The Integration of Technology into Pharmacy Education and Practice

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Most technology users employ less than 20% of the capabilities offered by both their hardware and software. This usually holds true whether one is considering personal computers (PCs), personal digital assistants (PDAs), word processors, or especially pharmacy operations management and documentation software. The appropriate use of technology requires a learning curve (usually ranging from a few hours to a few weeks) and many of us are neither patient enough nor committed enough to explore technology beyond that which is necessary to solve our most immediate problems. This means we will learn how to get a label out of the community pharmacy system or enter an order into a hospital system we purchased and then often stop right there. The inventory package to increase profitability or the key performance indicator reports are never discovered. In an everyday application like e-mail, once we learn how to answer e-mails and open attachments we are satisfied and move on to our next task. Unfortunately, we never learn the features and benefits offered by these and other technologies that will truly maximize our efficiency and effectiveness through their use in our practice.

The authors believe that technology needs to be so integrated into pharmacy education and the curricula of schools and colleges of pharmacy that students would never think of practicing their profession without the support of technology. In general, we realize we are more enthusiastic about this vision than most of our colleagues. One of the authors took his first computer course in 1966 and has been able to continually focus on all aspects of pharmacy-related technology while at Auburn. Remember, technology performs two primary functions which both relate to the work humans do. First, technology can be used to completely replace the work of humans, especially when that work is repetitive and tedious. Thus, there are many robotic dispensing systems that are faster and more accurate than humans doing the same task. Secondly, technology enhances the work humans perform.

We can think of no better example of technology that enhances human performance than that of information technology. Pharmacy informatics can be defined as the specialized application of computers and other information technologies that are used to advance the profession. With thousands of new articles being published every week in the biomedical literature, it is impossible for any practitioner to claim that he or she is "keeping up" with the relevant information generated globally that can impact the provision of pharmaceutical care. We believe that the primary purpose of all information is to reduce our uncertainty when making decisions. Technologies classified as information appliances can deliver evidence-based information at the point of care that

has been updated on a daily basis. Wireless technology allows us to review clinical information, such as laboratory results, as soon as they become available. Technology is available to support the provision of pharmaceutical care in the achievement of desirable patient outcomes. Pharmacy educators now need to integrate the support of all available technologies into pharmacy education.

At least one of our clinical colleagues claims to be old enough that he had to learn how to practice pharmacy with only primary literature to guide his decisions. The authors viewed the Facts and Comparisons Web site and saw that their first tertiary publication was printed in 1947. During the 1970s there were many quality tertiary references from which to choose, but they were nearly all in book format. These resources are now being slowly converted into an electronic format. Some book publishers merely displayed their books electronically without change. Other publishing and prospective drug utilization review businesses initially released their tertiary references in an electronic form. Some of these still appeared more like books than electronic products. The format in which these references were presented became more granular and the best products today give our pharmacists and student pharmacists very quick to the exact nugget of information they seek. For example, a user desiring correct dosing on a drug for use in renally impaired patients can go directly to the information needed; therefore, there is no need to read a monograph or even a paragraph to find the answer being sought.

Publishers have progressed from books, to floppy disc-based, to CD ROM-based, to Internet-based, to PDA-based products. Furthermore, the buzzword in healthcare technology is Mobile Care. Technology now allows pervasive computing in pharmacy practice. We are able to acquire information and communicate our knowledge from anywhere to anywhere. In fact, one of the latest definitions of the Internet is every computer, cell phone, PDA, and pager in the world being able to communicate with every other one. The actual hardware that accomplishes this information management continues to weigh less and do more. A SmartPhone/PDA we acquired for less than $200 through our university allows us to simultaneously carry a cell phone, speaker phone, voice recorder, voice dialer, e-mail, Internet browser, fax machine, pager, MP3 player, digital camera, still and motion picture viewer, the Microsoft Office Professional document management application, and over 500MB of clinical references and pharmacy specialized applications. We can now be as connected as we wish. Our students need to be prepared to practice in a world supported by this level of technology. Wireless infrastructure in our program has made a wonderful difference in the level of utilization of student computers throughout our educational process. It is now possible for students to sit at picnic tables several hundred yards from our building and be completely connected to our network resources. Just as children grow up today thinking that the Internet has always been there, accessing the highest quality information to support the provision of pharmaceutical care should be second nature to our student pharmacists.

The clinical workup of the patient starts with appraisal, then moves to intervention, follows with the evaluation of the impact of interventions, and concludes with a plan for monitoring and following up with each patient appropriately. Technology exists to support each of these steps that will make providers more efficient and effective at managing their practice. Moreover, technology exists that is affordable, portable, and more recently connected to a multidisciplinary care team where the five rights (right

drug, right strength, right form, etc.) we use in pharmacy can be extended to include the right provider doing the right procedure in the right facility for the right patient at the right time. A wealth of technology exists to assist the delivery of pharmaceutical care, whether the problem being addressed is medication regimen adherence, screening for drug-related problems, patient safety, measurement of therapeutic outcomes, or patients' self-care management. Integration and standardization of these technologies is now one of the highest priorities for all of healthcare.

For students to become equipped to utilize this array of technology, they must first become computer literate. We have placed this requirement in our admissions material at Auburn University. We stipulate that basic computer, Internet, Microsoft Office Suite, and electronic communication skills be obtained in students' two-year pre-pharmacy education prior to starting our four-year professional program. We require students to have or purchase a wireless laptop computer that meets a set of specifications (listed on our web site). When the student arrives on campus we load off line CD-ROM-based drug references, PDA emulators, and a variety of utilities necessary to complete our pharmacy curriculum and connect to our specialized systems. WebCT is our primary syllabus management technology. We utilize GroupWise as our organizational groupware package for managing e-mail, to do lists, calendars, appointments, and special events notification.

When we initially launched the notebook computer requirement, we utilized a lease program but found that allowing students to purchase their own computer at or above our specifications was much more satisfactory. Without fail, when we specified an individual computer and negotiated the lease price for 24 months, a significant price reduction would occur on the specified computer within 30 days following our signing a contract. When technical difficulties would arise during the lease period, students would bring the notebook computer we "made" them purchase back to the school and say, "What are you going to do to fix this problem?" When students purchase their own technology some of them exceed specifications and purchase ultra-portable devices. Since they own the device they tend to work directly with the manufacturer for technical difficulties they encounter and are able to make their computer last beyond the 24 months of the previous lease program.

We have tested students for computer literacy upon arrival, but have found that their computer skills are seriously lacking. Approximately 20% of our admission classes are still relatively computer illiterate when they enter the pharmacy program. This should be self-correcting as public schools expose young students to greater levels of computing in their early education.

We have placed a significant number of electronic resources online for student use. We have a wide array of medical and pharmacy references online that are mounted with restricted access by username and password. We require that students construct their own web page for professional promotion and for posting various projects required in our classes. We are incorporating an electronic portfolio that will further list the educational accomplishments and competencies attained by students. In many of our courses grades are communicated electronically, assignments are collected electronically, and documentation of patient care visits are transmitted as e-mail attachments for use by faculty mentors who provide students with verbal and electronic feedback. We have acquired a full-featured electronic medical record and are modifying the existing 37

specialties to include a customized pharmacotherapy specialty and a hospital/inpatient specialty. This secure record will house all of the documentation of patient care rendered in our educational program, research initiatives, and clinics operated by the school. It will serve to create an enterprise solution for all of our inpatient and ambulatory uses.

In a recent curriculum revision, we are constructing a curriculum-wide skills laboratory that has the potential for 24/7 access by students and eventually by alumni. This laboratory material may account for as much as one third of the educational effort required by a student each semester. Distance education techniques, even within our professional program, will be utilized for many of the skills taught through the laboratory. When students need to manipulate an actual object such as a blood glucose meter, a visit to the laboratory will supply them with needed tools. Several pharmacy programs in the US to include Minnesota and Cincinnati have constructed such a laboratory and seem to be utilizing them successfully in their respective programs. One possible scenario for collaboration is that a "centers of excellence" approach will emerge in the country (and perhaps internationally) so that redundant development of materials will become unnecessary. For example, while Auburn University may have modules in Healthcare Informatics and patient communication available for use by other schools, we may wish to connect to information concerning herbal treatments or oncology from other universities.

Some schools have adopted and required the use of PDAs from the beginning of their curriculum. We have elected at Auburn to train second and third year students in the selection and use of PDAs and have supported them in the discounted purchase of both hardware and software. We encourage the use of PDAs in their interdisciplinary module sequences during their second and third years and in clinical rotations during their fourth year. We are considering the requirement of PDAs for fourth year students to be able to measure the clinical impact (and potential financial benefit) of our students in clinical rotations sites. De-identified patient data could be collected and aggregated to measure both financial and therapeutic outcome evidence. These data should provide information on the benefits being derived by institutions that are providing practice settings for our student pharmacists. Similar to any healthcare setting, colleges and schools of pharmacy need to be able to integrate all aspects of their educational program to ascertain where improvements are both needed and possible.

So far we have discussed the progress made in teaching students how to use technology in the practice of pharmacy. However, much less progress has been made in using technology in the process of teaching. In essence, technology has been used mainly to facilitate traditional teaching methods rather than to enhance or transform them. For example, many lecture halls are electronically assisted with LED projectors and display cameras. Material presented during lecture in PowerPoint, Word or Adobe Acrobat formats is also available for download to the students' computers. Electronic publishing is the next generation of document reproduction that has supplanted mimeographing, dittoing, and Xeroxing of classroom materials. But the written linear nature of the material has not changed. The material is still to be read and understood by the student.

The great challenge in teaching is to use technology to create more dynamic and realistic learning environments that require the student to actively explore material and

reach their own conclusions. For example, our colleague Bruce Berger teaches first-year students how Motivational Interviewing can serve as a more effective approach to helping patients address compliance issues. He assigns readings for class, lectures on the material, holds discussions about the material, and conducts limited role playing in class. There is still a major leap remaining if the students are to incorporate Motivational Interviewing into counseling of patients. Many students never make this transition; however, Interactive computer technology offers the potential to help students make the necessary transfer.

Toward this end, we have begun to develop a standardized virtual patient that would allow students to experience using Motivational Interviewing with a patient. The second author of this paper and Brad Barker, a graduate student, have used software for digital video and speech recognition to build an engine for a prototype virtual patient. Digital video is used to present a patient's comment. Currently the student pharmacist is limited to saying one of three to five possible responses to the patient. Once the computer has recognized which alternative the student has used, the computer branches to play one of several different videotaped patient responses. Because the lag time is only one to two seconds, the virtual patient has the feel of spoken interaction with a real person. The interactive script allows students to experiment with a multitude of paths through such a counseling episode. In this manner, students can experience how counseling based on Motivational Interviewing helps patients to increase compliance with their treatment regimen. In addition, the program can allow a virtual coach (ie, a video of the instructor or an animated avatar figure) to pause the flow of interaction and provide feedback and just-in-time instruction. We believe that a library of such standardized will allow students to achieve a level of assessment, repetition, and skills attainment that would have been previously impossible. In addition to simulating general counseling and interviewing skills, a virtual patient can potentially simulate many other kinds of interactions including clinical appraisal, history taking, and training sessions.

Virtual patients can be further incorporated into the case studies often used in problem-based learning. Instead of presenting students with a patient's history, students would be required to take the virtual patient's history. If the student uses poor interviewing strategies, the virtual patient can become resistant and fail to provide the information required to arrive at an acceptable treatment plan for the patient. Instead of communication being a supplemental skill taught on the side, communication would become an integral aspect of the case study method. Students would be able to practice interviewing and counseling patients in a wide range of case studies throughout their courses.

In summary, we envision all potential scenarios for the current and future delivery of pharmaceutical care (and pharmacy education) as employing high levels of technology. The Institute of Medicine is promoting an informatics emphasis in all health curricula. We are enthusiastic about the increased efficiency and effectiveness that can be achieved through the appropriate integration of supporting technology for the student, teacher, and practitioner. While there will always be a required learning curve and rapid obsolescence when using technology, we are confident that the benefits outweigh the barriers for its use.

Please feel free to contact us to discuss this commentary in greater depth.

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