Education, Teleconferencing, and Distance Learning in Respiratory Care

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Among health professions the field of respiratory care (RC) once enjoyed a leadership role in integrating new technologies in teaching, largely because of the excellent match between branching-logic clinical simulations and microcomputer technology. RC can reclaim leadership status by concentrating on effective teaching and the judicious (rather than lavish) deployment of educational technologies. Teleconferencing has been important in RC education, but its role is waning as Internet-based teaching becomes the dominant technology. RC instructors should avoid the media-comparison research pitfall. Research indicates that students who learn at a distance do not learn better or worse than students in traditional classrooms, although student attrition is a serious problem in Internet-based courses. Online courses are time consuming to develop and deploy, effectively serve limited numbers of students per course, and are not suitable for some topics and learners. RC is probably not a good match for courses and programs delivered entirely via the Internet, but RC is an excellent match for Internet-supported courses. Faculty should concentrate on teaching effectiveness, instruction design strategies, and making judicious, conservative use of educational technologies. With or without technology, instructors should develop learner-centered, authentic instruction. In RC education there are abundant opportunities to employ technology, but RC programs will be well served by distilling a detailed vision of effective educational-technology integration, rather than by continuing to pressure programs and faculty to adopt technology without careful consideration of the value added (or subtracted) by each specific technology. *Key words: computers, distance learning, distance education, educational technology, computer-assisted instruction, Internet, teaching methods.* [Respir Care 2004;49(4):410–420. © 2004 Daedalus Enterprises]

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Introduction

> There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things.
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> —Machiavelli, 1513

In the flood of technology applications designed for education and instruction, which attended the introduction of personal microcomputers in the early 1980s, among health professions the field of respiratory care (RC) enjoyed a lead role in technology integration. This was due to 2 important factors:

1. The fortuitous coincidence of the National Board for Respiratory Care's deployment of the branching-logic clinical simulation registry examination in 1979, which replaced the inefficient oral examinations,[1] and the explosive success of Apple's microcomputer. Text-based and interactive, the examination's branching-logic format was a near-perfect match for the rudimentary computing and database management capacity of first-generation microcomputers. Computer-managed clinical simulations were much superior to the crude drill-and-practice and tutorial applications used in health professions education and education in general at that time.

2. The ingenuity and industry of a number of imaginative RC educators and technology integrators, including Sally Hixon Cavanaugh, Bob Kacmarek, and Christine McGuire, who played important roles in developing the branching-logic clinical simulation methodology for RC. Also important were David C Assmann, founder of MediSims (an important early commercial instructional software publisher for RC), and Ron Koncher (founder of Algorithms Unlimited, which published the popular SimuWriter program that allowed instructors to create custom computer-managed clinical simulations). It is worthy of note that the clinical simulation method for the advanced practitioner examination moved from paper-based to computer-based 2 decades after those visionaries saw this potential in RC. Computer-managed clinical simulations are now a routine element in RC training.

Following this initial burst of innovation RC education experienced a blossoming of technology applications, and a series of commercial instructional publishers entered and left the scene. Although their efforts became increasingly sophisticated and graphics-rich as media development tools evolved, they rarely stepped outside the bounds of the early clinical simulation, drill-and-practice, and tutorial formula.[2] Computer-based training tutorials in RC have had solid content but a paucity of good instructional design and imagination, often accurately described as "electronic page turners." Few of those early RC-education-materials development companies have survived, and the major textbook publishers have made only tentative efforts in developing and marketing RC-instructional technology. Drill-and-practice software, a staple in RC training, has been generally dismissed in the larger field of educational technology. Although intuitively the interactive quality of computer-based training seems to be important, there has been little research evidence of the value of interaction in instruction.[3] RC has not been a sufficiently large or lucrative market for long-term development of instructional media. We are, in part, to blame, as software piracy has been a factor in discouraging instructional media publishing efforts for health professions.

Computer-managed clinical simulations have become routine in RC training, for teaching and practicing clinical skills, and for preparing for credentialing examinations. But there is a danger that enthusiasm for technology could lead some to the questionable conclusion that simulated, technology-driven exercises reliably represent the real-world experiences of clinical practice. As I have argued elsewhere,[4] that a student performs well on a clinical simulation examination does not necessarily indicate a high degree of clinical acumen. Similarly, there is reason to question whether high performance on branching-logic clinical simulations truly reflects critical thinking, especially if users have been extensively drilled in the methodology. Media-rich simulations have been rightfully criticized for teaching gamesmanship, giving an appearance of target-skill competence when in fact the student merely learned to score well within the game.[5] For instance, a simulation on pediatric asthma management that uses a spaceship metaphor in which the user scores points by laser-zapping mucus plugs and environmental triggers may increase the student's competence in scoring game points but may have little effect on a patient's asthma management.

In this report I will address emerging on-line teleconferencing technology and its current status and potential in RC, and I will outline the present state of online teaching technology and theory. I will propose recommendations for employing on-line technology in RC teaching, and I will address the question of efficacy in distance learning. I will conclude with a prescription for adopting current instruction technologies and propose specific recommendations for RC education to reclaim a leadership role in technology integration.

Teleconferencing

Teleconferencing, using various technologies and combinations of technologies, has been an important mediated form of distance learning, but its use is waning. The intent is to instantaneously transmit the live classroom experience, often with 2-way communication between teacher and students. This can be done using dedicated transmission lines, satellite links, or compressed video via telephone line, with or without 2-way audio communication. This "same time, different place"[6] approach enjoyed brief

popularity in medical education, but much greater and sustained interest in the corporate world. The technology tends to be quite expensive and effectively reaches limited numbers of students (those in technology-intensive, wired classrooms). In United States medical fields teleconferencing is rapidly being supplanted by online course development.[3] An aspect of teleconferencing courses that seems to be universal is tedium. This was abundantly clear in my own limited experience with videotaped lectures by subject-matter experts and live audio for questions and interaction. There are frequent anecdotal references to this problem in the literature, including reports of students cheering when the teleconferencing machinery fails.

RC was a pioneering medical field in educational teleconferencing, with the American Association for Respiratory Care's (AARC's) long-running "Professor's Rounds" satellite conferences, which began in 1990 (William Dubbs, AARC, Dallas, Texas, personal communication, 2004). In its first year an estimated 10,000 health practitioners from 350 institutions participated. The series has continued for more than 10 years, with various changes in vendors and technologies, and now provides videotapes of the conferences, permitting participation by institutions that do not have satellite downlink capability. Each year the AARC conducts 8 videotaped sessions. For the 5-year period 1998–2002 an average of 5,300 participants per year earned continuing respiratory-care-education (CRCE) credit. This approach provides continuing education to institutional staff for relatively low cost per participant.

Comes Now the Web

Plato complained that widespread dissemination of writing technology would wither memories.[7] Every major technology introduction has been attended by wild claims that it will revolutionize education[8–12] or that it will destroy education. This was the case with the introduction of motion pictures, radio,[9] television, and now the Internet.[3] Although media technologies have sometimes played important roles in education, including a critical role in training service men and women during World War II, their long-term impact on educational practices has been, on the whole, slight.[11,13,14] Some argue that the introduction of the Internet is the most important development in communications since the introduction of television in 1939,[15] whereas others suspect that it represents a technological and cultural phenomenon unseen in recent history.[16,17]

The recent advent and proliferation of the World Wide Web (Web) and Internet technologies sparked a furious, highly competitive drive by higher education and the corporate world to develop and deploy online courses. In 2002, 1,680 educational institutions offered more than 54,000 online courses.[3] Approximately 20% of training in "world-class" business organizations is being delivered by online educational technology.[18] But online pedagogy has lagged far behind technology innovation[6,19] and even further behind the ambitious plans and claims of educational institutions ravenous for shares in an anticipated borderless, virtual university. One researcher described this phenomenon as a "frenzied drive toward the Web-based cliff."[20] Some authors have rendered scathing indictments of the explosion of thin online courses by many colleges, labeling them "digital diploma mills."[21] Institutions and administrators embraced online teaching as a way to expand institutional turf borders, with the potential for serving vast numbers of students in a single course. But there is research evidence that online courses cannot effectively manage more than 10–20 students,[20] and instructor work load in completely online courses is about 3 times greater than in traditional courses.[16,19] As one veteran Web course developer said, "The paint never dries."[22] This is a daunting aspect of online instructional development; tightly designed, commercial-quality, interactive, Web-based training or computer-based training typically requires 100–400 hours of development time per hour of delivery time.[23] And online courses are simply not viable for some learners and some topics.[12,24]

The Question of Efficacy

A pitfall for Internet technology adopters in RC is to participate in the vain search for quasi-experimental research evidence of efficacy.[5] RC seeks to be science and evidence-based[25,26] and performs its work under the direction of physicians, who are well known for adherence to scientific principles. But, whereas clinical studies of drug efficacy may be designed with near-perfect definitions of terms, drugs, dosages, and pathologies, constructs such as "traditional teaching" and "online teaching" are fuzzy and unworkable. What is traditional teaching? Is a course on the same subject by 2 instructors really the same? Is the same course delivered by a single instructor to 2 classrooms identical? What is online teaching? Fully online? Partially online? Synchronous (same time, different place)? Asynchronous (different time, different place)? Using what tools and techniques? Indeed, the very process of adapting a classroom course for distant delivery, for comparison purposes, often transforms the course at a "bedrock" level.[27,28] This media-comparison conundrum has frustrated educational technology scholars for decades, culminating in the startling and profound conclusion by Clark[29] that, "The best . . . evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition." Clark based his conclusion on meta-analysis of 6 decades of research on educational media. Similarly, Clark and Sugrue[5] wrote, "It is the prescription compound that influences biology, not the

medium of delivery. . . . It is not the computer that alters learning any more than the tablet influences biological processes in a different way than the liquid form of a drug." To appreciate that disquieting deduction it must be recognized that traditional classroom teaching is but one of many choices in technology and media. When the dependent variable is learning, the overwhelming evidence is that there is no significant difference between methods that employ various combinations of media.[14] This ubiquitous finding has been dubbed the "NSD" (no significant difference) phenomenon[30] and has led most researchers to abandon media-comparison studies. Although still a contentious topic in educational technology,[31,32] the question has been answered to the satisfaction of most researchers.[3,33–35]

Clark[36] reemphasized this position a decade later and further pointed out that, because there is no substantial advantage with any of the competing methods or media, the prevailing factor in selection should be economics (ie, impact the most students with the least money).

The research clearly shows that students who learn at a distance do not learn better or worse than students in traditional classrooms.[3] We must keep in mind that there is precious little reliable research evidence that traditional classroom instruction is as effective as we presume.[37] Indeed, I am frequently asked if online teaching provides the same quality educational experience as the classroom, and my standard answer is, "I hope not." I am in agreement with the important Boyer Commission report on undergraduate education,[38] which declared, "Some . . . instructors. . . may be tenured drones who deliver set lectures from yellowed notes, making no effort to engage the bored minds of the students in front of them." An online course that attends to instructional strategy in any meaningful way is certain to best the stale information-recitation classrooms we have all endured. The point is that distance-learning courses, like traditional courses, have the potential for effectiveness. This is certainly not to suggest that hasty, sloppy, distance-learning courses— of which there are many—are necessarily effective.

The answer to the efficacy question seems to be that teaching and learning are exceedingly complex phenomena[39] and the key to success is clearly not in the *media*, but in the *instructional strategy*. As Jonassen[40] recently wrote, there is no unified theory of teaching and learning. Competent teachers achieve similar, positive results using almost any vehicle or medium. Similarly, Pratt[41] believes there are 5 fundamental approaches to teaching (transmission, developmental, apprenticeship, nurturing, and social reform) and that each can provide good or poor instruction. Some researchers have found an advantage, though not a statistically significant advantage, in nontraditional methods.[42,43] But even the most enthusiastic supporters of nontraditional teaching admit that the advantage is in many cases attributable to tighter instructional design, an inherent aspect of nontraditional teaching, or to the novelty factor,[5,37] and not to choice of technology.

Research on the efficacy of online courses has tended to examine outcomes for single courses and not for entire programs.[44] A research finding that deserves attention in RC is that online teaching is best matched to mature, self-directed students.[45] Successful online students tend to be intrinsically motivated, abstract learners.[3] Does that describe the student base in RC? Similarly, current online teaching technology necessarily supports a collaborative instructional style,[46] because of the bandwidth limitation, and that learning environment is not well suited to many learners.[24,46] My own teaching experience suggests that graduate students often succeed in online and partially online courses, whereas undergraduates are rarely well suited, in terms of temperament and maturity, to online teaching.

Online Teaching in Respiratory Care

As to the question of online RC programs, I conclude that RC is not suited for entirely-online education, for 5 reasons:

1. The attrition rate in online courses, as high as 50%,[47] is unacceptable.
2. The RC student pool is not a good match for current online teaching technologies.
3. RC is a "doing" vocation that involves many complex psychomotor skills, and that is a poor match for current online teaching technologies.
4. I believe it is essential to have close continuity and coordination between classroom instruction and clinical instruction.
5. A commercial effort to create an entirely-online distance learning RC program could create a "diploma mill" that does not provide the quality of RC education we should require.

Issues of efficacy aside, and as I have argued before,[27] the matter of RC's professional image should not be taken lightly. Becker[48] reported a survey of RC managers; 60% of respondents considered baccalaureate degrees earned via distance learning to be equivalent to degrees earned in the traditional classroom, and 75% of RC manager respondents recommend graduate programs conducted entirely online. I agree with the latter, because motivated and mature graduate students are more likely to succeed in the online environment. However, only 26% of 1,444 responded to the survey, so the Becker study does not provide a high level of statistical confidence, which points to the need for further research on the subject. Although I do not favor RC courses or programs that are totally online, I

do favor partially online- or Internet-supported courses, as I will describe below.

I am troubled by Becker's statement that ". . . advanced degree programs should have mechanisms to provide credit for prior educational coursework and life experience." I vehemently disagree, as that states the "diploma mill" approach in exact language. Institutions that have too eagerly embraced distance learning often seem to extend this to acceptance to all manner of dubious short cuts and fast tracks toward advanced degrees. RC managers who seek an advanced degree are well advised to demand high-quality education and a degree that will be respected in the professional community—not merely convenience. In the realm of higher education, unearned degrees are openly scorned, and in my opinion RC's professional image has already been tarnished by the correspondence-school stigma.[27] Without question, it negatively influences recruiting efforts—a far more important issue than the distance learning efficacy question.

Distance learning is often tedious and students prefer meeting face-to-face in the traditional classroom,[3] but the powerful cost and flexibility advantages of distance learning sometimes prevail. Online discussion technologies seem particularly well suited to the goal of providing "opportunities to engage in critical discourse in order to improve communication, negotiation, decision-making, and reflection."[25] Bonk and Reynolds[49] described specific on-line learning strategies for creative thinking and critical thinking, describing the latter as ". . . activity wherein students identify main points, search for cause and effect, find patterns and relationships, rank ideas, develop timelines, build taxonomies . . . draw comparisons and contrasts, examine costs versus benefits, or interlink ideas. . . . "

A Technology Prescription

Reeves[43] cautions technology integrators to beware the "big technology lie," that technology will make learning fast, easy, and fun. The words of astrophysicist Clifford Stoll[50] ring true: "Most learning isn't fun. Learning takes work. Discipline. Commitment, from both teacher and student. Responsibility." Rather than being swept away by the siren song of each tantalizing innovation in technology, a prudent position in technology integration is patience and deliberate, thoughtful technology choices. The first successful Web browser (Mosaic; now Microsoft Internet Explorer) was introduced but a decade ago.[51] We cannot possibly have learned how best to teach on the Internet in that short time. However, there is enough research and experience to offer some sound strategies for Internet teaching. First among these is for RC instructors to consider Web support or Web enhancement for their courses, rather than completely online courses. Some researchers have recommended this approach as a way to achieve maximum educational impact with minimal time and expense,[20,22,28] and with a gradual introduction to students. Table 1 lists advantages of Internet support of traditional courses.

There are abundant resources that address operational aspects of Internet teaching[52–55] and a growing number of resources on instructional strategy.[3] A serious and unresolved concern in fully online courses is student attrition,[44] and that issue alone should give the RC training industry pause in planning Internet course development. The current state of Internet teaching makes the goal of converting traditional lecture courses to online courses difficult indeed. Instructors find that a successful classroom course, when converted wholesale to a Web site, often results in dreadful "shovelware"—content put on the Web as fast as possible, with little regard for appearance or usability—that is neither pleasing nor effective. Online teaching requires fundamental rethinking of instructional strategies,[19] and the Internet's bandwidth limitation favors discussion and collaboration approaches more than presentation-style instruction. Instructors must also cope with the complex challenges involved in teaching without physical presence; absent eye contact, body language, voice tone, and facial expression.[56]

Teaching: Not Technology

Technology fascination is widespread in education—what Salomon[14] called a trivialized, "technocentric" approach to technology integration. But educational technology researchers have repeatedly stumbled on the simple truth that technology integration isn't about technology—it is about teaching.[57] In 1999 I wrote that technology is "expensive, fragile, and stupid,"[58] and this is still my opinion. It is rare for an instructional event dependent on technology to proceed without a glitch. As a case in point, I worked with a technical communication faculty colleague to develop and refine an online survey instrument to gather preliminary data for this report. The hour that we sent hundreds of e-mail invitations to the survey, the survey vendor's servers malfunctioned and remained inoperable for 3 days.

Seasoned RC faculty should take encouragement and bring to bear their own considerable teaching skill and experience to technology integration. We must stop waiting for a technological "magic wand" to solve our instructional woes. Technology integration in education, especially in the case of Internet technology, is a process that is tedious, frustrating, and protracted—exactly as Rogers has described the universal phenomenon of technological innovations.[59] With or without technology, effective teaching relies on time-proven, "bedrock" strategies[60,61] such as those identified by Chickering and Gamson,[62,63] who maintain that good practice in undergraduate education (1) en-

Table 1. Advantages of Internet Support of Traditional Courses

Housekeeping	Instruction
Distribute housekeeping information to all students quickly and reliably, via Listserv, bulletin board, or course Web site	Instructor can post a single response to a representative content question, via Listserv or bulletin board
Paperless syllabus (student may choose to print)	Students can post content questions
Syllabus can be instantly updated	Students can respond to student content questions
Prospective students can browse course materials	Post course content links (posted by instructor or contributed by students)
Instructor contact information can be centrally posted	Conduct online surveys and polls
Post readable, printable, searchable documents (in PDF [portable display format])	Facilitate topical discussion (live or asynchronous)
Provide a central, simple, and consistent way to find institutional course information	Promote Internet competence and "technoconfidence"
Schedule appointments online	
Confidentially post grades online	
Students can deliver reports and other assignments via the Internet	

courages contacts between students and faculty, (2) develops reciprocity and cooperation among students, (3) uses active learning techniques, (4) provides prompt feedback, (5) emphasizes time on task and communicates high expectations, and (6) respects diverse talents and ways of learning. Credible educational technology researchers have concluded that ". . . it seems clear that technology cannot replace the human factor in higher education."[44] The Boyer Commission report[38] agrees, stating, ". . . technology cannot be a substitute for direct interactions with human minds."

A plank of the theory of instructional design is the work of Gagné,[64] who maintained that, regardless of instructional method, there are 9 events of instruction that support learning:

1. Gain attention
2. Inform the learner of the instructional objective
3. Stimulate recall of prior knowledge
4. Present content
5. Provide learning guidance
6. Elicit performance
7. Provide feedback
8. Assess performance
9. Enhance retention and transfer

Merrill[65] reviewed instructional design theories to identify what he termed "first principles of instruction," which are prescriptive design principles on which the various theories and models are in essential agreement. The foundational work of Knowles[66] in adult learning theory is evident in this. Merrill[65] reported that learning is promoted when:

1. Learners are engaged in solving real-world problems
2. Existing knowledge is activated as a foundation for new knowledge
3. New knowledge is demonstrated by the learner
4. New knowledge is applied by the learner
5. New knowledge is integrated into the learner's world

The implication of all this important theoretical work is that instructors who attend to these elements, as many exemplary teachers do, will be successful with any education medium.[67] It is attention to instructional strategy that distinguishes professional instructional design.[61] It is, obviously, difficult to attain many of those essentials of successful instruction by postal-correspondence-style distance learning. How can rapid feedback be achieved? How can critical thinking[25,68] be meaningfully addressed, much less linked to clinical instruction?

An exciting side benefit in learning to teach effectively online is that the instructor's classroom courses often improve as new teaching skills and strategies are discovered and the instructor begins to move from a craft approach to teaching[69] as we were taught, to more sophisticated and research-grounded methods. Many of the recommendations for successful Web-based courses are applicable to instruction delivered in the classroom, such as clearly defined goals and expectations, ongoing assessment, time on task, content expertise, and rapid feedback.[52,57]

Focus on the Learner

As I have argued elsewhere,[27,58] a central issue and stumbling block in technology integration in teaching is the tendency to adopt a teacher-centered, as opposed to learner-centered, approach. Teacher-centered technology applications tend to be highly visible, technically formidable, and frightfully expensive. Learner-centered technology applications tend to be subtle and comparatively inexpensive, using technologies already at hand for most instructors, but with substantial "bang for the buck." Instructors can invest enormous amounts of time, energy, and money converting lectures to

PowerPoint presentations, including impressive graphics, sounds, and video. But for learner outcomes there is little instructional advantage in that approach, because with that approach the learner's role is to listen passively. Presentation tools such as PowerPoint, widespread in education, were designed for high-impact sales presentations. Applying the same strategies to teaching, using color and media for emphasis, often results in presentations in which everything is delivered with emphasis. But if everything is emphasized, nothing is emphasized. We know very well that passive listening is not effective in achieving long-term learning goals, especially if the objective is beyond memorization of facts and details but instead requires reflective thinking and active learner engagement.[49] As Jonassen wrote, ". . . learning is a process of meaning-making, not of knowledge reception."[39]

Similarly, the Boyer Commission report[38] stated: "The skills of analysis, evaluation, and synthesis will become the hallmarks of a good education, just as absorption of a body of knowledge once was." Just as there is nothing magically instructive in transmitting text across the Internet to be read in isolation on a computer monitor,[27] there is no inherent instructional value to students in linear PowerPoint presentations. There are, however, certain mechanical advantages in presentation software, in that it is possible to streamline student note-taking by preparing automated lecture handouts.

"Bedrock" Technologies

Examples of what I have termed "invisible technologies" include:

- Word processing, which is the "King Kong" computer application in education and by itself justifies the expense of a personal computer and printer. Instructors can create and recycle templates for lecture outlines, course syllabi, assignments, and other essential documents. This saves preparation time, which can be translated directly into instructional time. And powerful, easy-to-use citation management software (eg, Endnote, Thomson Learning, at http://www.endnote.com) automates the tedious work of storing, organizing, and referencing citations and creating bibliographies.

- E-mail is inexpensive, rapid, widespread, reliable, and highly effective in leveraging instructor time and effort by reducing telephone and face-to-face housekeeping communications.

- Listservs offer simple, inexpensive, and rapid e-mail interaction with a group of people. Listservs allow the instructor to send housekeeping or content messages to everyone in the class or program with a single e-mail. Students can respond or post their own messages. Subject-matter experts can participate in topical discussions with near-conversational immediacy. This gives students the essential experience of subscribing to and participating in a professional listserv.

- Automated hypertext markup language (HTML) allows easy creation of Web pages from word processing and presentation files. This allows the instructor to faithfully save documents as HTML files to be posted on a Web site for student access. The instructor can thus quickly post policies, schedules, procedures, and other documents and resources for wide distribution. Some instructional technologists have suggested that the "Save as HTML" button on popular word processing applications may come to be seen as the most important instructional development of our time.

- Online document transfer, via Web-site-posting, e-mail attachment, or course Listserv offers rapid, easy document distribution, instructor-to-student, instructor-to-class, student-to-instructor, or student-to-class. This is a powerful and efficient way to facilitate rapid feedback, which is a critical factor in an exemplary online course.[57] A document can be saved as a word-processing file, as a rich-text-format (RTF) file (which is portable between word-processing applications), or in portable document format (PDF, developed by Adobe Corporation, http://www.adobe.com).

- Synchronous online chat rooms and asynchronous discussion boards are flexible, inexpensive online tools to facilitate discussion and collaboration. Students can address content issues with one another, with or without instructor participation. Instructors can hold "virtual office hours," reducing driving time for students and serving multiple students at once. Instructors can create useful FAQ (frequently-asked questions) files to post to a course Web site or include in the syllabus.

- Online content databases, which are becoming widely available, give access to current research and literature (including the full text of many reports) for instructors and students. For example, the University System of Georgia's GALILEO "virtual library" (http://www.galileo.usg.edu) is splendid, as are the abundant literature resources available from the National Library of Medicine's PubMed Web site (http://www.ncbi.nlm.nih.gov/pubmed). An instructor who comes to class with the very latest abstracts on the course topic makes a far more impressive use of technology than the instructor who invests the same amount of time choosing presentation fonts and colors. It is also an important opportunity for the instructor to model judicious technology application, as is the instructor's use of word processing

Table 2. Examples of "Technocentric" Versus Judicious Technology Integration Approaches

High-Tech/Low-Impact Technology Integration	Low-Tech/High-Impact Technology Integration
Select fonts and font sizes and colors for a PowerPoint presentation	Search an online database to find, print, and skim 5 topical, full-text journal articles, none more than 2 years old
Scan a graphic image to add impact to an important slide	E-mail a subject-matter expert and receive an informative response
Edit a troublesome Web page using hypertext markup language (HTML)	Use a template from another class; revise and print a class lesson plan
Transport, set up, and trouble-shoot hardware for PowerPoint presentation	Prepare a problem-solving exercise with a word processor, save it as an HTML file, and immediately post it on the class Web site
	Respond to a thoughtful e-mail message from a mentor
	Using inexpensive and simple software, create and print a crossword puzzle on content terms
	Field a half-dozen quick e-mail messages from students and off-campus colleagues
	Discuss a lab exercise with a faculty co-worker
	Meet with a student in an online chatroom

and participation in professional discourse using online tools.

Key elements in these technologies are that they:

- Are grounded in sound teaching theory
- Are designed to teach, not to "wow"
- Tend to free instructor time for coaching and instruction
- Are adopted in a scholarly, critical manner, with due consideration for return on investment
- Tend to be "at your fingertips"
- Are robust, student-centered, and oriented toward learning more than teaching

Table 2 compares "technocentric" and judicious technology integration.

Refine the Technology Vision

Perhaps the most important step toward technology integration—more important than buying and implementing hardware, software, and related items—is to distill a vision of technology's place in teaching. RC instructors are bombarded with technology-promotion messages from all sides, yet there is rarely a clear and consistent vision of technology integration at their institutions or within their departments. The results are "fuzzy goals"— black holes of squandered resources, energy, and time, and with little hope of success.[70,71] One way to address this is to gather technology stakeholders (students, faculty, colleagues, administrators, and clients) in a focus group to pose the question, "What would we see in the RC program that has effectively integrated technology?" Without a clear vision, technology integration bogs down in false starts, squandered resources, and withered enthusiasm.

The Future

RC is very well suited to technology integration in teaching and learning, both online and local. The knowledge and skill sets of RC practitioners are comparatively well defined and, unlike many fields, not subject to large variations and widely-divergent interpretations between institutions and instructors. These qualities of RC suggest the potential to reclaim a leadership role in technology integration. The following examples will illustrate.

All of the approximately 300 advanced practitioner programs must provide a pharmacology course, but pharmacology has been a problematic course subject because few RC instructors claim deep expertise in pharmacology, so it is often difficult to identify and recruit qualified adjunct faculty to provide a pharmacology course tailored for RC students. It would be possible using current technologies and instructional development tools and techniques to empower a nationally recognized subject-matter expert to produce one high-quality pharmacology course for all RC programs. In this way a modest annual payment by the programs that deploy the course (which would be less than the cost of local instruction) would yield a pharmacology "super course." This course could be continuously updated and refined, would provide learning objectives and instructions for integration with the laboratory and clinical elements of the local programs, and would provide top-quality instruction that is congruent with current best practices and consistent across the field. There are also other topics in the RC training curriculum that would lend themselves to super courses for wide deployment, including aerosol therapy, emerging diseases, and death and dying. Super courses might consist of a powerful, flexible com-

bination of textbooks, online tools, video resources, teleconferencing, and resources for independent study.

RC has earned the reputation that its practitioners and teachers embrace and exploit technology, often well ahead of other medical fields. RC can fulfill a leadership role in educational technology integration by modeling an approach of judicious, rather than lavish, application of technology in teaching. Demers[72] made this point in 1983, writing, ". . . one must resist the temptation to use computers solely 'because they are there.'" It is easier to adopt the role of "technology cheerleader"[73] than to adopt a stance that with regard to technology integration in teaching, less is often more. A maxim in the field of performance technology is, "Small successes are great!"[70]

I have similarly argued against the application of technology for its own sake, especially Internet technologies,[28] and I have presented as a model successful technology integrators[58] who have selected and employed technologies carefully, and often frugally, and shown substantial advantages in learner outcomes. For example, requiring students to master word processing technology and prepare their paper assignments that way is a powerful, learner-centered step toward preparing practitioners who can write as professionals. This is in keeping with the Boyer Commission report,[38] which noted that, "Many students graduate. . . without knowing how to think logically, write clearly, or speak coherently." Addressing those fundamental communication skills helps move an RC program beyond the realm of training and into true professional education.

Similarly, student assignments that require the learner to master the fundamentals of spreadsheet and database applications can be effective in teaching essential skills for future RC managers. It is a subtle but critical distinction that technology should be used as a cognitive tool—the student learns *with* the technology rather than *from* the technology, and that the technology is not used as just as another way for the instructor to attempt to linearly transmit facts.[7,14] Most college campuses provide abundant technical training opportunities, and there are highly effective and inexpensive online tutorials[74] (eg, Skills Assessment Manager and Training Online Manager, Thomson Learning, at http://www.course.com). These tools provide instruction, testing, and remediation online, and students can access them at any time, and at their own pace.

In June 2003 the AARC conducted its first Webcast, and this promising Internet technology may evolve to become a major innovation in CRCE. There have been 15 AARC Webcasts to date (there are plans to do approximately two per month), and attendance has averaged about 65 participants, each of whom earned one free CRCE for their participation [William Dubbs, AARC, personal communication, 2004]. These Webcasts are currently limited to 100 participants and are available only to AARC members. For members unable to view the live Webcast, the AARC maintains an accessible archive of each event on the AARC Internet server. AARC members can access archived Webcasts at no charge, and they earn one CRCE if they pass the 10-item test that is based on the Webcast. (There is a small fee of $15 to access the test and earn the CRCE credit.) Participants in the Webcasts first access a vendor Web site to verify that their Internet-connected computer is properly configured to receive the transmission, and to download and install needed client software. When the Webcast begins, participants log in using passwords, and listen to high-quality live audio while viewing on-screen slides, similar to a PowerPoint presentation. Participants can type and post questions and comments to the entire audience and presenter, or to individual participants. Moderators screen questions for presenter responses.

My subjective impressions of the AARC Webcasts are positive and lead me to recommend expansion of AARC educational Webcasts and development of similar Webcasts by state societies, educational institutions, and clinics. The enormous advantage in this technology is that it is delivered via the Internet, at low cost, and is viewable with widely available hardware and software. Unlike satellite technology, which is expensive and not widely accessible, Internet Webcasts can address the continuing education needs of a great many practitioners. The experience is comparable to listening to a professional lecture in a large classroom, but with the important advantage of being able to submit questions, and to view a complete archive of the event. Although not perfect, the technology appears to be robust.

Current online teaching technologies make it possible to involve practitioners, colleagues, and subject-matter experts from the community and beyond. For example, synchronous or asynchronous discussion technology can allow students to present case studies that involve community respiratory therapists, physicians, textbook authors, and even students and faculty from other programs or states. This is an exciting opportunity to develop professional networking skills and to promote collaboration across the field and even across professional boundaries. Webcast and teleconferencing technology need not be exotic. Some innovators have cobbled together effective but relatively "low-tech" solutions with familiar software tools. For example, it is a simple matter for a subject-matter expert to create a PowerPoint presentation, save it in HTML format, make it accessible on a Web site, and then verbally present it to a live audience via teleconference call with speaker phones, while a classroom or individual learners view the Web site slides, ask questions, and participate in discussion. For that type of presentation all that's needed is an Internet-connected computer and a telephone.

RC serves an enormous patient population and this suggests an opportunity to develop consistent online information resources on pathology, procedures, home care, and

other topics. Adult patients with cardiopulmonary disease might benefit in numbers from that type of media development, and it could also serve the RC student population. It would be an excellent way to keep the field in a visible leadership position in technology integration. Telemedicine is currently undergoing research and development for applications in remote consultation, monitoring, education, and mentoring. Many of the same technologies and techniques apply to distance education.[3]

Web camera technology is inexpensive and easy to use, and RC might investigate the role of Web cameras in home care. Though it would certainly not be a substitute for a home visit by a respiratory therapist, Web-camera video might permit limited supplemental home-care "virtual visits" by which the respiratory therapist could check equipment, visually evaluate the patient, and respond to questions and concerns— quickly, with no travel, and at low cost.

Instructional-technology publishers provide Web sites to support most of their printed textbooks. This is very helpful, and RC faculty could collectively lobby for similar online resources for the major RC textbooks. Such online resources, created by the textbook authors, could include proposed course syllabi (downloadable and modifiable— even automated syllabus creation!), study guides, self-assessment quizzes, PowerPoint slides and presentations, high-quality graphics (corresponding to textbook images), various instructional aids, laboratory exercises, annotated Internet links, and even examinations (password-protected). These resources would ease the preparation load of faculty and promote consistency between textbooks and program-level instruction.

Summary

RC can reclaim leadership status in educational technology by concentrating on effective teaching and the judicious deployment of educational technologies. RC is an excellent match for Internet-supported courses. There are abundant opportunities in RC to employ technology in teaching, and developments such as the AARC's Web-casts make RC educational technology an exciting frontier.

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Discussion

Volsko: Don't you think that some of the pressure to implement Web-based learning and distance learning, especially at universities, is because of administrative pressures? When a university sees declining enrollment, they push to "batch" classes. A distance-learning graduate program that I'm in partners with 4 different universities and colleges. It's really put my computer skills to use, because everything is paperless, from finding the articles on the Web (using database and library services such as Ohio Link) to disseminating data through bulletin boards, and online, timed examinations. I could see from the instructor's point of view how difficult it is to manage a classroom that's 3–4 times the size, with a barrage of television screens around the room and having to coordinate activities at 4 different sites.

Hopper: There is definitely administrative pressure in higher education to move courses and programs onto the Web. There's tremendous pressure from all sides for faculty, including RC faculty, to do more with technology in the general sense, and specifically to do more online teaching. The institutions are afraid of being left behind. None of them wants to be the last one to offer online programs. They're afraid of being muscled out by some other program. Those are important worries. Some of the big online courses are siphoning away good adjunct faculty, because the online courses pay a little better. There's definitely pressure that doesn't come from the best interests of the students and certainly not the best interests of faculty. It burns faculty out. It's just not for everybody. There are faculty who love it, but my experience is that it is so tedious that it's not for everybody.

Chatburn: I didn't quite follow what you meant about context affecting learning, particularly in the example of learning blood gas interpretations. It seems to me that should be context-insensitive. It's just a set of numbers and you just learn the algorithms and use them.

Hopper: It seems that way to me, too, but apparently it isn't. There's a lot of research indicating that context is very important. If you take even a well-understood concept out of where it was learned and where it was applied and put it in an unfamiliar context, especially a stressful context, it doesn't transfer well. Part of this is that learners have a difficult time recognizing events in the clinic that were addressed in the classroom. Instruction designers recognize this hurdle and try to create learning environments that are as similar as possible to the workplace.

Chatburn: So it's a psychological effect? It sounds like you're saying that the students can't apply their learning. It's not that the learning didn't happen.

Hopper: If it is applied in a new context, they don't seem to recognize that what they learned yesterday in the classroom is what applies here at the patient's bedside. This is precisely why the cognitivists support authentic-problem-based learning. Topics such as arterial blood gas values that are learned in the classroom and practiced on computer tend to become isolated knowledge fragments that have no clear connection to the clinical world. This changes when students connect laboratory reports in the emergency department and intensive care unit with real patients, and this results in a much deeper, richer understanding—an understanding that will stick.

Walker: You mentioned that report by Clark[1] that used the delivery-truck analogy, and as I remember, that same report also discussed various technologies and education. There was also a story about Benjamin Franklin, who was criticized in school for wanting to use a slate instead of tree bark. My point is that Webcast online education is just a tool. It's up to the RC educator to determine how they're going to present the course content. Not all of our staff can attend the weekly ventilator rounds of pulmonary conference or a lecture on ventilator weaning, but if I could deliver that via Webcast and archive it, I might have a very strong tool for disseminating that information. In RC we're divided between tacit and explicit knowledge: we not only have to know how to hook the ventilator up; we also have to know how to manipulate it, so RC is a complicated field from an education standpoint, but, again, I think it's up to the educator to determine what type of tool and presentation to use to disseminate information.

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Hopper: I think you've got my point. It's a value judgment as to what you make about Clark's thoughts on the matter. And I take it as good news that you can't say that it's *better* to teach with a Webcast, but you can say there's ample research evidence that it's likely to be effective if it is done well. Clark went on to say that the deciding factor for which technology you choose probably should be economics, meaning teaching the most people at the least cost, which really makes the AARC Webcast something astonishing. Tom Reeves from the University of Georgia points out that some media offer advantages in some cases; his analogy is of deliveringice cream on a flatbed truck in Georgia. The context affects the choice of delivery vehicle.

Giordano:* As I heard you, Keith, you were really referring to both the pedagogical education and post-pedagogical education. We see the AARC Webcast as more of a post-pedagogical educational experience. So you've got life-long learners and we're satisfying that need to learn; whereas your comments, I think, relative to the undergraduate respiratory-therapist-in-the-making, are right on because of the discipline that's necessary for distance learning.

However, one thing that did not come up and that I think is profound in terms of distance education of all types is access. It's truly about access and expanding access. While I think the technology is in its infancy, if we were to vision forward 3 or 4 generations, God knows what they'll be talking about as "nontraditional," but it certainly won't be distance learning, because it'll probably be traditional, and certainly the technology, even in *our* foreseeable future, certainly within the next 60 months, will take giant leaps forward to make it a bit easier. So if we were to put that fork in the road and then choose the one, I think right now distance learning is good, and not because the AARC offers it, but because it's a good way to get in touch with its constituents and help with their mission of providing the best quality respiratory care.

I truly believe that in terms of undergraduate education, while you may use some technology as a device, if you will, to get a point across or a particular series of points across, that the discipline necessary to do the top job for preparing respiratory therapists of the future has to come in the classroom. The challenge, then, resides with the instructors to deliver the goods in an informative way.

I'd also like to ask you one other question. As I mentioned to you before, I've always had difficulty with these online journals and the like. I tend to read government reports, and they're just horrible to read, or the Federal Register, which is horrible to read. Even though we're going more and more online with journals, is it really going to be the answer? Are we really going to get into this so-called paperless society that some people talk about?

Hopper: I'll try to answer both those questions. Your second point is definitely on the money. You're not the only person who has noticed that. People do not like to read a lot of text on screen. That's been researched thoroughly. They just don't. That's just a limitation of dealing with humans. There's something tedious and boring about it. To some students online teaching is cruel and unusual punishment. That is a big factor. I also want to emphasize that you're definitely on the mark with your observations about undergraduates versus practitioners. Practitioners, especially credentialed ones, are a different learner pool, and they are a good target for online teaching. Now, again I make the distinction that I don't categorize Webcast technology as online teaching of courses or programs. I think of Webcast as a form of teleconferencing, but it really makes no difference. All the well-known theory on adult learning applies. You've got mature learners who are in many cases self-directed and self-motivated and they want to tie it directly to their jobs. They're going to use the information quickly. They need it to keep their licenses. So you've got a special audience that's likely to make Webcast distance learning highly effective.

Ford: As an RC manager care I have to hire about 20 people a year because of high turnover, but our RC programs are graduating 1,000 fewer respiratory therapists than we have positions. In San Diego last year we interviewed the managers and we had 40 vacant positions and the schools were graduating a grand total of 11 students. That opened up my mind some to distance learning. Prior to that I didn't even interview an individual who was associated with a distance-learning program. Nowadays I do, and I've found 2 extremes. I have a kind of competency-based interview in which we hand the applicant a simple face mask. Some distance-learning students say they've never seen one before and have no idea what it does, and of course the interview ends about then.

But I've also found that the people who have done well in distance learning make extraordinary respiratory therapists. I think if they've done well in distance-learning programs they have the characteristics you talked about—the independence, the self-learning, the ability to assimilate information that way—which are part of being a good respiratory therapist. I've had some remarkable surprises. I can't say that's for the most part, but there are exceptional distance-learning students out there.

Hopper: I appreciate what you said. I've heard similar comments from managers, and I empathize with the quandary you're in. If you can't get them from the traditional schools, where are you going to get them? And you're not going to like my answer. You made an interesting point—that the people who survive distance-learning programs are probably pretty special. I certainly wouldn't make a blanket statement denigrating people who have earned their degrees via distance learning. I teach a course in performance improvement, and if you analyze the problem, which is, "I can't get trained RC practitioners in numbers when I need them," the short-term answer is to get them from anywhere. But, ultimately, that's going to bite us, because it has an effect on quality. The ultimate answer to why we don't have people applying for the field is that it doesn't *pay* enough. No technology on earth is going to com-

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pensate for that. It may just be that things will have to get bad enough for long enough that we'll have to pay these people more. That's happened to a lot of fields, especially medically-related fields.

Gardner: I knew 2 people who in medical school took a pathology course that involved looking at slides. They could go to the class or not. They would look at slides and pick a slide and make their guess as to whether it showed a certain kind of cancer or something. If there were 5 slides, they chose the one they thought showed the condition in question, and if that wasn't it, it told them why and they went back and looked again at all 5 slides. They could also go into the classroom and get it explained in the lecture. With over 100 medical students, maybe they had 10 in the classroom. They passed the exams, did very well, and they loved it. The instructor was named Instructor of the Year for 5 years and then was hired off by another university. All of that seems to be just the opposite of what you've told us. Is it an exception? How come?

Hopper: I may not have a clear enough picture of what that person's teaching style was to answer that, but it turns out that in education it doesn't really matter what you do. It all seems to work to some degree. Some students can thrive in a loose teaching style like that. The best students seem to teach themselves, sometimes even in spite of poor instruction.

I soften Clark's statement[1] to my own graduate students by saying that there's an assumption—and I don't think Clark would disagree with this—that the medium has enough "bandwidth" to handle the message. If you take Clark's statement to the extreme, you'd conclude that we should be able to teach medical ethics using smoke signals. But that's silly. That medium (smoke signals) just can't convey messages as complex as those involved in medical ethics. In a *Monty Python* episode once they pretended to do *Wuthering Heights* with semaphore flags. You can't take it to extremes. The medium has to have adequate "bandwidth" and the teaching style has to fit the topic and the learners.

Two hundred years ago a Canadian newspaper publisher, William Lyon Mackenzie wrote that the most profound and eminent scholars, statesmen, authors, and poets were all self-taught, without benefit of a schoolmaster. My experience as a teacher and as an instruction technologist is that just about anything you do that gets people in contact with and grappling with the content is probably going to work.

Let's also keep in mind that instructors and schools often rconcentrate on *examination performance* more than on *workplace performance*. It is common for graduates to score well on examinations while actual workplace competency is unexamined. I sometimes reflect on the fact that in my years as a clinician and a clinical instructor not once did a clinical problem present as a multiple-choice question. We are fooled by our own testing methods and it is easy to forget that our goal is to create safe, effective practitioners—not skillful test-takers.

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