developed for Internet distribution has not been noted for its reliance on established design principles for educational software and user interface design. Third, the Internet seems to have overcome barriers to distribution, in terms of access to both producers and to consumers of information. Today, nearly every user of the Internet can also be a producer of information. This leads to wide variability in the quality of information available. All of the issues described are further complicated by the sheer size of the Internet. Scalability of both assessment tools and quality measures is essential.

4. Patient-specific Case Simulations

The third and fourth articles are similar in their focus. Both papers present reports of successful implementation and use of computer aids for the planning and performing of surgical techniques. The editors have selected reports of similar developments in the use of imaging in support of preoperative and intraoperative feature localization. The work reported by Hayashi et al. [21] and by Vander Sloten et al. [22] demonstrate advanced applications resulting from computational integration of imaging, direct physical measurement, and other patient data. Although the authors do not specifically report educational uses of their systems, the preoperative simulation aspects of both reports represent important harbingers for the future of medical education in the areas of anatomy and surgery.

For several years programs have been available that provide simulated anatomy of humans. These programs range from simple anatomical illustrations designed for home educational use, through reasonably sophisticated programs designed to teach anatomy to medical students [23], to high-end modeling systems (such as those described here) based on principles derived from computer-aided design software intended to assist surgeons in planning and performing dangerous or difficult procedures. The previous two years have seen tremendous growth in this area with the release by the US National Library of Medicine of the Visible Man and Visible Women data (discussed elsewhere in this volume). Applications using the NLM Visible Human Project dataset have resulted in real-time dissection software based on real human data [24]. The use of real human data has tremendous potential for educational purposes.

There are, however, acknowledged limitations of the data of the Visible Human Project. One disadvantage is that the Visible Human Project contains data for only one male and one female. Although different approaches have been suggested for the representation of normal and pathological variability in simulated cadavers, ultimately, clinicians must face the natural variety of the human form. The systems described by Hayashi, et al. and by Vander Sloten, et al. are representative of a possible next step in anatomical and surgical simulation. Although neither report provides data on the impact of the systems on clinical training, such use can easily be extrapolated from the need the authors describe to enable the surgeon to practice or simulate surgical procedures. Over time, data from patient cases can be accumulated to provide greater variability in simulations to which users may be exposed. More significantly, the data can be matched to real surgical outcomes, thus improving the quality of the feedback used for the simulations. Systems like those described will permit the development of a library of educational case simulations, as well as provide preoperative simulations and intraoperative assistance when actually performing a surgical procedure on a specific patient.

5. Conclusion

The papers presented in this section provide evidence of continuing progress in overcoming technical barriers to the use of computers in medical education. In fact, the dizzying pace of technological advancement assures nearly limitless opportunities for investigation of applications of computers to health care and the education of health care professionals.

Despite the possibilities, many obstacles remain. Although there is general agreement regarding the positive impact of computers in health care, computers are yet to be fully integrated or utilized in the practice of medicine. Similarly, the use of computers for the purposes outlined by Friedman and Dev - instruction, assessment of learners, access to information resources, and managing the educational process is widely viewed as a positive, however, computers are not yet universally incorporated into medical education and there remains apprehension. even resistance, to the use of computers by both medical students and faculty.

These barriers may be addressable, in part, by a change in focus. Education is inherently a human endeavor, the goal being the improvement of the (human) student. Whether using computers to teach or teaching people to use computers, the human nature of the enterprise must not be lost. Along with advances in the computer technology, efforts must continue to be made to understand the learner and the process of learning in order that the computer will have its greatest effect, both in the educational process and as a result of the process. Friedman and Dev suggest a similar approach through greater collaboration between medical informatics and education professionals. New collaborations may offer new insights to old problems, as well as new opportunities.

The future is bright. Greater integration of computers into medical and allied health education promises to be a challenge continuing into the next century. And in the challenge lies the excitement.

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