New Models, New Tools

The Role of Instructional Technology in Radiologic Sciences Education

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Introduction

Professor Carl E. Wieman, Ph.D., who won the 2001 Nobel Prize in Physics, could spend most of his time today expanding his research on laser technology. Instead, he chooses to advocate for change in how undergraduate science classes are taught.[1,2] "Put in the starkest terms — our physics courses are actually teaching many students that physics knowledge is just the claim of an arbitrary authority, that physics does not apply to anything outside the classroom, and that physics problem solving is just about memorizing answers to irrelevant problems."[3]

At the University of British Columbia and the University of Colorado at Boulder, Dr. Wieman's education initiatives aim to change course design from large classrooms with lecture-style delivery to evidence-based science education that applies the latest advances in pedagogical and organizational evidence. By incorporating information technology, students move from passive to active learners.[2,4] "Everyone is aware of the enormous increases in the capabilities of information technology (IT) over the past few decades, years, and even months. These offer many fairly obvious opportunities for dramatically changing how teaching is done in colleges and universities, and in the process, making higher education far more effective and more efficient. Unfortunately, these vast opportunities remain largely untapped. While there are a few spectacular examples, generally the educational IT currently available is quite limited in both quantity and quality."[5]

Dr. Wieman is one of many educators and organizations looking to reform postsecondary education in the 21st century. It's a movement that has taken place largely in isolated pockets to meet student demands or to match faculty interest.

One example of a radiologic sciences education that offers innovation and success is at the MedVance Institute in Nashville, Tenn. Program director Bill May, M.Ed., R.T.(R), FASRT, teaches online courses, image production through computer simulation and requests electronic versions of research papers. "I take every opportunity to move students into the electronic world," said Mr. May.

As a member of the ASRT Task Force on New Educational Delivery Methods, Mr. May knows that the student population desires new methods of curriculum delivery

and he agrees with the philosophy of movements such as Dr. Wieman's. "Increasingly, when students walk into a classroom and all you're going to do is stand there and lecture to them, you've lost them. They consider the quality of the instruction inferior because the [educator] is not embracing any of the electronic devices that are out there to enhance instruction."(Transcript of ASRT Task Force on New Educational Delivery Methods meeting, Nov. 19, 2007, Albuquerque, N.M.)

The Educational Delivery Methods Imperative

Student demand drives technology use in new educational delivery methods in the radiologic sciences. Students also need new delivery methods to move from passive listeners to problem solvers and lifelong learners. Although some postsecondary institutions and educators have implemented new technology in their programs, many administrators and faculty members need information and direction to fully embrace innovative educational delivery methods.(Task force, November 2007)

The use of informatics and new technologies in education has developed slowly, with B.F. Skinner first reporting on computer-based learning in the 1950s. However, for several decades, the technology mainly delivered content, leaving the student a passive learner. Slow adoption can be attributed to technology in education that mimicked the instructor, and to some instructors who were slow to acquire the skills needed to employ instructional technologies. [6]

ASRT Task Force on New Educational Delivery Methods

The ASRT formed the Task Force on New Educational Delivery Methods based on research from the ASRT 2004 Faculty Development Needs Assessment. The research reported a high consensus among program directors, full-time faculty and part-time faculty in the radiologic sciences that curriculum could be provided via distance learning.[7] In spring 2006, the task force started to identify new instructional delivery methods that would enable educators to transition from content experts to context experts; explore instructional strategies that utilize new technology in clinical and didactic settings; and provide information toward developing a white paper that addresses new educational delivery methods.

Initial task force members produced reports on areas of interest and expertise related to new instructional delivery methods.[8] Their research formed the basis for a Nov. 19, 2007, meeting of task force members in Albuquerque, N.M., and this resulting white paper. The meeting attendees and their biographies are included in the Appendix. ASRT will continue to serve as a conduit for discussion and information on these issues in the future.

Technology in Education

Before proceeding to further discussions of the task force and the use of new educational delivery methods in radiologic science education, a brief glossary of definitions may clarify terms that are new or are often used inconsistently in conversation and published literature. For the purpose of this white paper, the following terms are defined:

■ E-learning (and e-curriculum): Education using electronic media, such as online courses, DVDs, portable electronics, wireless classrooms, use of electronic mechanisms to search literature, e-mail, computer-based simulation, etc.

■ Simulation: A computer-based model in which the learner tests ideas and methods. Simulation based e-learning involves "learning by doing" because it "focuses on the learner's performance outcomes in a context that mirrors the real work environment, demands more intuitive responses (judgment), is usually constrained by time and takes into account the complexity of possible interactions across key variables."[9] Simulations are dynamic learning events in which students perform a task and experience the results just as if present.

■ Distance education: Various forms of study in which students are not present in the same room or under immediate supervision of faculty but nevertheless benefit from the planning and guidance of an instructor. Distance education can include correspondence courses by mail, as well as newer technology-focused deliveries.[10,11,12](Task force, November 2007)

■ Online instruction: Classes that are delivered completely via the Internet. Online instruction is a form of distance education.

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■ Hybrid or blended courses: Courses that combine traditional classroom and online components.

■ Web-based or computer-aided education: Software or the Internet used to deliver or supplement education, such as using the Internet as a search tool in a classroom or to communicate information to students who also meet in a classroom.

■ Portable electronic devices. This refers to any portable device — usually handheld — that can store or transmit information using any format without a permanent link to a federal network. It includes cell phones, personal digital assistants (PDAs), smartphones, MP3 players, etc.[9,10,11]

Interactive Teaching Strategies

In his instructional reform, Dr. Wieman emphasized the benefit of moving students from passive learners to active learners. Many instructional models focus on the value of student-centered learning, problem-based learning and other delivery methods to improve the educational process and nurture development of lifelong learners.[4,13]

The key to using technology and new educational delivery methods lies in incorporating these instructional strategies and learning goals through technological features and benefits. Viewing instructional technology and educational philosophy as separate or disparate goals can lead to unusable applications and unsuccessful course outcomes. The early uses of computers in education essentially mirrored the dominant teacher-directed instruction models in place at the time. The technology served as an additional vehicle for memorizing facts and procedures. As research and concepts of learning expanded, so too did the understanding of technology's role in supporting students' conceptual understanding through active engagement.[14]

According to K.A. Lawless and J.W. Pellegrino in the journal *Review of Educational Research*, treating technology as an omnibus overly simplifies how technology is integrated into educational instruction:

> *Available evidence suggests not that technology creates educational improvement, but rather that educational improvement comes about through coherent instruction and assessment that supports high-quality*

student learning. Technology can make it quicker or easier to teach the same things in routine ways, or it can make it possible to adopt new and arguably better approaches to instruction and/or change the content or context of learning. Decisions about when to use technology, what technology to use, and for what purposes cannot be made in isolation of theories and research on learning, instruction, and assessment.[14]

Therefore, a brief overview of teaching strategies is critical to discussing new educational delivery methods.

Student-centered Learning

In contrast to the lecturer-listener delivery style, student-centered learning encourages students to actively participate in their education.[15] New definitions of learning emphasize goal-directed construction of meaning and recognize that individual students learn differently.[16] Students are more likely to gain and retain understanding when they construct new concepts based on prior knowledge or experience and incorporate and test their own theories and beliefs.[15] Learning a subject by doing activities replaces learning a subject by listening to a lecture and taking notes; faculty members become context experts and managers of student learning.[17,18](Task force, November 2007)

Content is subject matter, usually contained in books, that is significant. Context connects the words and weaves together the parts of a discourse to help explain the meaning of the content. Active learning helps students understand the meaning of subject matter in a contextual manner.[19]

In particular, adult learning is an interactive and collaborative experience whereby the educator facilitates how students construct knowledge and context.[16,20] Educators note that online instruction enhances a student's responsibility and initiative for learning. Many characteristics of student-centered learning are inherent in new instructional technologies.[15](Task force, November 2007)

Problem-based Learning

As students take responsibility for learning, they begin to apply knowledge and activities in concrete situations. Learning in context is common practice in medical education and is defined today as "problem-based learning." By confronting students with problems directly from practice, they learn to apply relevant areas of knowledge in a flexible manner.[21] For example, radiologic sciences students learn mathematics by calculating radiation dosages rather than performing standard workbook-based mathematical assignments.[13] Problem-based learning is student-centered, may occur in small groups and is guided by an instructor. Instructors present authentic problems at the beginning of a learning sequence that serve as tools to achieve the required knowledge and problem-solving skills necessary to eventually solve the problem.

Self-directed learning helps students gain new information to solve the problem.[21] New educational delivery methods provide the tools necessary for students to solve problems for themselves. A major trend in higher medical education is problem-based learning supported by information technologies.[22]

Lifelong Learning

The purpose of lifelong, or continuous, learning is to create a "reflective practitioner," who develops critical-thinking skills. The skills and knowledge gained in problem-based learning become entrenched. Because students are accustomed to self-directed discovery, they also initiate self-directed continuous learning. This is critical to employability and to staying abreast of changes in the workplace. G. M. Matkin[23] states that "the pressure for desirability of learning throughout one's lifetime will increase."[23] However, many educational programs in the medical professions fall short of developing lifelong learners. Program graduates simply cite the need for continuing education credits as evidence of continued learning and actual self-directed responsibility for learning is sporadic.[13]

When students learn to solve problems through self-directed, faculty-guided instruction, they also learn how to think critically about the problem and to

discriminate among information. This contrasts with students who deem the traditional presentation of information credible because it comes directly from the instructor.[13]

At East Tennessee State University in Johnson City, Tenn., associate professor Ester L. Verhovsek, Ed.D., R.T.(R)(M), gives assignments that require research. Students must search the Internet and conduct personal interviews with physicians for case studies. Dr. Verhovsek also requires students to research and critique current events in health care.(Ester L. Verhovsek, Ed.D., R.T.(R)(M), e-mail, Aug. 28, 2006) With practice and guidance, a radiologic sciences student can learn to use new educational delivery methods to gather information and knowledge throughout his or her career.[13](Task force, November 2007)

Other Learning Concepts

There are many educational models and philosophies, and each institution has its own goals and strategies. Research on employment and the effectiveness of new educational delivery methods refers to several learning and instructional delivery models. For example, technology has transformed "just-in-time" learning, or the application of information to a real problem when it occurs and where it occurs, and plays a particularly vital role in the medical professions.[23](Task force, November 2007)

As students learn to gather information and apply that knowledge in an educational context and in real time, they develop information literacy, an ability to analyze information, think critically and further professional and educational skills. The ability to research a problem rather than passively receive and memorize solutions serves a learner throughout his or her career. And in the current environment, where technology can deliver information in an instant, learners must be discerning researchers. It is too easy to accept readily available information as credible without the filter of an instructor or textbook. As students master information literacy to solve problems in a manner that is self-directed, but under the guidance of an instructor, they also develop the filters, skepticism and the experience necessary for future learning and problem-solving. Information

literacy is critical to students' future professional development and educational advancement.(Task force, November 2007)

Instructional Technologies

Advances in information technology have significantly affected U.S. postsecondary education in recent decades. As with other industries, educational institutions have taken advantage of new technologies to streamline administrative tasks and improve marketing and communication. Technology also has opened the door for new student enrollment options. The proliferation of technology in educational course delivery is a natural progression,[24] serving as both a "medium and a message of educational innovation."[25] Colleges and universities throughout the country have adopted software programs such as WebCT and Blackboard (which merged in October 2005 and now operate under Blackboard Inc. of Washington, D.C.) and Desire2Learn (Desire2Learn Inc., Kitchener, Ontario, Canada) to facilitate online and blended instruction. The programs allow instructors to create virtual learning environments. Instructors can upload discussion boards and reflective journals in addition to educational materials, quizzes and other items into work spaces.[26] Students can communicate in discussion boards as if they are participating in a classroom discussion, with the classroom mirrored through discussion boards. (Dr. Verhovsek, e-mail, Jan. 29, 2008). These technologies have provided new dimensions to education. New technologies facilitate learning, but fundamentally depend on the underlying pedagogy and learning methods and strategies that are involved in incorporating the technologies.[27]

Many educational programs — including some radiologic sciences programs — have successfully integrated new educational delivery methods that are based on information technologies. The list that follows offers a sampling of programs and technologies and the opportunities they represent in the radiologic sciences.

Distance Education and Online Instruction

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Although distance education can take many forms — such as mail, television and radio — online instruction is the most prevalent method used to educate students who are not present in the same classroom. It can be argued that online instruction has moved distance education from an "extension" service of the academic institution to the norm.[25] The terms "distance education" and "online education" often are used interchangeably now that online instruction is so prevalent. From 1997 to 2001, there was a 34 percent increase in the online instruction available in postsecondary institutions.[28] By the academic year 2000-2001, approximately 90 percent of public community colleges and universities in the United States offered distance education courses.[12] By 2004, more than 2.3 million college students were enrolled in at least one online college course.[29] In 2006, a rule was lifted that required postsecondary institutions to offer no more than 50 percent of their coursework online, further contributing to the growth of distance education.[30] Growth estimates projected enrollment of 5 million students in Internet-based educational offerings by 2006.[31]

Some institutions have fully embraced and integrated online instruction, while others are merely enhancing traditional education with online technology. Although the varying degrees to which educational programs have incorporated online instruction may speak to the delivery method's flexibility, they also may reflect challenges such as faculty and administrative acceptance, cost and pedagogical integration.

Conservative use of online instruction, where most delivery occurs through the traditional classroom, often is called the supplemental model. The replacement model, also called blended, hybrid or mixed online instruction, substitutes interactive computer technology for a portion of traditional classroom-lecture instruction. Students alternately "attend" campus and online classrooms. Fully online instruction may be delivered synchronously, with multimedia features such as audio, video, whiteboard and chat. In asynchronous delivery, classes may offer multimedia features, but students can access them 24 hours a day, seven days a week.[29] Synchronous learning continues the face-to-face day and time requirements of traditional classrooms. Asynchronous learning removes

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these restraints, which is one of the most desirable attributes and conveniences of the learning model that students seek.

Course management systems such as Blackboard and WebCT, discussion boards and e-mail help an instructor manage the class and communicate with students.[32] Course content has been reported as the primary factor in determining online course effectiveness.[31] Studies have found that students prefer to move at their own pace, a characteristic that requires a high degree of self-management.[12]

The Role of Online Instruction

From the early history of distance education, it was clear that underserved students could benefit from this alternative method of course delivery.[25] Students taking online courses have reported that the delivery method is appealing because the scheduling and location help them balance responsibilities at home. The typical distance learning student is older, female and married, and can access courses at any time during the day from home or any location with an Internet connection. For example, at Midwestern State University (http://www.mwsu.edu in Wichita Falls, Texas, James N. Johnston, Ph.D., regularly conducts classes with students enrolled from around the world. Students from a nearby Air Force base start in the online bachelor's program and then are transferred to countries such as Germany, South Korea or Saudi Arabia. "This adds a wonderful variety of input for our classes and an infusion of cultural perspectives based on firsthand experiences. It makes for very challenging coordination of activities, but students love the convenience and flexibility of the education."(Written communication, Dr. Johnston, January 2008)

Faculty members also can access the "class" from virtually any location and at any time, which they note as an advantage and a disadvantage. Faculty members who teach online courses have reported opportunities for relationships with students that are not related to visual appearance; enhancement of self-directed learning and critical thinking; improved quality of student work due to peer interaction or emulation; enhanced ability to involve or link to experts or external Web sites; and increased success with instructional technology that has led to further exploring new delivery methods.[15,32,33] Faculty members also have

reported creating relationships with students through virtual means, such as Web pages with personal information that include photos of family, pets, workplaces, etc. In many cases, the relative "anonymity" students feel when they communicate electronically strengthens student-faculty relationships, along with the online model offering the opportunity to individualize instruction. Subsequent research indicates that instructors are improving online course design and becoming more proficient in the pedagogy of online instruction.(Dr. Johnston, February 2008)

The flexibility, multimedia and processing capabilities of online instruction have taken traditional distance education to a higher level. Online delivery has added new instructional possibilities, the ability to reach and engage new students and new faculty.[25](Task force, November 2007) In 2005, K. Collins and K. Having reported in *Radiologic Technology* that 72 percent of surveyed radiologic technologists indicated they were interested in pursuing advanced-level certification. Of those, 93 percent said that distance learning was an acceptable method to meet classroom requirements for the certification. The Internet was the preferred distance learning format among all those surveyed.[34]

Evidence-based Outcomes

Early literature that compared students' learning from online instruction with learning in traditional classrooms often reported no significant differences in outcomes. Students learned at least as well through online delivery as in classrooms. Much was made of the 1999 book titled *The No Significant Difference Phenomenon*, in which author Thomas Russell stated that more than 300 reports and summaries failed to show statistically significant advantages to e-learning vs. traditional classroom models.[30] Russell's analysis was based on surveys with sample sizes of less than 40 and the surveys were not identified with a systematic approach. In fact, Mr. Russell admitted that he listed every study that showed no significant difference, instead of using a scientific sampling method.[35]

One explanation for the lack of statistical evidence may be that students simply learn differently in the two environments.[12]   Students also possess

different motivations. A study by Rovai et al.[33] reported that students who enroll in online courses have stronger intrinsic motivation than traditional classroom peers as measured by the drive to know, accomplish things and experience stimulation. Student motivation is one of the most important factors that influence student success.[33] Qualitative differences in learning are more difficult to measure, particularly if they contribute to job performance months later or to skills such as lifelong learning and critical thinking.[36](Task force, November 2007) In a 2000 study, students taking an online psychology course performed better on course examinations and in acquiring content knowledge than their peers who attended lectures.[12] In 2003, E. Cassell, who had taught law online for six years, pointed to the advantage of fewer classroom interruptions, distractions and annoyances, in addition to other advantages of online learning that were reported in the literature.[30]

Perhaps most importantly, Zhao et al.[35] explained that many factors needed to be looked at in greater detail in reports and meta-analyses that compared traditional and distance learning. For example, published reports of online education programs prior to 1998 tend to show no significant difference, while studies published after 1998 weigh much more heavily in favor of online education's effectiveness. Other factors that influence the efficacy of online education include the instructor as author, outcome measures, level of faculty involvement and content area.[35] The effectiveness of online education continues to improve, probably because more faculty are delivering coursework online and experience over time improves delivery as instructors learn what works and what doesn't. In addition, many institutions have provided workshops and training in online education for new faculty members, who may also consult with experienced faculty colleagues.(Task force, November 2007; Dr. Verhovsek, January 2008)

Examples of Online Instruction

The National Center for Academic Transformation (http://www.center.rpi.edu/index.html) at Rensselaer Polytechnic Institute in Troy, N.Y.,

supports colleges and universities that are trying to redesign course instruction to include technology. The center provides several models of successful online instruction, as well as other new delivery methods that involve technology.

At Midwestern State University, Dr. Johnston only teaches two of his radiologic sciences courses in person. The rest are online. The courses have differing levels of interactivity and incorporate various new technologies. Dr. Johnston is quick to point out that developing an online course is much more than "taking all my lecture notes, throwing them online, throwing some PowerPoint at it and calling it an online course."(Task force, November 2007) Dr. Johnston emphasizes that instructors should ensure they understand the interaction between the medium and learners so that course design is driven by pedagogical strategies, not by technology.[37]

Hybrid radiologic science courses in patient positioning at the University of Nebraska Medical Center [http://www.unmc.edu/] help bring rural clinical sites and UNMC instructors and students together, said Connie Mitchell, M.A., R.T.(R)(CT), program director and ASRT president. Ms. Mitchell teaches online and in the classroom.(Task force, November 2007)

At Midwestern State University they have used online instruction to create a unique associate degree program. Because clinical sites are spread throughout North Texas and Southern Oklahoma, most of the didactic information is delivered in the first year. Students relocate to their clinic site city for the second year, during which several courses such as radiation biology and patient care are delivered exclusively online. This allows maximum utilization of time and resources. "We have excellent success with this format, with pass rates and job placement meeting or exceeding national averages," said Dr. Johnston. "Our bachelor's program is 100 percent online. It is a post-certification baccalaureate open only to registered technologists and radiation therapists. In many cases we never physically see these students until graduation."

The Midwestern master's program is a hybrid model with two face-to-face seminar weekends per semester and online course supplements for the remaining content. "We also have several elective courses that are offered only online for added flexibility, said Dr. Johnston.(Dr. Johnston, February 2008)

Associate degree radiography students can complete their Bachelor of Science degree requirements completely online. At East Tennessee State University, radiologic sciences students can take digital imaging as an online course. "Most students have clinical experience with digital imaging but no formal classroom instruction," said Dr. Verhovsek. "They learn the concepts and link their clinical experience with published material," she said.(Dr. Verhovsek January 2007)

New Technologies in Educational Delivery

Many new technologies can be incorporated into distance learning, traditional classroom models or as stand-alone educational delivery methods. For example, podcasting is a popular method for delivering entertainment content, but it also is an increasingly accepted method for delivering information and education. Podcasting can be used to replay a lecture or portion of a lecture for students who miss class or want to review material. Podcasting also can be used in place of a guest lecturer to supplement traditional classroom material. Finally, a podcast can provide a subject lecture that students download from an educational site, review and keep for review as a just-in-time learning experience.[38](Task force, November 2007)

Instructional technology that is wisely planned, developed and incorporated offers many flexible options for radiologic sciences education delivery.

Portable Electronic Devices

Today's generation of students is accustomed to using portable electronic devices PEDs) for communication and entertainment. Personal digital assistants (PDAs), new mobile telephones (such as smartphones and Apple iPhones), laptops and tablets and MP3 or MP4 players provide platforms to leverage instruction. Audio recordings, photos and radiographic images, PowerPoint presentations, even videos and podcasts, can be transmitted over various PEDs.(Task force, November 2007)

A smartphone combines the capabilities of a cell phone and many computer-like functions.[39] Nearly every student today has a mobile phone of some kind. Many educational institutions are using text messaging to deliver reminders, alerts and even learning content and revision tips.[40](Task force, November 2007)

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Laptops and tablet PCs are commonplace in postsecondary institutions, with students using them in and out of classrooms. And students are beginning to prefer to work electronically in many instances, turning work in electronically and requesting information in digital formats.(Task force, November 2007) In the 2002-2003 academic year, at least 25 percent of all dental schools required students to purchase or lease laptops. The benefits of these devices include portability, the ability to bundle software, access to e-mail communication and the ability to access presentations from programs such as PowerPoint (Microsoft Corporation, Redmond, Wash.) or podcasts.[11] In some instances, smartphones are replacing laptops, at least for portable, in-class uses.(Task force, November 2007)

A PDA is essentially a handheld computer; the technology was introduced in 1994 with the Palm Pilot (Palm Inc., Sunnyvale, Calif.). Today, the PDA also offers mobile telephone and wireless transmission capabilities.[39] Medical students and physicians have been using PDAs for some time, and third-party software applications enable medical students to record patient encounter and procedure logs on these devices. Software for PDAs allows housing clinical decision software or guidelines and drug databases. For example, the American College of Radiology's Appropriateness Criteria, which are evidence-based tools for imaging decision-making, are available for PDA and pocket PC software on the ACR Web site.
(http://www.acr.org/SecondaryMainMenuCategories/ACRStore/FeaturedCategories/QualityandSafety/ac_pda.aspx).

In 2005, Nakata et al.[41] reported on a system to transmit radiology images over a mobile server to PCs and PDAs. The server was digital imaging in communications and medicine (DICOM) compliant. The report stated that an advantage of the system was the ability to carry PDAs in pockets and retain the power of a PC, along with DICOM images for research and education.[41]

Although the literature provides more information on clinical uses of PDAs and other PEDs, educational uses also have increased. A 2004 study of medical education placed the greatest number of PDA users in medicine and pharmacy colleges, each with about 65 percent of students reporting PDA use. Nursing and dentistry colleges followed close behind with 59 percent and 56 percent use, respectively.[42] Studies have shown it is

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possible to use PDAs to display wireless transmissions of live laparoscopic surgeries for telementoring.[43,44] Medical texts and journal articles also can be downloaded directly to the PDA.[39] A report from Duke University School of Nursing in 2005 concluded several educational benefits from nursing students' use of PDAs. The report stated that PDAs help develop strong student organizational skills and empowerment, enhance just-in-time learning in the clinical setting and can reinforce core knowledge for practice.[45]

At the University of New Mexico in Albuquerque, N.M., and sites such as Prince George's Community College in Largo, Md., PDAs are used to track clinical activities and student performance in the clinical setting.(Task force, November 2007) Some dictionaries and other references are available as PDA software for radiologic sciences students, along with appropriate standard content developed for the health professions. Examples can be found at http://www.pepid.com/default.asp. [46] PDAs can be synchronized with PCs for easy transfer of data that may be gathered on the portable devices.[39,43] However, devices such as newer versions of Blackberry smartphones no longer have to synchronize to PCs via cable to update medical software. Wireless capabilities and software technology allow for over-the-air updates.[47]

At Mayo Clinic in Jacksonville, Fla., radiology program director Myke Kudlas, M.Ed., R.T.(R)(QM), reports that one clinical instructor uses PDA in the clinical area to access dictionaries, calculators and other medical references. The staff has begun putting Mayo's positioning manual on PDA, which supplements the electronic version on PCs in exam rooms. Thirty-second videos of each radiographic examination cover positioning, radiation safety and critique.(Kudlas, e-mail, Aug. 28, 2006.)

Podcasting

One type of portable electronic device—the MP3 or MP4 player—allows for a unique delivery method called the podcast. Named after the Apple iPod (Apple Inc., Cupertino, Calif.), which was the first handheld digital audio player launched in 2001, the podcast is a downloadable multimedia file that can be stored in the player and listened to or viewed at leisure.[38] Podcasts also can be stored and viewed in PCs. Therefore, although more than 42 million iPods alone have been sold since Apple introduced them, students who don't have MP3 players also can access podcasts via computers.[38,48]

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Podcasts may be free, available by subscription or paid for per cast. In subscription podcasts, the user receives the data through a "really simple syndication," or RSS feed.[48]

Podcasts have been used primarily for entertainment and news dissemination; with the medical community relatively slow to embrace the educational advantages of podcasts.[38] Many medical organizations are recognizing the potential of podcasts as a learning tool. The technology can deliver training modules specific to a learner's needs.[48] Late in 2005, Harvard became the first medical school to provide its entire syllabus of lectures for download to MP3 and MP4 player files via the university's intranet. In 2006, a senior lecturer in microbiology at the University of Bradford in West Yorkshire, England, began delivering all his first-year biochemistry lectures via podcast instead of in the classroom. Professor Bill Ashraf, Ph.D., said such lectures better suit the needs of distance learning students and those attending part-time, and that students can ask questions via text message, then check the professor's blog for responses. Students can access podcasts by MP3 player, telephone or computer.[38,49] Free samples of Dr. Ashraf's lectures are available on Apple iTunes by searching his name under "artist" (http://www.apple.com/itunes/overview/).

As Dr. Ashraf stated, podcasts are recognized for portability and their on-demand, just-in-time capabilities. It is likely that the use of this delivery system will continue to grow in popularity as a source of information and educational delivery. In addition to increased popularity of MP3 and MP4 players, high-speed Internet access is more readily available and computers and other storage devices can hold more and larger files.[50,51] The American Association of Neuromuscular and Electrodiagnostic Medicine began offering free podcasts (http://www.aanem.org/education/podcast/index.cfm) in spring 2006. Members and nonmembers can listen to the podcasts for free; a fee or membership is required to obtain continuing medical education credit.[50]

The Society of Critical Care Medicine reported in 2007 that it had designed and implemented the first podcast as an international medical society. The iCritical Care Podcasts cover a range of clinical topics. The SCCM also published an article in the *Journal of the American Medical Informatics Association* (http://www.jamia.org/cgi/content/short/14/1/94) in January 2007 documenting how it created the podcast.[51]

At Midwestern State University, the nursing department is using podcasts in clinical education. Furthermore, the university is researching grant money to make the service available to all departments through a recording studio and a repository of medical lectures. In the radiologic sciences, podcasts could be used for just-in-time teaching, make-up lectures or to replace lectures.(Task force, November 2007)

Virtual Reality and Simulation

Virtual reality, which has its roots in video game technology, allows a learner to step into a virtual world and shift from text-based learning to multisensory, experiential learning. From simulation of real situations on computer models to 3-D virtual environments with computerized mannequins, the possibilities are endless. Flight simulation is a common early model, with the military making use of simulation technology for about 30 years.[37,52] Some industries have expanded on the technology's origins, taking a games-based approach to encourage active learning.[53] Local and national conferences such as the Florida Educational Technology Conference (www.fetc.org) help educators learn about games in educational instruction.(Task force, November 2007)

There is no doubt that today's learners accept the technology. More than 9 million people now reside on Second Life (http://secondlife.com/), an online virtual community that allows residents to take on personas and participate in virtual and real commerce exchanges. Educational institutions have set up shop there too; hoping to expand their distance learning capabilities.[54] Virtual reality offers students the opportunity to learn standard or complex procedures without fearing the repercussions of potential harm to patients.[27]

The virtual patient is generating interest in medical education.[10] Multimedia can enhance a patient's physiology, such as in a video of a consultation, completely on-screen avatars, or a physical model such as Laerdal's SimMan (http://simulation.laerdal.com/), which hooks to medical devices and computer electronics. SimMan has been used at Sinclair Community College in Dayton, Ohio, to help teach medical professionals, including radiologic technologists. The Arizona Simulation Technology and Education Center, also known as SimLab (http://www.astec.arizona.edu/), at the University of Arizona Medical School in Tucson, uses simulation to help radiology residents learn how

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to handle various megacodes, contrast reactions and a collapsed lung. An article in the *ASRT Scanner* (http://www.astec.arizona.edu/PDFs/ASRTScanner-July07.pdf) in July 2007 included information on the program and is posted on the SimLab Web site.

At St. Louis Community College, sonography students learn to scan abnormal pathology—a skill not easily taught in the classroom—through using the UltraSim system (http://www.medsim.com/products/products.html; MedSim, Ft. Lauderdale, Fla.). The ability to simulate endovaginal examinations is another advantage, since instructors draw a line on using student models to practice the procedures.[55]

Even practicing radiographic exposures in a computer lab is a form of simulation. Mr. May says he uses this method of showing exposures and distances to prevent wasting film and chemistry. "And the simulation software shows them what the exposure to the patient would have been," said Mr. May.(Task force, November 2007) Coupled with telehealth technology, virtual reality offers distance learning opportunities to individuals and groups.[27] Mayo Clinic's ultrasound program in Rochester, Minn., and Jacksonville, Fla., are connected via telehealth technology, allowing for interactive educational opportunities between the two sites.(Task force, November 2007)

Mayo Clinic's College of Medicine offers multidisciplinary simulation-based education that supports learning for physicians and allied health personnel. Visitors to Mayo's simulation center Web site (http://www.mayo.edu/simulationcenter/) can view a seven-minute video that demonstrates the technology.(Myke Kudlas, M.Ed., R.T.(R)(QM), personal communication, March 19, 2008).

Simultaneous training and collaboration can increase interaction and improve conceptual learning.[27] On an individual level, virtual reality features and simulation offer excellent learning opportunities, such as involving the senses, user control over the learning experience and immediate feedback from the simulator.[37,55] Virtual reality and simulation may provide the "missing link" that can take radiologic science courses, currently considered by many educators as "unteachable" in an online setting, to the realm of distance learning. Skills such as patient positioning may eventually be taught online through these technologies.(Task force, November 2007) The use of these technologies in health care education continues to grow, as evidenced by the current

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1,500 members of the Society for Medical Simulation in Healthcare (http://www.ssih.org/public/).

Other Computer-based Technologies

Computer technology offers many other choices for new educational delivery. Computer-based methods already have made their way into the classroom in forms such as PowerPoint presentations, which replace overhead projectors, and using DVDs over traditional audiovisual delivery.

Today, not only are most lectures presented with new audio and visual aids and through computer software, many students also complete work in dynamic PowerPoint presentations.(Task force, November 2007) Using software, or during classroom discussions, students and instructors can instantly link to the Internet and other electronic sources to supplement classroom lecture or online courses — or to answer questions during discussions. The use of Web-based instruction as part of the educational experience supports key components of adult learning, such as the ability to access and integrate multiple information sources.[27,52] Many instructors use interactive games built into presentation software or ask students to build their own games as assignments.(Task force, November 2007)

Web 2.0 allows students and educators more sharing and interaction on the Internet. In addition to podcasts and RSS feeds, wikis, blogs and chats encourage information gathering and active participation. Together, these often are referred to as "social software." Blogs are regular diary-like entries, written as "one-to-many" conversations. Instructors can use blogs to keep students informed, respond to questions and supplement online instruction. The use of blogs and Internet sources outside the instructor's direction may require some training in discerning the credibility of sources and facts.[56](Task force, November 2007)

Audiovisual tools also can combine with computer technology for desktop conferencing. Much like teleconferencing, the technology can be applied to small groups, such as graduate students sitting for oral competency exams or defending their thesis or capstone project. By joining via a Web address and using microphones and Web cameras, the committee chair invites the student and other committee members to the defense.

Everyone has the means to employ both written and oral communication.(Task force, November 2007)

As the younger generation of adult learners enters educational institutions, students not only will be more technologically savvy, but will likely prefer electronic choices, even for reading text. Some prefer e-mail, text messaging and instant messaging to telephone or in-person conversation. Depending on a student's learning style, he or she may prefer to read information off the screen, or combine reading information from the computer and print it.[57] Some schools are working with publishers to bundle textbook selections into "e-books" that are downloaded or delivered by CD-ROM.[58](Task force, November 2007) Bundling can be customized to deliver only the chapters that apply to a particular course, within copyright restrictions.

Dr. Johnston has seen e-books used at Midwestern State University. "It's great because all of the books are electronic, and students can pop them into their laptops and scroll through the chapters and look at pages. They can highlight certain pages instead of writing in a book. There's a place for notes in the margins. And the library can cross-reference information to other texts. For instance, you might be able to cross-reference something from an imaging textbook with something in a physics textbook that relates to it and just pull up the information. There's no hunting through the books and chapters."

Dr. Verhovsek said that science faculty at East Tennessee State University use blogs to communicate with students. "I've had a student say to me that he would rather read a blog than a book," said Dr. Verhovsek.(Task force, November 2007)

Educator Steve Hargadon maintains a blog (http://www.stevehargadon.com/) that addresses various aspects of technology and education.[59]

For the most part, these and other technologies are easily integrated into classroom or online instruction. Success lies in using pedagogical strategies versus installing technology for technology's sake.[62](Task force, November 2007)

Challenges and Opportunities

New educational delivery methods offer opportunities for students, faculty, institutions and the profession. As with introducing any technology or change, integrating new instructional technologies into community colleges does not come without challenges.

Assessment and Measurement

New instructional strategies and delivery methods have necessitated revised assessment methods. Transitioning from reciting facts to solving problems as students develop critical-thinking skills challenges the traditional quantitative "grade threat." In fact, making errors can be a natural part of the problem-based learning process.

Student-centered course design should include frequent assessments to provide students and instructors with student achievement and comprehension measurements. Group problem-solving, discussions, regular quizzes and using audience response systems can support assessments.[60] In online delivery, discussions can include chats, discussion boards, forums, list servers, e-mail and blog responses. Students can be awarded points for participating, and instructors can follow up by persuading students to elaborate on responses that will better assess comprehension.(Task force, November 2007)

Self-assessment is an important component of formative feedback.[60] Online instruction frees students from the restraints of a synchronous 50-minute class timeframe. When composing their responses in the asynchronous environment, students have time to reflect before articulating thoughts or to review responses.[15] Technologies such as virtual reality and simulation offer immediate self-assessment and the opportunity for problem-based learning through safe trial and error.[55](Task force, November 2007)

Audience Response Systems

New technology allows instructors in the classroom to immediately know if students understand information in order to generate discussion or adjust the speed and content of a presentation. Audience response systems (ARS) are sometimes called

personal, group, classroom or electronic response systems, clickers or keypads. Small, remote devices enable students to respond to an instructor's posted question; and the instructor can instantaneously collect and post the results. Although early systems were wired and more cumbersome, modern systems send signals via infrared or radiofrequency signals. The instructor uses software to compose questions and set grading for responses. Most ARS software also can export or upload scores to classroom management systems such as Blackboard and WebCT.[61] The systems are used on at least 700 campuses nationwide, according to TurningPoint (http://www.turningtechnologies.com/),[2] only one of the vendors that produce audience response systems.

Often, audience response systems help generate discussion in classrooms, but their usefulness is not limited to large lecture situations. The systems are used in classroom sizes that range from 15 students to more than 200 students. Questions may be designed to focus or generate discussions, require peer interaction or collect votes after a debate. The many uses of these systems include assessing student preparation and accountability, polling students on opinions, determining lecture direction and the ability of students to apply material and prepare for examinations. Reports have shown that instructors use ARS feedback to change teaching approaches and students have reported increased engagement in classes.[61]

Active student response is correlated with gains in achievement. Students receive immediate feedback, which can help them adjust and self-manage learning, even in a traditional classroom. Reports have shown that as many as 90 percent of students who normally hesitate to respond or participate in class believed the ARS helped them participate.[62]

Studies of audience response systems show that immediate self-assessment is one of the pedagogical uses of the systems that surveyed students value most.[62] Traditional assessments also can be adapted to new delivery methods. Online quizzes and readiness assessment tests have proven effective in helping to determine if students are grasping concepts.[17]

E-portfolios

Training portfolios have emerged as valuable tools to assess competency, particularly in problem-based learning. They provide a systematic and organized collection of evidence of a student's progress and may substitute for more formal testing methods to ensure or document accountability.[16,63] Portfolios in radiologic sciences may include projects, lab reports, problems solved, videos and written explanations of each entry's importance. Selection portfolios are developed to achieve a particular goal. A student works with an instructor on the goal, then selects his or her best work to illustrate achievement of the goal.[19] E-portfolios are electronic versions that include assignments and e-journals with class notes and handouts.[32]

Dr. Johnston asks for e-portfolios from students at Midwestern State University. "They submit PowerPoint presentations of their experience at the practicum side. The e-portfolio is a lot more work than just making copies and sticking them in a binder. Students go to a lot of trouble to present something to you in this format; I'm very impressed." Midwestern's radiologist assistant students provide e-portfolios that they submit by e-mail or on a device. Dr. Johnston said that the advantages include a digital back-up copy and volumes of paper that are saved.(Task force, November 2007)

The key to structuring assessment when implementing new educational delivery methods is to focus on course goals and objectives and clearly communicate those goals, much like instructors currently design assessment.(Task force, November 2007)

Maintaining Personal Interaction

Critics of online education have expressed concerns about adverse effects of the delivery method on student-to-instructor and student-to-student interactions. Similar concerns were expressed at the early stages of e-commerce and yet the trend among consumers to purchase online and create virtual communities has continued upward.[31] In 2005, companies reported $93 billion in product sales as e-commerce transactions.[64]

Concerns about the ability of distance education to replicate interactive features of classroom instruction date back to early correspondence courses. Since that time, anecdotal and empirical evidence have varied. However, technology can provide the tools to facilitate personal interactions similar to those that typically take place in classrooms and on campus between students and their instructors and among students.[25,31] Late in the 19th century, W.R. Harper listed several disadvantages of a correspondence system. But he also was skeptical of traditional classroom settings and remained quick to debunk myths concerning the superiority of the classroom over correspondence.[25]

Researchers have studied the effects of new technologies on interaction in instructional delivery. More research is needed because the debate continues on whether interaction is important to learning and the success of programs and delivery methods. Peltier et al. found that instructor-to-student and student-to-student interactions were the least important factors in evaluating overall effectiveness of online courses, with content the most important factor.[31] A 2003 study of computer-mediated delivery systems on social interaction preferences identified cooperative, competitive and individualistic preferences.[12] Independent or individualistic learners prefer the autonomy and flexibility that instructional technology offers, while those who are competitive and cooperative may desire the socialization and support that interacting with faculty, staff and peers provides.[12,31,36] Studies that compare computer-mediated delivery systems with traditional classrooms also vary in the extent to which students perceive that this interaction occurs. Instructional design and pedagogical strategies also may play a role in participation.[12,35]

Student-instructor interaction

It is clear that even in traditional classrooms, the teacher no longer is the center of knowledge and the student is no longer a passive recipient of information.[31](Task force, November 2007)

The amount of interaction that individual students require with faculty, staff and one another varies a great deal.[17,31] A report from Excelsior College in New York stated that 20 percent of students took up 80 percent of staff time. A minority of students felt a strong need to interact with humans, but the vast majority required little interaction.[17]

Scholars who followed Harper emphasize how distance learning fosters individualized instruction.[25] One vision of online education is the ability to have one instructor teach a greater number of students through the efficiencies that technology offers. Experienced faculty, teaching assistants and carefully designed programs help balance the issues of online class sizes and personal interaction with students.[5,35] Zhao et al. reported that when instructor involvement is low, online education classes are generally rated lower than traditional classes. But when instructor involvement is high, distance education courses often receive higher satisfaction marks than education that takes place in person.[35]

Peltier et al.[31] studied how effective online education and virtual communities are in marketing education. Instructor support required a mix of facilitative learning, providing direction and explanations, maintaining rapport with and between classmates, actively participating in discussions, motivating and providing effective feedback.[31]

Current technology provides virtual communities and virtual classrooms, as opposed to early online instruction models in which the computer replaced the instructor and interacted with students individually.[6] Virtual communities are maintained through a stream of discourse, with communication occuring via computer-mediated technologies. Those involved in the community sustain the social interaction and often set their own standards and rules under the guidance of an instructor.[31] Intelligent tutoring systems employ problem-based learning concepts to provide opportunities for students to learn by doing. They then offer feedback that mimics the personalized interactions that take place among instructors and students.[25]

Student-student interaction

Some students in online courses have stated they miss the peer-to-peer interaction afforded by traditional classrooms.[36] The literature indicates that virtual communities related to online education offer students the opportunity to engage with other students and build close relationships.[31] There have been reports of students using computer technologies, e-mail and the telephone to stay in touch with online classmates. In many cases, students have developed relationships in which they share feelings about personal, as well as class-related

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matters, with some relationships lasting beyond a course's conclusion.[36](Task force, November 2007) A growing body of research suggests that some students feel more comfortable speaking up in the online environment of a forum, such as a discussion board, than in face-to-face situations.[31]

Dr. Verhovsek requires her radiologic science students to develop a personal Web page on the university's Web site at the beginning of the semester and post the URL on their discussion board. "This year, many of the students requested MySpace and FaceBook to create their pages," she said. Dr. Verhovsek allowed them to and was surprised by the amount of interaction and discussion. "They became friends just like they do in the regular classroom."(Task force, November 2007)

Some tools that facilitate interaction are easy to access, such as MySpace (http://www.myspace.com/). Other tools that manage both synchronous and asynchronous interactions among students, and between faculty and students, continue to develop. The tools may require some cost, resource time and management. Students must learn how to use the tools, but often excel at peer-to-peer training on technology. Inevitably, a super-user steps up to help fellow students gain access.[35](Task force, November 2007) When tools such as group projects and discussion forums are used online, optimum group size is a consideration: Too many students can limit participation, whereas too few may limit the insights of the group.[31] Most radiologic science programs could be the optimum size for virtual communities.

Online instructors should provide students with hardware and software requirements up front, as well as other technology requirements and expected costs, such as the purchase of ARS clickers.

Addressing the Needs of Adult Learners With Disabilities

In addition to students with a number of physical disabilities that range from orthopedic impairments to low vision, an increasing number of students with learning disabilities and attention deficit hyperactivity disorder (ADHD) are entering postsecondary education programs. In the traditional classroom setting,

physical accommodations have been easily understood in many cases. For example, it is simple to note the need for a ramp to allow wheelchair access to a classroom. But other accommodations are not so apparent, such as the need for extra time, which can help students with disabilities better compete with student peers.

Instructional technologies and new delivery methods may open the door for some students to "attend" radiologic science classes with fewer accommodations. And simulation software has been used even in the classroom to assist students with disabilities in improving problem-based learning options.[65] As in the traditional classroom, an educational program should consider each student's needs.

Universal design, the design of settings such as those used in education to provide broad accessibility, has minimized the need for individual accommodations. By proactively incorporating design features that include as many people with as many needs as possible, community-based institutions have opened access to many more facilities and services. For example, curb cuts are useful for people in wheelchairs, along with people on skateboards and parents pushing baby strollers. In recent years, the literature has reported the concept of universal design principles in technology and telecommunications. For example, the TRACE Research and Development Center (http://trace.wisc.edu/about) at the University of Wisconsin is developing ways to make standard information technologies and telecommunications systems more accessible to and usable by people with disabilities, which can enable their use in instructional technology.[66]

So while many students with disabilities may benefit from new instructional technologies, programs still must address the ability of students with learning disabilities or ADHD to succeed in a self-directed environment. Questions also might arise as to the proficiency in computer-based skills of some students with disabilities when they transition to the postsecondary setting. Research at one university compared students with and without disabilities while they performed basic computer operations and other components of instructional technologies. College students with disabilities did not appear to have the same

level of experience with or exposure to online and technology-blended courses as peers without disabilities. Some students with disabilities expressed discomfort with e-mail communication and multitasking on the computer. However, all the students expressed moderately high to high levels of comfort with 13 measures of learning technologies. Among these measures were trying new technologies, WebCT/Vista courses, computer-based-tests and non-course uses of technology.[67]

Content Development

Integrating new instructional delivery methods can take some time initially. It's not effective simply to take material currently used in lectures and convert the material to a computer-based format. Instructional technology can enhance traditional classroom learning. In some cases, technology allows entire courses to be taught in a different format, such as through online delivery. Instructors must use available resources and their own experience to determine which courses work best in varying models of delivery so that course design is driven by pedagogical issues versus technology. They also must be comfortable with instructional technology. Faculty can help each other generate ideas and provide peer support.(Dr. Verhovsek, January 2008).

The danger lies in the two extremes. The first is assuming any individual lecture or course can be converted to a new delivery method with no thought as to how it's done or attention to revising content, assessment or other features. An example would be converting a medical terminology or anatomy course to online delivery without developing ideas for encouraging participation, taking advantage of multimedia resources or directing students to available virtual human links.

The second extreme is assuming that a course such as radiologic sciences can't be taught online, a comment that has been heard in the profession. With proper content development, faculty interaction and available technology, nearly any topic can be and is taught online, or at least in a hybrid environment. "If they can teach surgery online, we can teach radiologic sciences," said Dr. Verhovsek.(Task force, November 2007) Such skills-based courses are taught in

health care programs, often with the instructor facilitating students' research abilities and problem-solving skills and closely monitoring learning.[20]

With adult learning teaching strategies such as problem-based learning, instructors evolve from content experts to context experts.(Task force, November 2007) The right context also is needed for instructional technologies to succeed. Educators must determine which technology works best for health care courses. Faculty and institutional goals also must align.[44,68] For instance, effective instructors consider pedagogical strategies and approach each learning situation differently. Those who teach online develop material that is highly interactive, and also facilitate participation in online discussions.[20] Administration must support faculty with the time and resources to help them restructure courses for new instructional strategies and delivery methods.[44,68]

The relative novelty of online instruction and other new instructional technologies corresponds with a lack of empirical evidence on the effectiveness of these instructional strategies. Clearly, more research will emerge to demonstrate successes and help improve the theoretical frameworks on which the instructional models are based.[12]

Institutional Strategies and Support

Too often, criticisms of distance education have not carefully considered the programs' aims, processes and products. Much of the empirical research has focused on delivery technologies independently of the instructional methods and outcomes. Opinions also have been influenced by "diploma mills," which do not represent all distance learning.[25]

Zhao found in a review of studies published on distance education that outcomes were significantly higher when the study author was the instructor of the distance education course. When the author was not the distance education instructor, no significant difference was found between the classroom setting and distance education. When the author's status was unknown, distance education was found to be more effective, though slightly less so than when the author was the course instructor.[35]

When new technologies are developed that facilitate instructional delivery, institutions add them for a variety of reasons. In 1998, G. Rhoades provided evidence that information technology had changed the social structure of community colleges. He also determined that "managerial professionals" who specialized in areas such as instructional technologies gradually were replacing faculty members at the core of many institutions, with faculty marginalized in favor of professionals with technological skills.

Yet higher education scholars have presented the benefits and necessities of incorporating technology into instructional practice. Clarity and purpose of institutional policies is critical to successful incorporation.[24] When knowledgeable radiologic sciences faculty can identify content that is technology neutral, technology driven or technology enhanced, they can develop content and incorporate new methods of delivery accordingly.[20]

Lawless and Pellegrino of the University of Illinois at Chicago have said, "Technological literacy has fast become one of the basic skills of teaching. The sheer increase in the availability of electronic resources in schools and classrooms makes it important for teachers to be prepared to effectively integrate technology into their instructional practices."[14] Professional development of faculty is essential. As radiologic sciences faculty gain exposure to new technologies, they gain new skills and new instructional tools.[14](Task force November 2007)

Issues such as cost can be overcome with research and consideration of student needs and resources, similar to how decisions are made for any new service a college or university offers. Dr. Verhovsek said that, in general, her students have said they would have no problem purchasing PEDs if required for class. "They would rather spend their money on that than on a book," she said.(Task force, November 2007)

On the institutional level, T. Bishop has reported that institutions must manage the pedagogical and fiscal considerations of changes, such as teaching in an online environment.[29] The literature on online education has targeted it as costing too much and being pushed on faculty as a revenue enhancer.[24] Costs of some technologies, such as podcasts, could be expensive to produce if the

institution invests in high-end equipment. But with proper hardware and software availability, podcasts are relatively inexpensive to produce. The organization also may have to invest personnel resources into the effort.[69](Task force, November 2007) A cost-benefit analysis can determine if new technologies create a return on investment over a reasonable amount of time.[44]

Some value to the use of technology, such as increased admissions, improved retention or increased satisfaction among radiology employers, may be difficult to measure and compare. However, replacing target areas of traditional models with new technology-based delivery models has proven financially viable for many institutions.[29]

Conclusion

In a 2006 review of online education, Larreamendy-Jones and Leinhardt made the following observations:

> In sum, the Internet has given distance education a new appeal, either because it taps into unexplored instructional niches, such as just-in-time learning (i.e., training delivered to workers when and where they need it) and corporate training, or because it deals more effectively with limitations that traditionally have been attributed to distance learning. In this context of technological change, it is not surprising that universities attempt to seize the online market with the expectation of expanding their reach, increasing revenues, and recovering some of the investments that they have made in technology. In addition, universities and corporations often see investments in online technology and development of online programs as indicators to the outside world that they are up-to-date and on the cutting edge of instructional strategies. In that sense, the use of online technology is both a medium and a message of educational innovation.[25]

Radiologic science program faculty, along with directors and administrators at their institutions face an imperative to investigate how

instructional technology can be integrated into their programs. This involves determining how the technology can accommodate the content, context, pedagogical strategies and the fit of students and employers served by the institution's current or desired population. It also creates an imperative to develop faculty, and for faculty to embrace technology. Regardless of how faculty has been taught, the way they teach the radiologic sciences in the future will differ markedly. Institutions must revisit their mission, priorities and resources to increase use of technology and support faculty in integrating technology in teaching the radiologic sciences.

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Appendix

Task Force Members

Robert Fosbinder, R.T.(R)
David Frazier, B.S., R.T.(R)(QM)
Frances Gilman, M.S., R.T.(R)(CV)(CT)(MR)
Linda Holden, M.S., R.T.(R)(QM), RDMS, FASRT
James Johnston, Ph.D., R.T.(R)(CV)
Myke Kudlas, M.Ed., R.T.(R)(QM)
William May, M.Ed., R.T.(R), FASRT
Connie Mitchell, M.A., R.T.(R)(CT)
Ester Verhovsek, Ed.D., R.T.(R)(M)

Select Task Force Member Biographies

James Johnston, Ph.D., Chairman

James Johnston is an assistant professor of radiologic science at Midwestern State University in Wichita Falls, Texas. Prior to accepting the position at Midwestern, he served as a program director at a community college radiography program for 10 years. Dr. Johnston currently teaches courses in the bachelor's and master's programs at MSU.

Dr. Johnston completed his radiography education at South Plains College in Lubbock, Texas. He obtained his bachelor's and master's degrees in radiologic science from MSU. He then received his Ph.D. in health studies from Texas Woman's University in Denton, Texas. Dr. Johnston is certified in radiography and cardiovascular and interventional radiography. He is an active researcher and writer, and lectures at the local, state, national and international levels. He has used several instructional technologies throughout his educational career including:

- E-portfolios as an option for a graduate student practicum course.

- Student submissions of numeric human characteristics (age, height, weight, etc.) in an online statistics course to use as a data set throughout the class. Students could determine the significant correlations and differences in the characteristics of their classmates.

- A directory of useful Web sites that is developed and maintained based on instructor searches and that of each class of students.

- Presents a case study file in a medicolegal course where students are given files in a selected order to review and analyze as if they are an expert witness. They present points of view and arguments as assignments and on a discussion board. The assignment requires Internet research as a part of the process.

- Students create and administer an online "mini-instrument" in a graduate statistics course. After administering to the class, students write a plus/delta to share with their classmates, and review and critique others.

- Notes that these interactive projects (with the exception of e-portfolios) help build and maintain a sense of community and interaction in an online environment.

- Currently contracted to write and help create desktop VR animations to teach radiologic physics and imaging.

Myke Kudlas, M.Ed., R.T.(R)(QM)

Myke Kudlas is originally from Rochester, Minn. His primary training was as a secondary social studies teacher and his first position was at the Ubangi Academy in Zaire where he began teaching in 1987. After teaching for six years, he completed his radiography training at Mayo Clinic in Rochester and joined the staff of Mayo Clinic in Jacksonville, Fla.

In 1999 Mr. Kudlas served as the first program director of the Mayo Clinic Jacksonville Radiography Program. As program director, he developed online resources for students and created instructional videos for student use. Mr. Kudlas received his master's degree in educational leadership from the University of North Florida in Jacksonville in December 2005. In February 2008, Mr. Kudlas joined the staff of the American Society of Radiologic Technologists as the director of instructional technology.

William May, M.Ed., R.T.(R), FASRT

William May graduated from the Indiana University Associate Degree

Radiography program at Gary, Ind., in 1971. After working as a staff technologist, he

began his career in radiography education in Michigan City, Ind., in 1973. He is a past

president of the American Society of Radiologic Technologists and served as a charter board member of the ASRT Educational Foundation. He spent nine years on the board of directors of the Joint Review Committee on Education in Radiologic Technology, two as chairman of the board of directors. He is currently an Education Chapter Delegate to the ASRT House of Delegates and chairman of the ASRT Education Chapter Steering Committee.

Mr. May graduated Summa Cum Laude with a Bachelor's Degree in Radiologic Sciences from Midwestern State University, Wichita Falls, Texas. In 2002 he was certified as an online instructor from Walden Institute, Florida. His interest in online instruction led him to graduate summa cum laude from Jones International University, Centennial, Colo., with a Master's Degree in Internet education and a specialization in technology and design.

Mr. May has been teaching online courses with Itawamba Community College, Tupelo, Miss., since 2000. He was instrumental in Mississippi successfully creating the Mississippi Virtual Community College, which coordinates the online instruction activities of the 15 community colleges in the state. In 2004 he became director of the radiography program at MedVance Institute in Cookeville, Tenn. He received the Higher Education Academic Excellence Award given by the Mississippi Legislature. While continuing his online instruction at Itawamba Community College in Mississippi, Mr. May has led development of hybrid instruction at the MedVance Institute in Cookeville.

Connie L. Mitchell, M.A., R.T.(R)(CT)

Ms. Mitchell is the assistant professor and radiography program director at the

University of Nebraska Medical Center in Omaha, Neb. She currently serves as president

of the ASRT Board of Directors. Ms. Mitchell received her master's degree in health,

physical education and recreation science from the University of Nebraska in 2001. Ms,

Mitchell has worked in radiologic sciences instruction for more than 30 years, serving as

a clinical supervisor, assistant instructor, clinical education coordinator and assistant

professor and instructor before becoming a radiography program director. Ms. Mitchell

has authored chapters and presented numerous workshops on the topic of gerontology for

radiologic technologists.

Ms. Mitchell has served as co-investigator on programs funded by grants from the

Human Resources and Services Administration's Bureau of Health Professions

concerning career advancement through distance education technology. She teaches

courses in traditional classroom settings and through online delivery. One of Ms.

Mitchell's initiatives as ASRT president has been to produce this white paper on new

instructional technologies.

Ester L. Verhovsek Ed.D., R.T.(R)(M)

Ester L. Verhovsek has been a registered radiologic technologist for 24 years,

with advanced certification in mammography. She has a bachelor's degree in radiography

from La Roche College in Pittsburgh, a master's degree in education from Frostburg

State University in Maryland and a doctorate in educational leadership from West

Virginia University in Morgantown. Dr. Verhovsek currently serves as associate

professor and graduate coordinator at East Tennessee State University in Elizabethton.

Dr. Verhovsek has online teaching experience in the following courses:

Leadership in Allied Health, Digital Imaging, Information Technology in Allied Health

Sciences, Interdisciplinary Health Care Teams, Fundamentals of Curriculum Management, and Administration at the Department Level. Her instructional technology methods include: PowerPoint presentations, article critiques, written and oral discussion boards, reflective logs or journals, problem-based and simulation-based learning, tests and development of Web pages.