
Assessing and enhancing medical students' computer skills: a two-year experience

By Sue Hollander, M.P.A., M.L.S.
Assistant Health Sciences Librarian

University of Illinois at Chicago
Library of the Health Sciences—Rockford
Rockford, Illinois 61107

In 1984, the Association of American Medical Colleges (AAMC) issued recommendations for the reform of medical education. One recommendation was that information sciences be incorporated into the medical curriculum. In fall 1996, a survey was conducted to learn more about computer use by medical students at the Rockford regional site of the University of Illinois at Chicago College of Medicine. The purpose of the survey was to gather information not only about computer skills, but also about overall comfort level in using computers and about expectations for enhancing computer skills while attending medical school. Over a two year period, 208 students representing four classes received this survey in their e-mail. Non-respondents received a follow-up print copy in their student mailboxes. Results, based on a 60% response rate, showed a majority of Rockford students entered medical school with good skills in using e-mail and word processing, but many lacked the skills necessary to search the medical literature or to use computer-assisted instructional programs. Overall, 80% of students expected to learn more about computers while attending medical school. Results contributed to an increased effort to integrate computer applications into the medical curriculum and to use computers as a means of communicating with students.

INTRODUCTION

In 1984, the Association of American Medical Colleges (AAMC) issued recommendations for the reform of medical education in "Physicians for the Twenty-first Century: The GPEP Report." One recommendation was that "information sciences be incorporated into the medical curriculum so that, at the very minimum, graduates would be able to retrieve information from the published knowledge base . . . and would have basic familiarity with computer technology" [1]. Seven levels of increasingly complex computer skills were listed in an appendix to this report, and the report suggested the first four be achieved during the four years of undergraduate medical education. Minimally, it recommended students be able to: (1) use word processing and e-mail, (2) choose and use educational materials, (3) access databases and evaluate systems, and (4) use specialized systems and databases [2]. Almost a decade later, the ACME-TRI report, "Educating Medical Students: Assessing Change in Medical Education—the Road to Implementation," followed up on recommendations of the GPEP report and other re-

ports of the 1980s addressing medical students' education with a survey of North American medical schools. Sixty-nine of eighty-four schools responded to the section of the survey regarding the recommendation that medical schools offer instruction aimed at developing information management skills. Primarily, successes have been in providing students with access to computers and in using computer-assisted teaching, such as interactive videodiscs, in required courses. Results also showed considerable effort has been made in providing students with skills to search the literature [3]. The need to educate students in information technology is even more compelling today. However, challenges proposed in the past decade remain largely unmet at many medical schools [4].

Since publication of the GPEP report and the ACME-TRI report, medical information available on the Internet has increased exponentially. Grateful Med software was developed by the National Library of Medicine to assist health care students and professionals in searching MEDLINE and other health-related databases. Full text of dozens of core clinical journals and medical textbooks is now available electronically. Nu-

merous articles have been published advising educators to teach access to and evaluation of electronic information, and urging physicians and other health care providers to use digital libraries and digital information [5–6]. Yet, relatively little has been reported in the literature regarding computer skills of undergraduate medical students, or the expanding role health sciences librarians are playing in helping students become more computer literate.

LITERATURE REVIEW

Following publication of the GPEP report, several studies in the literature suggest many medical students feel their computer skills are lacking and a majority of students are interested in learning more about computers while attending medical school. While some studies have been conducted in the United States, computer anxiety among medical students appears to be global.

In 1986, Bresnitz et al. found almost 40% of students representing four classes at the Medical College of Pennsylvania in Philadelphia had no experience with computers prior to entering medical school, and 75% of students would take a computer literacy course in medical school if one were offered [7]. Several years later, almost 95% of medical students participating in a surgical clerkship at the University of Arkansas College of Medicine expressed an interest in learning more about how to use a computer, should time permit [8]. Orr and Edelstein, in a survey of three successive classes of matriculating medical students nationwide, found, although the level of computer literacy of the average medical student in their sample was on the rise, over half of the students felt time devoted to instruction in the use of computers was inadequate [9]. Similar findings were reported in studies conducted abroad [10–13]. These studies, covering the period 1990 to 1994, suggested many students in the health professions experience anxiety in using computers and often did not feel confident in carrying out a simple task, e.g., printing out a document or copying a file to disk.

This paper contributes to these studies and provides a better understanding of computer skills and attitudes of undergraduate medical students at the Rockford regional site of the University of Illinois College of Medicine at Chicago.

BACKGROUND

Medical students come to the University of Illinois College of Medicine at Rockford (hereafter referred to as the College of Medicine at Rockford) in their second year after completing the first year of basic sciences at the University of Illinois College of Medicine at Urbana-Champaign. The College of Medicine at Rock-

ford was established in 1971, in response to a needs assessment that indicated the area was medically underserved. It is community based in its approach to teaching undergraduate medical students. The College of Medicine at Rockford owns and operates three community health centers in rural northwest Illinois to which students are assigned in their second year. In 1993, the College of Medicine at Rockford launched a rural medicine (RMED) program. The program's goal is to prepare medical students from the State of Illinois who will, upon completion of residency, locate and practice in rural Illinois as family practice physicians. The first class of four RMED students graduated in 1997. RMED students comprised 35% of the class of 2000. This program requires that students complete a sixteen-week clerkship in a rural area of Illinois during their fourth year in the program.

The Library of the Health Sciences at Rockford (LHS-Rockford), a regional site of the University of Illinois at Chicago Library of the Health Sciences, primarily serves the needs of faculty, students, and staff of the College of Medicine at Rockford. The College of Medicine at Rockford and LHS-Rockford support two microcomputer labs. One lab, located in the library, is available to faculty, students, and staff during hours the library is open. A student lab, located adjacent to the library, is open all hours the building is open—eighteen hours per day. Students need a key card to access the student lab. The student lab provides access to twelve microcomputers (PC and Mac), and the library lab provides access to ten computers. All computers in the student lab provide Internet access, as do the majority of computers in the library. The primary purpose of these computer labs is to support and strengthen the academic preparation of Rockford students by providing technology and resources that will enhance learning within and outside the curriculum.

Since 1989, a second year medical student has been appointed as a teaching assistant (TA) to be available to assist students with computer problems approximately ten hours per week. The TAs work closely with library staff who also spend an ever-increasing amount of time assisting students with a broad range of connectivity and networking applications, as well as the more general computer uses such as database searching and word processing.

METHOD

In the summer of 1996, this author, in collaboration with medical faculty, composed a short questionnaire to assess the degree of computer literacy across the three classes of medical students at the College of Medicine at Rockford. Questions were grouped to gather information regarding: (1) student ownership of computers, (2) student skills in using a range of computer applications (based on skills recommended in

Table 1
Self-reported computer skills of undergraduate medical students (% of actual responses—numbers rounded)

Activity	Excellent/good				Fair				Poor/none			
	M2*	M2	M3	M4	M2*	M2	M3	M4	M2*	M2	M3	M4
	2000*	Class of 1999	Class of 1998	1997	2000*	Class of 1999	Class of 1998	1997	2000*	Class of 1999	Class of 1998	1997
E-mail	65	66	80	50	24	19	4	28	11	16	17	23
Word processing	75	71	92	89	16	18	0	11	8	10	8	0
Searching journal literature (MEDLINE)	40	23	57	56	29	26	35	28	32	51	8	17
Searching online catalog	33	23	35	32	26	18	12	19	40	58	54	50
Presentation software	24	16	30	19	16	21	17	31	60	63	54	51
Spreadsheets (e.g., LOTUS)	19	25	8	32	30	21	40	6	51	54	52	63
Database management	19	18	31	19	24	8	26	0	58	74	43	51
Computer assisted instruction (CAI)	43	30	65	47	30	14	4	6	27	41	30	47
Telecommunications software	28	32	45	27	26	15	25	13	46	63	30	60

* Second year medical students (M2) representing the Class of 2000 were surveyed one year later than the Class of 1999. Results of this group are discussed separately. They are included in this table for ease of comparison.

the GPEP report), (3) student attitudes toward using computers for certain tasks, and (4) student expectations for enhancing computer skills during undergraduate medical education. Additionally, students were asked to provide comments as to how they felt computer skills might best be taught in the undergraduate medical education curriculum.

In the fall of 1996, this fifteen-item questionnaire was sent, via electronic mail, to all second (M2), third (M3), and fourth (M4) year medical students. A follow-up print copy was placed in on-campus student mailboxes two weeks later. After another two week interval, a second print copy was distributed to increase the response rate. In the fall of 1997, using the same procedures, the same questionnaire was sent to the new M2 class.

RESULTS

In fall 1996, 86 of 158 students completed and returned the questionnaire, for a 54% response rate. The breakdown by class was 18 M4 students (40%), 26 M3 students (49%), and 42 M2 students (72%). Thirty-two students (37%) completed and returned the questionnaire electronically. One quarter of the respondents were RMED students.

The first set of questions was grouped to determine if students owned a computer, had a UIC computer account, or used e-mail at least three times a week. Computer ownership varied only slightly among classes—48% of M2 students owned a computer, 54% of M3 students, and 56% of M4 students. Of the 42 students responding that they did not own a computer, 43% cited financial reasons as the major barrier, 26% cited uncertainty as to what to purchase, 26% cited expectation of the school to furnish or provide access to a computer, and 19% cited no interest in owning

one. Twenty-six percent expressed other reasons, e.g., they could use a computer at their parent's home. Almost all respondents knew they had a UIC computer account that would enable them to use e-mail and access UIC resources from home; 7% were unsure.

Fifty-two of those responding to the survey (61%) indicated they used e-mail from home or school at least three times a week. The majority (77%) used Pine, an electronic messaging program for UNIX; most of the others used Eudora. Respondents not using e-mail on a regular basis gave a variety of reasons. Thirty-one percent cited lack of instruction, such as "forgot how to log on" or "do not know how to look up e-mail addresses." A few expressed difficulties in switching from another university e-mail system. Twenty-five percent felt their time was better spent on other forms of communication, and 22% indicated they would use e-mail if they had access from home. Two-thirds of those not using e-mail listed other reasons including, "lazy," "not interested," "lack of time," "no one to write to that I don't see personally," or "I prefer to write a letter." Regular e-mail use, at least three times a week, was considerably higher (20% or more) with M2 and M3 students.

Three questions used a five-point Likert scale to allow students to rank what they perceived to be their skill level in using a variety of computer applications, their perception of how useful they felt computers would be in performing a variety of tasks, and their comfort level in using computers. This information is summarized in Tables 1, 2, and 3.

Finally, students were asked to indicate whether they expected to acquire or enhance computer skills while in medical school. An increasing majority of students—67% (Class of 1997) to 84% (Class of 2000)—indicated they expect to acquire or enhance computer

Table 2

Student perception of usefulness of computers for specified activities (% of actual responses—numbers rounded)

Activity	Very/somewhat useful				Limited use				No use/don't know			
	M2*	M2	M3	M4	M2*	M2	M3	M4	M2*	M2	M3	M4
	2000*	Class of 1999	Class of 1998	Class of 1997	2000*	Class of 1999	Class of 1998	Class of 1997	2000*	Class of 1999	Class of 1998	Class of 1997
Problem solving	68	65	54	77	18	22	25	6	13	13	21	18
Information seeking	100	96	81	100	0	2	0	0	0	2	4	0
Communication	95	100	88	94	5	0	8	6	0	0	4	0
Self-education	74	88	87	94	21	7	14	6	6	5	0	0
Review	68	79	67	82	21	10	21	6	11	10	13	12

* Second year medical students (M2) representing the Class of 2000 were surveyed one year later than the Class of 1999. Results of this group are discussed separately. They are included in this table for ease of comparison.

skills as part of their undergraduate medical education. Ninety-two percent of students expecting to serve as physicians in rural areas had this expectation.

Many students offered comments as to how they felt computer skills should be taught in undergraduate medical training. The suggestion cited most frequently was to offer optional workshops or seminars on varied topics so that interested students could attend. Other suggestions were to educate staff so that they can answer questions for students; develop a "floating manual" with important points and features of e-mail, word processing, etc.; make tutors available who can work with students one-to-one. One student suggested the best time to offer instruction in the use of computers would be at the beginning of the semester, followed by refresher sessions later in the semester. Possibly the most significant comment offered was: "Make it an expectation; if I were forced to use computers, I would do it."

In a continuing commitment to monitor computer skills, the same questionnaire was sent in fall 1997 to the incoming class of M2 students (Class of 2000.) Thirty-eight of fifty students (76%) responded, 41% via e-mail. Close to one-half of respondents were RMED students. This finding suggested the growing significance placed on the need for computer skills by those planning to practice in remote, rural settings. Forty-seven percent of respondents from the Class of

2000 reported they owned a computer, compared to 48% of the M2 class of the previous year.

Eighty-four percent of respondents from this group of students reported they use e-mail, from home or school, at least three times a week. This percentage represented an increase of 40% over M4 students surveyed in fall 1996 and an increase of 20% over M2s and M3s surveyed at that time. Computer skills, perception of the usefulness of computers for performing a variety of activities, and degree of comfort in using computers were previously summarized for this class of M2s in Tables 1, 2, and 3. Consistent with classes surveyed in fall 1996, the vast majority of incoming M2 students (84%) responding to the survey indicated they expected to acquire or enhance their computer skills during medical school.

DISCUSSION

Results of this survey provide a better understanding of where medical students at the College of Medicine at Rockford stand in terms of the basic computer skills recommended for undergraduate medical education in the 1984 GPEP report, and what they expect in terms of learning more about computers while attending medical school. This information has been shared with medical faculty and with members of the Academic Computing Committee, which focuses on curriculum integrated instruction. This action contributed to an increased effort to integrate computer applications into the medical curriculum and to use computers as a means of communicating with students.

Findings show use of e-mail on a regular basis (at least three times a week) increased significantly over the four groups of students surveyed. This increase could be attributed to several things. A formal library orientation for the Class of 2000 included, for the first time, instruction in using e-mail. Also for the first time, students in this class were automatically assigned a computer identification and password, which would allow them to use e-mail immediately upon entering

Table 3

Student comfort level in using computers (% of actual responses—numbers rounded)

	M2*—Class of 2000	M2—Class of 1999	M3—Class of 1998	M4—Class of 1997
Very strong/strong	44	47	85	50
Fair	37	33	12	44
Poor/very poor	18	19	3	6

* Second year medical students (M2) representing the Class of 2000 were surveyed one year later than the Class of 1999. Results of this group are discussed separately. They are included in this table for ease of comparison.

the College of Medicine at Rockford. This information was placed in each student's on-campus mailbox prior to the beginning of the semester. Prior to this class, students were responsible for securing their own computer accounts should they so desire. Finally, in fall 1997, these students, as well as all other Rockford medical students, were subscribed to an electronic mailing list established by librarians and the Office of Academic Affairs. Students received notice of this in their campus mailboxes and were informed that they were to receive important information regarding class schedules, program changes, upcoming events, etc. on this e-mail discussion list. In related efforts to encourage the use of e-mail, library staff have worked with students and faculty to set up distribution lists to allow communication among groups of students working together on community medicine and other class projects.

Results of this survey also suggested the majority of students at the College of Medicine at Rockford were self-assessed, early on, as well prepared (possessing good to excellent skills) to use word processing software. However, even though an average of 95% of students responding to the survey indicated they perceived computers to be very or somewhat useful in information seeking, only slightly more than 50% of third and fourth year students felt they possessed a level of skill necessary to access databases effectively to search the medical literature. Students at the College of Medicine in Rockford receive training in searching MEDLINE in their second year as part of the Pathophysiology in Clinical Medicine course. No formal, required instruction is provided at any other point in the curriculum. This suggests a follow-up MEDLINE training may benefit a significant number of third and fourth year students.

Findings indicate each succeeding class of students may be better prepared to choose and use appropriate computer-based instructional materials earlier in their medical education as societal exposure to computers becomes universal. Student comments, however, indicate they have mixed feelings regarding computer assisted instruction (CAI). Their feelings range from "Don't substitute computers for classroom teaching," to "Emphasize the advantages of using computers and provide simple print documentation." This survey, along with several other studies cited in the literature, shows that the majority of students are willing, if not eager, to acquire and enhance computer skills during their undergraduate medical education, as long as this does not impose additional time demands on them.

Several curriculum-integrated projects and informal workshops were planned to provide medical students opportunities to enhance their computer skills. The author worked with the teaching assistant assigned to the computer lab to develop informal seminars on varied topics, including an introduction to the Internet.

Although student comments indicated they would be interested in attending informal workshops, these optional offerings were sparsely attended compared to curriculum-integrated modules, for which attendance was required. This pattern strongly suggests the need to integrate computer instruction as part of the required medical curriculum.

Librarians and computer specialists at the College of Medicine at Rockford have been consultants to several projects designed over the past two years to involve students in Web-based instruction. One project, aimed at introducing students to information available on the Internet, provides second year medical students the option of viewing and diagnosing pathology cases on the Web. Students are given the option of working alone or in small groups so that they may gain information technology skills by working with more experienced classmates. Print materials are made available in the library for those choosing not to participate in this online exercise. Also, in their pathology class, small groups of second-year students engage in computer-based exercises arranged in a sequential problem-based learning format. Each exercise includes patient history and physical exam data as well as visual and graphic pathologic images. Students are given the opportunity to interact in a variety of ways including requesting more tests, interpreting results, and making a diagnosis. Student responses are transmitted to "offline" instructors via e-mail.

In fall 1997, for the first time at the College of Medicine at Rockford, one-half of second-year students enrolled in the Essentials of Patient Care course were randomly selected by their instructor to complete all epidemiology assignments for the first four weeks of the course on the Internet. The class was surveyed beforehand to determine which students had previous experience in computer-assisted instruction, and the instructor took care to match pairs of inexperienced students with those who had some experience in using computers. Their classmates attended traditional lectures covering the same material. Test results of the two groups will be compared to provide feedback on how well each group did with material covered. This information will be used in future curriculum design.

Third and fourth year students are required to use computers in select clerkships. A computer-based module on fluid and electrolyte balance has replaced a traditional lecture in the pediatrics clerkship. In the surgery clerkship, students are required to use computers to log-in their clinical skills and surgical procedural experience. These data are examined by faculty to help determine whether individual student goals are achieved and whether program goals are met.

Perhaps those students receiving the most exposure to computers are those enrolled in the rural medicine program. In their first year on the Urbana campus,

RMED students interact with faculty in Rockford via e-mail. They attend monthly seminars and learn about rural health care issues. One specific goal of the RMED program is to develop computer skills with assignments that require use of the Internet and online databases. In their fourth year, RMED students are required to complete a four-month preceptorship with a primary care provider in a rural community in Illinois. The program loans each student a laptop computer to use during this time. Students are required to log-in clinical data from each patient encounter and to provide program administrators with an ongoing assessment of the educational quality of their experience. Dial-up Internet access provides students with databases and Web sites to search for information to support patient care and to complete their Community Oriented Primary Care project and their Community Structure reports. In the past year, RMED students have been given the option of completing a four-week neurology clerkship via the Internet. Participants are asked to review sixteen cases. They are provided patient histories, relevant labs, and pictures of general pathology. Library staff have worked with medical faculty in executing MEDLINE searches to locate articles to provide additional information that may be useful in determining a diagnosis and formulating a treatment plan. These articles have been scanned on a password-protected Web page. Once a diagnosis has been made and a treatment has been recommended, the student sends this information to faculty at the College of Medicine at Rockford via e-mail.

These efforts to promote or enhance computer literacy among undergraduate medical students at the College of Medicine at Rockford have shed light on issues that must be dealt with in designing future Web-based instruction. Some students have expressed dissatisfaction at being subjected to computer-assisted instruction without first receiving some type of instruction in using computers. This reaction suggests the need to offer optional computer skills training to students prior to their entrance to medical school or early on in their medical education. Many of the problems encountered in these early efforts to integrate computers into the curriculum, however, deal more with hardware and software issues than with lack of user skill or course content. While the idea of "electronic reserves" is an issue under discussion at many academic libraries today, the reality of making reading materials available on the Internet is more complex than it would seem. Copyright issues relating to electronic materials have not been fully resolved, and dated equipment often complicates the process of placing reading materials on the Web. Many of the computers at the College of Medicine in Rockford lack sufficient memory to produce good, clear copies in a timely manner. These issues require joint planning between

medical teaching faculty, librarians serving students and faculty, and computer specialists.

FUTURE STUDIES

Responses to this survey serve as baseline data regarding the computer skills of students entering their second year of medical school at the University of Illinois College of Medicine at Rockford. The study does not take into account information technology skills of medical faculty who may, at some point, need or wish to become involved in designing curriculum for future classes. An assessment of medical faculty computer skills and attitudes toward using computers is planned.

CONCLUSIONS

The literature spanning the decade after publication of the GPEP report clearly indicates that many medical students, even with the proliferation of home computers in that same decade, feel somewhat uncomfortable using computers and most of them hope to acquire and enhance their computer skills while in medical school. This survey has found that students at the Rockford site of the University of Illinois College of Medicine are no exception. With the exponential increase in medical information, much of it now available online, and a move to teach evidence-based medicine, students are increasingly recognizing the necessity of strengthening those information technology skills so important to the practice of medicine in the twenty-first century. Health sciences librarians, with their training and expertise in using computers to communicate, teach, and retrieve information, can be significant partners in helping to meet these expectations.

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