Educational Technology and Instructional Development in Health Care[1]

By

Craig Locatis

Introduction

Educational technology is employed in different settings. General societal forces affect each context, and those working in a given setting have their own priorities, values, and culture. All of these factors affect the education and training agenda and, consequently, the way technology is used and instruction is created. In this chapter, I review educational technology and instructional development in health care settings, especially as it relates to educating and training physicians and other health professionals. I emphasize medical education particularly, since many trends in medicine carry over to other health science disciplines. Although professional education is stressed, related areas, such as patient and consumer health education, also are addressed. The chapter begins with an overview of education in different areas of health and a brief history of medical education. The latter is used to frame a discussion of education and training in the health care field and the factors currently driving application of technology and development of instruction. Educational issues important to the health science community are identified, and an attempt is made to portray the overriding concerns of those working with education and training in health care.

Education, Technology, and Health Care

One of the first things that you learn working in the health care field is that it is very broad. Most of us associate health care with hospitals and doctors' offices. The health care field not only involves the delivery of health services, but also biomedical research. It includes the medical profession and its varied sub-specialties plus the professions of veterinary medicine, dentistry, nursing, allied health, and public health. Biotechnology (the use of DNA and protein sequences to engineer biological substances) and

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medical informatics (the application of information-communication technology to support medical research, practice, and education) are emerging as new sub-specialties due to advances in genetics and computer science. The health field not only includes varied professions and specialty groups, it also embraces such related sciences and disciplines as anatomy, biochemistry, molecular biology, physiology, and psychology. In addition to academic institutions, hospitals, clinics, and research centers, the health care field can also include certain regulatory agencies and industries involved in drug manufacturing, genetic engineering, and medical instrumentation. When you take a pet to the vet, visit a pharmacy, eat in restaurant, or buy food at the grocery store, some one in the health sciences, either directly or indirectly, has affected your life. Health care is comprised of sub-settings, and education and training varies in each.

The most obvious sub-setting for education and training in health care is the professional schools, especially schools of medicine. Medical schools have departments of medical education that evaluate students and courses and develop curricula. Many have departments of biomedical communication doing medical illustration, photography, and video production. Some have academic departments in medical informatics doing teaching and research related to the application of computer and information technologies. Others have telemedicine offices for distant consultation and learning. Medical libraries provide computing and information resources supporting research and education and they usually have learning resource centers. Other health professional schools may have one or more similar departments, depending on size, and large university medical centers may have several professional schools sharing a single medical library. Many medical schools have developed interactive multimedia education programs and have made educational materials accessible on the web. For example, the Universities of Utah and Washington have published brain atlases on CD-ROM and the web, while Yale University Medical School has published several CD-ROM and web atlases on medical imaging. The University of Iowa's Virtual Hospital and the Loyola University Medical School's LUMEN (Loyola University Medical Education Network) projects are efforts to make major components of the medical curriculum available online.

Other settings for education and training in the health care field include 1) federal, state, and local health departments, 2) hospitals, clinics, and other care giving institutions, 3) pharmaceutical and biotechnology companies, and 4) professional societies and health associations. The federal government's

Centers for Disease Control and Prevention operate a satellite network that regularly provides training to state and local health departments, and some of these agencies have their own in-house education and training resources. Hospitals, clinics, nursing homes, and centers for assisted living may have departments for training nursing and house staff. Pharmaceutical and biotechnology companies not only train sales and other staff, they often underwrite educational programs at medical schools and publish materials of interest to the health professions. Sandoz (now Novartis) publishes faculty developed courseware on CD-ROM, for example, while GlaxoWellcome provides a grant supporting the George Washington University Medical School's streaming audio web site, Frontiers in Medicine. Merck Pharmaceuticals offers the Merck Medical Manual, a classic reference work, as text, a CD-ROM, and a web accessible resource. Foundations having ties to pharmaceutical and other firms (e.g., The Nemours Foundation, the Robert Wood Johnson Foundation, and the Kellogg Foundation) also support a range of health science education programs. Health professions associations have conferences and journals and many are starting to publish materials in electronic form. The Radiological Society of North American publishes one of its journals, RSNA EJ, online -- a "journal", it should be noted, that consists mainly of tutorials and case studies.

One area of education and training that cuts across all health settings is continuing education. Most health professionals are required to complete a certain number of hours of continuing education each year. Almost every medical school and professional society has a continuing medical education (CME) program. Sometimes CME credit is provided for attending workshops and conferences, but it also can be obtained by documenting use of educational materials. There are now commercial enterprises offering CME credit for participating in educational activities over the web. One might register to participate in a seminar that is netcast or to discuss a case with others by posting comments to an online discussion forum.

Another area of education and training that cuts across settings concerns skills training, such as first-aid, and general health education. The latter might include education related to disease prevention and health promotion or information for patients or individuals "at risk". Large hospitals and clinics publish educational materials for the general public. For example, the Mayo Clinic offers The Mayo Family Health Book and other publications in both print and CD-ROM and operates the Mayo Clinic Health Oasis web site providing general health information. The Dupont Children's Hospital provides health information for children on its KidsHealth web site. Clinics and hospitals also offer classes for patients who are pregnant or diabetic. Associations publish information and educational materials for preventing or coping with certain diseases. The American Heart Association, publishes cookbooks and other nutrition, exercise, and lifestyle information for preventing coronary disease and stroke. Government agencies, such as the Food and Drug Administration and the Centers for Disease Control and Prevention, have education and publicity campaigns geared to discourage children's use of tobacco products and to inform groups about reducing the risks of HIV. While these more general health education and training activities are quite diffuse, occurring in some degree in almost every health setting, they are usually they usually are managed by health professionals and often are targeted toward specific patient or consumer populations.

Medical Education: A Brief History

Another of the first things that you learn in the health field is the key roles physicians play in providing health care and leading teams of other health professionals. This leadership extends to management and other areas outside the direct delivery of health care (e.g., hospital administration, drug development, and computer/information system operation). Trends and standards in medical education often spill over into other domains as a consequence. But there are additional reasons why medical education affects other health professions. There tends to be more research and evaluation of medical education programs, so much of the empirical evidence guiding education and training in health care, emanates from medicine. Other health professions often mimic medicine's teaching methods. Nursing and public health schools, for example, have adopted many of the case-based teaching methods that are currently popular in medicine. Knowing the evolution of medical education is very helpful in understanding the culture of health care and the role technology.

It can be argued that educational technology has had a place in medicine from the time of Andreas Vesalius and Leonardo da Vinci. Their drawings, based on dissection of anatomical structures, were some of the first attempts to codify medical knowledge based on direct observation rather than speculation, superstition, or religious beliefs, and their drawings can be viewed as "research works" as well as teaching aids. Although "science" in medicine dates back to the Renaissance, it was not until the early 1900's that there was a concerted movement to develop a scientific foundation for the medical curriculum, at least in the United States. In 1910, a report to the Carnegie Foundation for the Advancement of Teaching by

Abraham Flexner documented the evolution of medical teaching from apprenticeship to more formal education. The "Flexner Report" noted that the first medical schools in the United States appeared in the late 1700's and were devised to more efficiently teach basic information that would better prepare students for apprenticeship. It decried the fact that while the first schools were affiliated with universities, later schools were independent institutions and commercial enterprises that emphasized didactic instruction. The schools operated with minimal facilities and without hospital affiliation. Doctors could graduate by memorizing symptoms and doses (e.g., if there is lower back pain, give quinine). Laboratories, except those for dissection, were usually absent and there was very little emphasis on the biological sciences and new medical technologies (e.g., stethoscopes, thermometers, x-rays, and laboratory tests) that were revolutionizing medicine at the time.

The Flexner report called for medical education's re-alignment with colleges and universities and affiliation with teaching hospitals. It also called for the development of standards and the introduction of scientific rigor. The practice of medicine should be based on observed facts of the same order and cogency as in other fields of pure and applied science, and medical education should not commence until students had some level of college preparation. The following key observation was elaborated in later sections of the report:

> "For purposes of convenience, the medical curriculum may be divided into two parts, according as to the work is carried on mainly in laboratories or mainly in the hospital; but the distinction is only superficial, for the hospital is itself in the fullest sense a laboratory. In general, the four year curriculum falls into fairly equal sections: the first two years are devoted mainly to laboratory sciences, -- anatomy, physiology, pharmacology, pathology; the last two to clinical work in medicine, surgery, and obstetrics." (p. 57).

The report did state that some clinical work might begin in the second year, but the emphasis was on learning the scientific method. While the report acknowledged that there was controversy over whether laboratory sciences should be taught from basic science or applied, medical perspectives, scientific rigor and empiricism were the primary concern. The scientific method was the glue holding the curriculum together. The method could be employed for diagnosing and treating individuals as well as for biomedical research.

The Flexner Report was very influential, revolutionizing teaching and practice by introducing the concept of "scientific medicine" (Bonner, 1998). While medical education improved as a result, the form of medical education the Flexner Report established remained essentially unchanged for seventy years (Association of American Medical Colleges, 1984). Whether intentional or not, its categorization of laboratory and clinical science led to bifurcation of the medical curriculum. In the 1960's and 70's a movement for problem-based learning (PBL) began that was a reaction to what many perceived as the uncoupling of science and clinical content (Albanese & Mitchell, 1993). Howard Barrows, one of the method's foremost proponents, differentiated between learning content within a problem solving context rather than applying knowledge to solve problems after it is acquired (Ullmer, 1999). Borrows and others argued that the former approach lets students determine what they need to know, enables them to synthesize information from multiple disciplines, develop transferable problem solving skills, and acquire effective self-study skills for life long learning (Barrows & Tamblyn, 1979). The methodology proposed for attaining these goals was exposing students to a rich array of real and simulated patient cases (Barrows & Tamblyn, 1979). Cases are presented and students, usually working in groups, have to distill the patient's problems, generate hypotheses, gather data, and, if their background knowledge is lacking, independently research and discuss information bearing on the case (Barrows & Tamblyn, 1979). Although coincidental, a national network of medical libraries and departments of biomedical communication were being established that could support curricula based on independent research about the time of the PBL movement.

In 1984, the Association of American Medical Colleges' Panel on the General Professional Education of the Physician and College Preparation in Medicine issued <u>Physicians for the Twenty-First Century</u>. The "GPEP Report", as it is often called, recommended curricular reforms that shared many PBL objectives. The report recommended reducing lectures, providing more time for independent study, integrating basic science and clinical education, requiring more active problem solving, and promoting application of information sciences and computer technology. It also recommended consideration of social science and humanities undergraduate coursework in addition to science when admitting students to medical school, and providing clinical learning experiences in settings other than hospitals. There was concern that students entering medicine were too narrowly focused and that memorizing facts took precedent over acquiring skills, values, and attitudes. There also was concern that too much emphasis was placed on curing disease at the expense of promoting health. The report noted that the population of patients in hospitals did not reflect the patient population most physicians encounter in practice, that economic and other factors were causing care to be provided in non-hospital settings, and that an increasing number of varied health professions were becoming involved in providing care. While the GPEP Report did not specifically endorse PBL, it generated increased interest in the method (Albanese & Mitchell, 1993).

In 1986, the Association of American Medical Colleges (AAMC) issued another report, <u>Medical Education in the Information Age</u>. It summarized the proceedings of a symposium on medical informatics and defined medical informatics as a developing body of knowledge and set of techniques concerning the organization and management of information in support of medical research, education, and patient care. The report reviewed medical informatics in the areas of literature data bases, decision support systems, information systems, and computer-based education. It called for including informatics in the medical curriculum and establishing academic units within medical schools. The report echoed some of the themes of the GPEP Report, noting that the knowledge explosion in medicine required de-emphasizing acquisition of facts and stressing knowledge management and problem solving. Information technology in medicine could engender more effective and efficient patient care, expedite medical record keeping and other clerical tasks, and improve medical education by broadening and rationalizing clinical experiences. The report stated that the legal implications of medical practice required physicians to keep current and that information technology, whether used to search databases or participate in more structured learning experiences, could facilitate life long learning. Computers and their emerging multimedia capabilities were considered to be very relevant in skills training, such as x-ray interpretation, and computer-based simulations were determined useful in teaching problem solving. Like the GPEP report, <u>Medical Education in the Information Age</u> has affected reforms in medical school curricula (Salas & Brownell, 1997). But factors other than reports from the AAMC have influenced change. Indeed, the reports themselves are, to some extent, an outgrowth of some of the research and development on clinical problem solving, medical education, and computer-based instruction that was going on at the time.

Problem-based learning is supported by research on clinical reasoning indicating that expertise is largely a function of previous problem-solving experience. Problem-solving expertise is dependent on the type of patient cases encountered, rather than being general and "content-free". Instead, it is "content specific", requiring rich, elaborated conceptual information about particular diseases and illnesses that can be associated with problems patients' present (Schmidt et al., 1990). As expertise develops, problem solving becomes automatic and more a matter of pattern recognition then formal deduction (Norman, 1985). Pattern recognition is important in clinical reasoning on several levels. On the one hand, it is recognizing constellations of symptoms patients present are manifestations of different diseases and conditions. It also involves interpreting images and visual information, such as abnormalities in x-rays or features of skin rashes, however (Norman, et al., 1996). Clinical problem solving research strongly supports exposing students to a range of cases representative of what they may encounter in practice. Computer-based patient management simulations were identified as one means of providing problem-solving experiences and measuring them (Norman, et al., 1985). Reviews of the use of computers for medical education showed computer-based simulations to be the most promising application for developing problem-solving skill (Barnett, 1989; Piemme, 1988). The nature of content specificity in clinical problem solving and the use of computers for measuring these skills continue to be active areas of research (Eva, Neville & Norman, 1998; Luecht, et al., 1998).

Other research has documented the benefits of problem-based learning. Meta-analyses and literature reviews indicate that students in PBL curricula perform as well or better than those in traditional programs on clinical reasoning tests, but somewhat less well on basic science exams. PBL students also have much more favorable attitudes about how they are taught (Albanese & Mitchell, 1993; Vernon & Blake 1993). There is also evidence that PBL students tend to integrate, retain, and transfer information better and that they have superior self directed learning skills (Norman & Schmidt, 1992). Given that the costs and outcomes of traditional and PBL programs are about the same, but PBL is far more enjoyable, some have gone so far as to conclude that the choice between the two approaches is analogous to deciding whether to reproduce by sex or by artificial insemination (Norman, 1988). Problem-based learning is very popular today and communication and information technologies are recognized as valuable tools supporting the approach. Anyone seeking educational technology positions in the health care field needs to understand the philosophical and empirical foundations of problem-based learning and tensions that exist as teaching institutions try to move away from the more compartmentalized traditional approach to teaching that resulted from the Flexner Report.

Observations About Health Science Education

Many important points that can be made about health science education, based on our brief survey on health sub-settings and history of medical education. Several already have been mentioned -- that the health setting is diverse with varied training needs, that physicians have pivotal roles in providing health care, that trends in medical education affect training in other health professions, and that there is a strong tradition of research on clinical reasoning and educational methods. While the current thrust is toward case-based problem solving approaches to teaching, there are other points that need to be made about education in health care. Some may seem obvious, but they are worthy of discussion none-the-less.

The health professions are helping professions in which there is much at stake. The idea of healing and helping people is more than just rhetoric to those electing careers in health care. Health professionals are concerned about others and they have high standards of conduct. These standards are manifest in the Hippocratic Oath, ethics standards published by professional associations, "best practices" recognized by professional societies or published by government agencies and expert panels, and legal precedents. Educational technologists in the health care field, like the health professionals with whom they work, can derive satisfaction from the feeling that their work also contributes to the social good. The subject matter taught, the skills learned, and the techniques and technologies employed can have life threatening consequences. The health field is one area where errors in learning literally can be a matter of life or death. There are risks not only for patients, but for health practitioners and students. Health professionals do not wear rubber gloves because they are trying to make fashion statements. They are exposed to contagious diseases and they work with hazardous substances routinely. The education of health professionals is serious business, and that is one reason why clinical problem solving and medical education programs are subject to ongoing evaluation and research and why ethics and attitudes are continuing concerns.

It almost goes without saying that most of the work of biomedical practitioners and researchers depends on making observations and reasoning about them. Some of the observations are of numerical data, such as when doctors and nurses take blood pressure or when epidemiologists plot the occurrence and spread of disease. Others are of sounds, such as when doctors and nurses listen to breathing and heart beat. Still others are of images. The images can be visual representations of numerical values, such as EKGs. Most, however, are of "raw data" and include skin lesions that physicians see during physical examinations, cellular alterations and adaptations that pathologist identify with microscopes, and x-rays and other images that radiologists interpret. The sensory nature of the raw data dealt with by most health professions makes it hard to imagine how biomedical researchers and practitioners could learn without exposure to audiovisual and multimedia information. What educational technologist working in health care need to be prepared for is the acuity with which health professionals process sensory information, especially images. A diagnosis literally can be seen in a biopsy specimen or a radiograph. New diagnostic imaging technologies, such as magnetic resonance imaging and computer tomography, which help eliminate the need for invasive, exploratory surgery are highly valued. There is probably no tougher or sensitive jury when it comes to image quality than health professionals. If you want instructional materials to be rejected, just include some sub-standard pictures. The pictures used in educational materials do not have to be always of the quality needed for diagnosis (which obviously have to be the highest possible), but they do have to depict content accurately. Image artifacts that might be misinterpreted or that might engender misunderstanding are particularly offending and readily detected.

The role of sensory data in providing health care further underscores the scientific nature of the health professions. Those working with educational technology in health care work with subject matter experts who are either scientists or practitioners having backgrounds in science. These people see teaching as an outgrowth of their efforts to provide care or conduct research. Consequently, they are probably less likely than other academics to be ego involved in their teaching and more likely to be open to and appreciative of the assistance educational technologists can provide. What educational technologist in the health care field need to know is that this scientific background makes health professionals prone to ask tough questions and to give more weight to reason and evidence when making educational decisions. This penchant for science does not necessarily stifle creativity or engender conservatism and, in fact, may foster willingness to experiment with new technologies and teaching methods. Some of the more innovative educational technology applications have been from the health care field and many of these have been created by health science faculty and practitioners working intuitively on their own.

Factors/Issues Affecting Education and Training

Varied factors affect the development of instruction and the application of educational technology in different settings. A factor that is significant in one context may be negligible in another. There are many factors affecting education and training in the health care field as a whole, but perhaps the four most significant ones are knowledge and research, regulations and standards, cost and managed care, and convergence.

Knowledge and research. Knowledge advances rapidly in health care. Consequently, its currency and integrity are overriding concerns. Given the visual nature of much of the content, these concerns extend to the level of the pixel. Any instruction developed must have accurate, up-to-date information. Timeliness is so important the use of information technology is itself becoming an important ingredient in health science curricula (Salas & Brownell, 1997). Information technology is seen not only as a mechanism for delivering structured, formal training, but as a mechanism researchers and practitioners must use to keep up-to-date. Fortunately, the costs of information technology keeps declining and it is increasingly possible to use it in teaching. When the National Library of Medicine's Medline database of the published medical literature was first ported to CD-ROM, medical libraries could treat searching it as a fixed cost because the database was available by annual subscription instead of on a charge per search basis. This enabled greater student access (Rapp, et al., 1989) and the fact that students could access the latest information put pressure on faculty to keep themselves more current. Now that the Internet has eliminated the National Library of Medicine's need to support a separate telecommunications system for database access, the Library offers free online searching. The resulting surge in searching by the general public may put more pressure on practitioners to keep more current as well.

Regulations and standards. Regulations and standards affect education and training because they dictate what has to be learned. Many of the substances and devices employed in health care and the procedures for their use are regulated. For example, there are federal Occupational Safety and Health Administration regulations regarding the handling and disposal of needles and Environmental Protection Agency requirements for the handling and disposal of the mercury in medical products that certain health personnel are obliged to learn. There are also requirements concerning the certification of health personnel and mandated continuing education. Some certification involves formal testing that impact the curricula. Medical schools cannot ignore the knowledge and concepts that are assessed on National Board of Medical Examiner's (NBME) examinations, for example. When educational reforms like problem-based learning are proposed, differences between what the curriculum teaches and what the exams measure have to be addressed (cf. Albanese & Mitchell, 1993; Vernon & Blake, 1993). Of course, the NBME also wants to make its exams more effectively measure problem solving rather than basic knowledge, and it has an ongoing research effort to use computers to better assess the clinical problem solving skills that are being emphasized in newer curricula (Clyman, Melnick & Clauser, 1995).

Costs and managed care. Although tuition for some health professions (e.g., medicine or dentistry) can be high, education is a cost, not a profit, center for health care institutions. These costs often are underwritten from income generated by hospitals and clinics. Attempts to curtail rising health care costs, especially with the introduction of managed care, not only affect the delivery of health services, but professional education and training as well. Insurance companies may limit coverage of certain services or fix fees and there is more pressure on faculty to spend less time teaching and more time seeing patients. Even though the overall time spent in clinics may increase, the time spent with individual patients may diminish, since they are often required to "process" so many patients per day. This further erodes the time they can coach students at the bedside or in the examination room. Managed care has sparked faculty interest in information technology as a way to lighten the burden of teaching, while others have become interested in its use for patient and consumer health education. Ironically, while many health maintenance organizations see information and education as a means to control costs (healthy people need fewer services), many patients and lay people view it as a way to insure they are receiving appropriate care. The surge in Medline use by the lay persons and efforts of the National Library of Medicine and other agencies to place medical dictionaries, health care guidelines, and other consumer health information online are, in part, a response to public interest in participating more actively in decisions regarding their health. They are researching their health care options following up on the recommendations of providers and practitioners (Bottles, 1999). Some government agencies are creating meta-sites linking only reliable, "filtered" online information sources. It is so imperative that individuals in the general public obtain reliable medical knowledge that doctors may have to learn to prescribe information sources as well as medicine (Bader & Braude, 1998).

Convergence. Converging technologies are effecting education and training in all fields, including health care. As television, telephony, and computing come together, applications are emerging incorporating these varied modalities. It is possible to stream a presentation on videotape and to simultaneously have a videoconference discussing the tape's contents. The same conferencing hardware and software may allow sharing a whiteboard and application software on different machines, to discuss information about a patient and to find information. As technologies converge so do applications. Students used to have to use standalone computer-based instruction packages to learn content initially and then to access a database separately on CD-ROM or online to search for additional information. As more instruction is developed for the World Wide Web and more databases become web accessible, the educational and database resources can be unified by simply establishing links. The boundaries between educational and informational applications are becoming increasingly murky, especially in problem-based learning where the use of information resources for independent research is part of the methodology. Instructional developers and educational technologist working in the health care field are becoming increasingly involved in activities like interface design and telemedicine that while not education per se, do have learning and instruction components.

Some Related URLs

American Association of Medical Schools web site

http://www.aamc.org

American Heart Association web site

http://www.americanheart.org/

Centers for Disease Control and Prevention web site

http://www.rwjf.org/

DuPont Children's Hospital KidsHealth web site

http://kidshealth.org/index2.html

Environmental Protection Agency web site

http://www.epa.gov

Food and Drug Administration web site

http://www.fda.gov/

George Washington University Medical School Frontiers in Medicine grand Rounds Lectures

http://207.78.88.15/

Kellogg Foundation web site

http://www.WKKF.org/

Loyola University-LUMEN project

http://www.meddean.luc.edu/lumen/index.html

Mayo Clinic Health Oasis web site

http://www.mayohealth.org/

Merck and Company web site

http://www.merck.com/

National Board of Medical Examiners web site

http://www.nbme.org

National Library of Medicine MedlinePlus consumer health resource

http://www.nlm.nih.gov/medlineplus/

Nemours Foundation web site

http://KidsHealth.org/nf/index.html

Novartis web site

http://www.info.novartis.com/index.html

Occupational Safety and Health Administration web site

http://www.osha.gov/

Robert Wood Johnson Foundation web site

http://www.rwjf.org/

RSNA EJ (Radiological Society of North America Electronic Journal)

http://ej.rsna.org/

University of Iowa Virtual Hospital web site

http://www.vh.org

University of Utah Neuroanatomy on the web

http://www-medlib.med.utah.edu/kw/webpac/about.html

University of Washington Interactive Brain Atlas on the web

http://healthlinks.washington.edu/courses/tutorials.html

Yale University Center for Advanced Instructional Media web site

http://info.med.yale.edu/caim/

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