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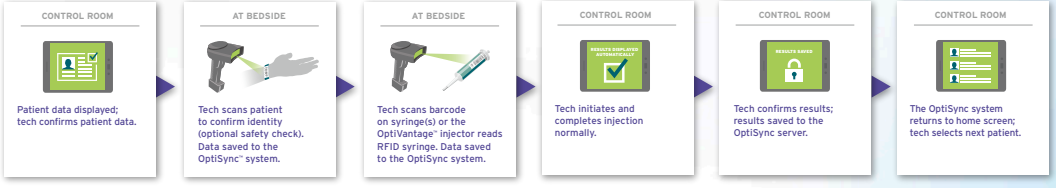

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Integrating Technology Into Radiologic Science Education

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Purpose To review the existing literature pertaining to the current learning technologies available in radiologic science education and how to implement those technologies.

Methods Only articles from peer-reviewed journals and scholarly reports were used in the research for this review. The material was further restricted to those articles that emphasized using new learning technologies in education, with a focus on radiologic science education.

Results Teaching in higher education is shifting from a traditional classroom-based lecture format to one that incorporates new technologies that allow for more varied and diverse educational models.

Discussion Radiologic technology educators must adapt traditional education delivery methods to incorporate current technologies. Doing so will help engage the modern student in education in ways in which they are already familiar.

Conclusion As students' learning methods change, so must the methods of educational delivery. The use of new technologies has profound implications for education. If implemented properly, these technologies can be effective tools to help educators.

Technology continues to play an increasing role in people's lives. The current generation of students is accustomed to using technology for entertainment and communication.[1] This same technology can be used to assist students and teachers in an educational setting. Increased diversity in today's student population makes it less likely that students in a class will be similar in background and capability.[2] Using technology in an educational setting is important because it uses tools and methods with which students are already familiar, which helps engage students, facilitates lifelong learning, and creates cohesion among the students, instructor, and course content materials.[1-2]

Only recently have educators begun to use popular technologies to assist in an educational setting. Martino and Odle wrote that the driving force behind using technology in new educational delivery methods has been student demand.[1] They also found that educational institutions, faculty, and administrators traditionally have been slow to fully embrace these developing methods. These new methods can be applied to the field of radiologic technology. Because imaging professionals must continually learn and use new technology, it is reasonable to believe that integrating technology into the education of radiologic technology students would be beneficial.[3]

A number of technologies are available to assist in the educational process, ranging from Web technologies such as wikis, instant messaging, blogs, social bookmarks, online instruction, and podcasts[4] to software and hardware technologies such as Microsoft PowerPoint presentations and mobile electronic devices.[3] To increase interaction among students, educators are encouraged to use new technologies.[5]

Properly integrating the available educational technologies into radiologic science education is critical to promote effective learning. New technologies can facilitate learning but ultimately depend on the underlying pedagogy, learning methods, and strategies used to integrate the technologies.[1] This literature review

focuses on the integration of mobile electronic devices, podcasting, online education, and social media into radiologic science education.

Methods

Research for this paper was conducted using journal articles found in online databases. The primary databases used were CINAHL (Cumulative Index to Nursing and Allied Health Literature), Academic Search Complete, and PubMed. The journals *Radiologic Technology* and *Radiologic Science & Education* as well as the Internet search engine Google also were searched. The search terms focused on integrating technology into radiologic science education and included the following phrases:

- Integrating technology in radiologic education.
- Incorporating technology in education.
- New educational technologies.
- Technology and online education.
- Technology education.
- Online education.
- Blended education.
- Technology in radiologic science education.
- Podcasting uses in education.
- Mobile electronic devices.
- Electronic devices in education.
- The social revolution.
- Social media in education.

Only those articles that focused on the role or integration of technology in education were included, with particular consideration given to qualitative and quantitative studies and articles related to radiologic science education. All searches were limited to articles published from 2006 to the time of the study. A total of 21 articles were used in the final compilation of this literature review.

Results

Several types of technologies that can assist in learning are available, and many of these technologies can be integrated into traditional classrooms, distance learning, or independent educational delivery methods.[1] Unfortunately, there is a paucity of literature available about these technologies, particularly in the field of radiology.[2] Most authors agreed that integrating specific forms of technology was not only possible but also effective in assisting educators in the delivery of education. According to the literature reviewed, the most commonly used applications were mobile electronic devices, podcasting, online education, and social media.

Mobile Electronic Devices

Today's students use mobile electronic devices for numerous activities in their daily lives, and because of the devices' Internet capabilities, their use is increasing.[6] Mobile electronic devices include personal digital assistants, iPods and iPhones (Apple), BlackBerrys (BlackBerry Limited), smartphones, laptops, and tablet computers.[1,3,6] Students use these devices to store and retrieve audio recordings, photos, videos, books, presentations, and other files. Because students are already comfortable using these mobile electronic devices and the devices are a portable, convenient way to store and retrieve data, educators should consider integrating them into the educational setting.[1,3]

Some software companies have developed programs that allow for individualized customization of data collection and storage that can be used for academic fields. This software can aid both students and instructors in data collection as well as the organization and storage of information that can be retrieved at a later time in a portable format. These programs could be valuable in the field of radiology for instruction and information gathering.[3,7] Students could log competencies, clinical time, and professional notes through software on mobile devices, allowing instructors access to continuously updated information. Such devices and programs also could allow students access to positioning guides and technique charts. These resources could give students extra confidence by helping them to make clinical decisions, allowing them to easily retrieve Digital Imaging and Communication in Medicine (DICOM) images, and providing information at the point of care.[1,3,7,8]

Similarly, educators can employ mobile electronic devices as instructional aids and clinical assessment tools.[3,8] Mobile electronic devices can be used as an effective method for transferring data to students in the classroom. File exchanges can be used instead of paper,

thus reducing material and service costs for the department and the university. Educators also can give quizzes and assignments via mobile electronic devices in lieu of paper-based formats.[3]

Some mobile electronic devices have the ability to download medical texts and professional journal articles.[7] Martino and Odle stated that mobile electronic devices "supported the development of strong student organizational skills and empowerment, enhanced just-in-time learning in the clinical setting and allowed for reinforcement of core knowledge for practice."[1] A study of nursing students by Williams and Dittmer showed similar results.[8] The authors tested the effectiveness of mobile electronic devices in clinical practice compared to traditional methods of educating with textbooks and concluded that students quickly mastered the technology and effectively used the device. The nursing students also liked the concise and portable nature of the device, and "no students expressed dissatisfaction or regret at being in the experimental group."[8] Mobile electronic devices that contain textbooks and positioning guides, although expensive, are quickly becoming commonplace for radiology students.[3,7,8]

Mobile electronic devices also are being used as polling devices and to provide podcasts. The use of mobile electronic devices as polling devices allows the educator to deliver quizzes and assessments, to quickly collect and organize data, and to create an interactive learning environment. Podcasts are video or audio recordings that are stored as media files. Teachers and students can download these files to mobile electronic devices or other computing or audio delivery devices. Using such formats, educators can record presentations and lectures before or during class so students can access these files to study the material at a later time.[3]

All the articles reviewed showed that mobile electronic devices are a valuable resource in health care education, but one study revealed negative feedback from students. In a study of nursing students using mobile electronic devices in clinical settings, Fisher and Koren found that some students believed that mobile electronic devices presented them in a negative light to patients.[7] The study used qualitative investigation to examine the integration of mobile electronic devices at the point of care in undergraduate nursing programs. Students used mobile electronic devices equipped with medically relevant software for 7 weeks.[7] At the end of the study period, the students participated in a discussion group to share their thoughts about the use of mobile electronic devices in the clinical setting. Although the majority of students found the integration of mobile electronic devices helpful and effective, a few stated that they thought the mobile electronic devices made them look inept or unprofessional when they were used in front of patients. Other students found it difficult to use mobile electronic devices in front of patients, reporting that it was more difficult to navigate the devices while the patient watched, as if they were under scrutiny.[7]

Podcasting

Podcasts are downloadable multimedia files that can be stored on MP3 or MP4 portable media player devices and can be listened to or viewed at one's convenience. Originally exclusive to and named after the Apple iPod, podcasts now are available to access on desktop computers, laptop computers, and tablets using the Internet.[1,4] Some podcasts may be accessed for free, while others require a subscription or a payment for each podcast.[1] Podcasting provides an innovative way for students to improve collaboration and communication.[4]

Podcasting technology can deliver training specific to a learner's needs. Known for their portability and on-demand capabilities, podcasts are available at any time and anywhere an MP3 or MP4 device can be used. The use of podcasts is expected to continue to grow as a resource for educational delivery, and podcasts' potential as an effective delivery method is being recognized by educators in the medical field.[1,2,4] Educators can develop content for and self-publish podcasts to better meet the specific needs of their students.

Several studies have evaluated the effectiveness of podcasting as an educational delivery method.[2,4,9] One study by Lorimer and Hilliard focused on replacing a traditional classroom lecture with podcasts and small group seminars.[2] Students were given podcasts with associated PowerPoint presentation files before class and were expected to come to weekly small group seminars ready to ask questions and discuss the information. A multiple-choice activity using an electronic voting system also was employed in the seminars. This study

showed that this combination of teaching methods was an effective revision to the established lecture-based teaching pattern. The use of the electronic voting system in combination with the small group seminars and independent study via podcasts was beneficial to students and faculty alike.[2]

A study by Saeed et al showed similar results.[4] The authors studied the use of podcasts and other electronic delivery methods in relation to students' different learning styles. They found that students who preferred podcasts were sequential learners who preferred understanding in linear steps, repeating the material, and continuing at their own pace. Both Lorimer and Hilliard[2] and Saeed et al[4] stated that well-balanced academic performance was achieved among all groups and the learning technologies did not pose barriers to students' education. Instead, "students' engagement with their learning and level of classroom interactivity were both increased when compared with the previous traditional delivery format."[2] The benefits of incorporating podcasts into educational delivery methods included increased flexibility in the time and place of study and a positive influence on academic performance.[2,4] Students stated that possible reasons for the positive influence on academic performance included an ability to pause or stop lectures and a lack of peer pressure during question-and-answer portions of the lecture.[2]

Only one study showed negative results from integrating podcasts into educational delivery. Daniel and Woody compared one group of students that read a lengthy article from a book with a second group that listened to the same article via a podcast.[9] The group that listened to the article via podcast did significantly worse on a quiz about the material than did the group that read the article. According to Daniel and Woody, students in the podcast group:

> *[P]erformed relatively poorly on the quiz and reported that they knew less, understood less, experienced more difficulty with the material, and, marginally, learned less than did students in the text condition.*[9]

Students who listened to the podcast initially reported that they preferred this method instead of reading, but after taking the quiz and even before receiving their scores, they stated that the podcast was not an effective method for their learning.[9]

Because of the recent innovations in educational technologies, the educational system is currently undergoing a fundamental change, a shift away from traditional classroom lecture delivery methods.[4] Podcasting is an effective tool for educators in traditional classroom courses as well as in online courses. Integration of podcasts in radiologic science education can draw staff and students closer together, both physically and virtually, by allowing cohesion and dialogue for in-person and distance-learning formats.[2]

Online Education

The Internet has become the predominant format for delivering distance education. Many institutions offer online courses that address the diverse distance and time needs of today's students who might not be able to attend traditional university classes.[10,11] Higher education has increasingly tried to reach more students in recent years, and as of 2013, more than 6.7 million college students were enrolled in at least one online course.[11-13]

According to Britt, "Online education can be defined as any course that is mediated via the Internet."[11] Online courses permit off-campus students to access quality education through the use of a course management system such as WebCT, Blackboard, Desire2Learn, and Moodle. These course management systems allow students to contact the educator and fellow students through e-mail and message boards and provide open communication and dialogue to help develop critical-thinking skills.[10-12]

For online education to be successful, the educator must encourage students to become autonomous and take responsibility for their own education.[14,15] This helps students to develop their knowledge and professional skills and to emphasize a student-centered learning approach.[13,14] Online education at the professional and postprofessional levels also can help students to engage in continuing education and lifelong learning.[1,12,14] This method of learning can help radiologic technology programs provide opportunities for students to assume responsibility for their own learning[14,16] and "reduce their level of dependence on staff and prepare them for the rigors of the workplace by developing high level cognitive and transferable skills."[14] Of the studies reviewed, most

supported online education as long as it is incorporated and implemented properly.[1,10-12,14,16]

Online education has been implemented into educational programs in varying degrees. Some institutions use online technology to enhance traditional learning in classrooms, known as the supplemental model. Conversely, the replacement model, which also is referred to as *blended*, *hybrid*, or *mixed* online instruction, integrates interactive online technology with or to replace some of the traditional classroom lecture instruction. Students might be taught fully online or might have varying degrees of virtual and classroom time.[1]

Two studies by Johnston[15] and Britt[11] show examples of integrating online technologies into radiologic science undergraduate programs. Johnston examined the instructional effectiveness of 2 radiologic science courses—patient care as well as radiation biology and protection—which previously were taught face-to-face and converted to a fully online format.[15] The study compared the students' grade-point average for the courses and the students' performance on a national certification examination in the areas covered by the classes. The results were mixed. The grades for both courses were higher for the online courses compared with the face-to-face instruction, although the difference for the patient care course was not statistically significant. In contrast, the national certification examination results for students in the patient care class were higher for the face-to-face delivery class than for those who received online instruction. No comparisons from the national certification examination could be made for the radiation biology and protection course because the standard deviation for both groups was zero. When it was time for the students to take their board certification examinations, it appeared that the students in the online classes did not remember the information as well as those who had taken classes in the face-to-face format.[15]

The objective of Britt's study was to determine the attitudes of students and faculty about online instruction.[11] Surveys were sent to faculty members in the radiologic technology and nursing departments at a university. Similar surveys were sent to radiologic technology students in the clinical phase of their education and to graduate nursing students. The survey gathered information about the subjects' attitudes toward online teaching and learning. Overall, the results were negative. Educators expressed that they experienced a lack of preparation time, a lack of contact with students, and that they were unfamiliar with the technology for online courses. However, they did consider the difficulty level of the online courses to be equal to or more difficult than traditional instruction. Students also expressed that the classes being taught online were as difficult as or more difficult than traditional classes. Fifty-two percent of the students reported no difference in their online course grades compared with classroom instruction, and, of the 48% who did report a change, 23% suggested that their grades were higher in the online classes.[11] No quantitative data were collected about course grade-point averages or performance on national certification examinations.

Despite the mixed results of these 2 studies, more studies are showing that online courses can be effective. Evidence-based outcome studies regarding the effectiveness of online education showed no significant differences in outcomes between online and traditionally taught classes, but studies published after 1998 are more heavily in favor of online education's ability to provide an effective student-centered learning environment.[1,11]

Although there is not one correct method for delivery, online education will continue to improve as educators adapt their teaching style, course content, and educational philosophy. As educators adjust, online instruction will continue to improve and promote a more learner-centered environment.[10,14,15]

The greatest appeal of online education is the potential to meet the needs of all students.[11] However, like every new model of instruction, challenges exist because online education is not a mass-produced product.[1,11] It differs greatly from face-to-face instruction and must focus on learning material and activities that engage students in the physical absence of a teacher.[15] Preparation for an online course is difficult and mentally challenging for both the teacher and the student.[11,15]

Success with instructional technology has led to more exploration of delivery methods. Educators who have taught online courses have reported an enhanced ability to involve or link to experts or external Web sites and improve self-directed learning, critical thinking, and the quality of student work.[1] Other positive

features of online education are increased flexibility in schedules for students and faculty, a reduction in travel expenses, alleviation of classroom space problems, and an ability to more flexibly meet the needs of all students.[11,12]

Some drawbacks to online education still exist. Sometimes, there is a limitation in the technology used for this delivery method.[12] A study by Kliger and Pfeiffer suggested that narrow bandwidths can be an obstacle to using dual media when communicating with students (eg, speaking to students while showing a video online).[12] In hybrid environments, students are still required to spend money on travel and other expenses to attend face-to-face classroom activities.[12] There also might be an unwillingness of educators to adapt to new technologies because of the time and extra work required to implement them.[11,12]

Because of the lack of face-to-face interaction in online education, it seems that increased learning could result from a more engaged effort through collaborative activities.[17] The power of online learning can be enhanced by collaborative learning through the ability to discuss problems, share ideas, reflect, and review, either synchronously or asynchronously.[17] Most current course management systems (eg, WebCT, Blackboard, Desire2Learn, or Moodle) incorporate tools such as e-mail, discussion boards, wikis, and live chats to encourage students to work together.[10,11]

Social Media

One popular avenue for collaborative online activities is social media. The past 10 years have seen a vast increase in social networking sites and software[18,19] and growing user participation in these technologies, known as the *social media revolution*.[6,19] *Social media* can be defined as an online space or technology that allows people to establish or maintain contact with others, interact with social networks, and share ideas about any topic at any time.[1,6,19]

Many social media platforms exist, including Facebook and Twitter, which allow people to share information about anything at any time; wikis such as Wikipedia and blogs that promote continuous information sharing within interested user communities; Skype and Ventrilo, which use audio-visual devices to enable face-to-face communication through the Internet; and video sites such as YouTube, which allow video sharing with anyone in the world.[5,6,17,20] The research showed that Facebook and Twitter are the most commonly used social media tools.[5,6,17,20]

Facebook

Facebook is an international Web site that allows users to easily build a personalized Web page, display photos and thoughts, and send messages to other users.[18] Users can join or set up interest groups to communicate about any subject.[6,18] Facebook has the potential to be a great tool for educational programs because its target demographic is so compactly gathered in one place, and it is dynamic enough to allow educators to create a communication channel of their own.[6] Educators can create such channels for students to interact with the instructor in interest groups for each course or for each student cohort.

A study by Giordano and Giordano showed that health professions students prefer to obtain news, weather, sports, entertainment, and social information online, with a majority of them heavily relying on Facebook.[6] It also showed that graduates often use Facebook to stay connected to their fellow alumni. This would suggest that Facebook spans both professional and personal bounds.[6] Such common use of a technology would indicate that it could be adapted to education. According to Freishtat and Sandlin:

> *Socially oriented digital media produce a* habitus *within digital spaces; meaning youths' experiences with technological culture influence the ways in which they will interact with technology.*[21]

This information about Facebook use by health professions students is helpful for faculty and administration.[6,18] According to Giordano and Giordano:

> *[Facebook] is a no-cost, viral way of getting the word out about school events and programming and can be used to keep students informed of new classes, special lectures, holiday hours, special events, and even emergency notices. Above all, it is about being social, allowing students a virtual meeting space to connect with alumni, establish school pride, announce reunions and sporting events, talk about group projects, interact with the community, and beyond.*[6]

In spite of the many applications of sites such as Facebook, educational institutions might be hesitant to adopt such practices because of a fear of privacy and security issues.[6,18] Facebook has been under examination for the sale of users' personal data to companies that sell this information to marketing firms.[18] Most of the research in this area is based on testimonials or correlational evidence, and although the uses for a site like Facebook are seemingly endless, there is little proof that Facebook is an effective tool in an educational setting.[6] Another area of concern is the issue of unintended feedback, harsh conversation, and negative or malicious comments by students or other Facebook users.[18] Burns and Wolstencroft suggested closely monitoring Facebook pages to ensure that no inappropriate comments are made and no uninvited users have access.[18]

Twitter

Twitter is an online platform for delivering short messages, similar to text messages, which educators can use to keep their students informed of class developments and schedules, as long as educators and students subscribe to be "followers" of the initiator of the Twitter feed.[18,19]

A study by Mistry examined the use of Twitter in critical care training of nursing students.[20] Students were given a simulation scenario and asked to comment via Twitter on how they would react in certain situations. Comments were sent to either the course instructor or to other students in the scenario in either a synchronous format (students actively engaged in participation at the same time) or an asynchronous format (students participating at different times over a given time period). Students were then given information back from the instructor or their classmates, creating a dialogue based on response.[20]

Many students expressed their satisfaction with the use of this method of education. Mistry found that, overall, the Twitter method was no different from any other online collaborative experience and that there was a "demonstrable articulation of ideas, assertions and diagnoses, sometimes conflicting with others' ideas, which sometimes led to a co-construction of ideas, working closely with the tutor or peer."[20] There was widespread agreement that the materials developed for the scenarios were engaging and educational, and the discussion of the clinical information was useful.[20] However, Mistry said that because of the time required for initial setup and constant involvement, effective use of this tool is a difficult, timely process and might not be applicable in all situations.[20]

Some students had concerns about aspects of Twitter as an educational medium. Students who were not confident in the learning process, the instructional material, or both, tended to lose focus and motivation. Also, some of the unthreaded discussions in asynchronous mode were difficult to follow.[20] Mistry suggested that instead of applying Twitter to all situations in an educational setting to try easing the technology into courses by replicating existing discussion forums and using it as a replacement tool for existing audience response systems.[20]

Using social media could be important to today's students as more than just the delivery method. Roland et al stated that students today are less skilled in written and oral communication and, because of this, are more hesitant to speak out or write independently for fear of ridicule by others.[5] These students need to be supported in the development of communication skills using these same mechanisms, by virtue of their knowledge and familiarity with these technological advances.[5] This comfort level will pave the way for increasing educational benefits, which recently have led to tremendous growth in online and hybrid education.[5,19] When social media is properly implemented and integrated, the lines between social networking environments and teaching and learning tools are blurred.[6,17,19]

Discussion

In an ever-changing world, radiologic technology educators continually modify their educational delivery methods. They must adapt to fluctuating learning styles and preferences, stay current with educational and radiologic science trends, and integrate new educational technologies into their teaching. Such technologies allow for better communication and delivery for educators and help provide education in a convenient, mobile, and effective mode with which most students are already familiar. Also, new educational technologies can give both educators and students the

luxury of setting their own schedule for communication and schoolwork. Modern technology has resulted in an age of instant gratification and information, the effects of which can be seen in health care and education.[19] This requires imaging professionals and educators to be aware of the risks associated with new technologies identified throughout this review and how to properly implement new technologies despite these risks.

Conclusion

Radiologic technology educators have many tools available to them to assist with teaching in a fluctuating educational environment. Mobile electronic devices, podcasting, online education, and social media have been shown to be effective in helping educators deliver convenient, quality, and successful instruction. This innovative culture helps to foster the concept of continuing education in students' lives and throughout their careers.

This review had some limitations. Many studies focused on the topics of mobile electronic devices, podcasting, online education, and social media; however, few actually performed qualitative or quantitative studies to prove or disprove their perspectives about these emerging technologies. Several reviews from non–peer-reviewed sources were based on opinions rather than facts, which is why they were not included in this review. It was difficult to find peer-reviewed articles reporting on studies with students as subjects, and only a small number of those covered the field of radiologic science education.

Although some studies have examined the use of new technologies in education, future studies should evaluate the effectiveness of evolving technologies and demonstrate their successful integration into the field of radiologic science education. Because individuals working in the field of radiologic technology continually work with new equipment and innovative technological advances, it is reasonable to expect that new educational technologies—if found to be effective—could play an important role in both educational delivery and learning. This integration of educational technologies could enable students to incorporate such methods into their daily practice.

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