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Are Doctor of Pharmacy Students Prepared for High Technology Learning?

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This study evaluated 104 Doctor of Pharmacy students self-reported preparedness for use and natural adaptation to computers in education throughout a course for which students received minimal technology preparation. The setting was a high technology classroom designed for student laptop computer use with Intranet/Internet access for each student. A single group, pre- and post-test survey design was employed to access essential computer terminology, applications, hardware knowledge, and file management skills necessary for successful participation in the course. Students' computer knowledge and skills improved for the identified essential technology items upon course completion, however, this was not adequate to achieve optimal success. Many problems were encountered as a direct result of inadequate requisite skill attainment prior to starting the course. Pharmacy educators must expect and receive technology support for themselves, their students, and the classroom environment to attain the value-added potential of high technology learning.

Keywords: Computer; Technology; Internet; Pharmacy education

INTRODUCTION

As computer technology becomes a more pervasive aspect of pharmacy education, practice and research environments, it is essential that pharmacy students gain the skills, knowledge and abilities required to function effectively and proficiently with computers. The value of computer use in professional education is supported by several simultaneous trends. Professional practice continues to depend increasingly on computers and technology. Improved availability, accessibility, and ease of use of integrated health information and care systems supported by technology favour further technology integration (Cataldo, 2000). This imminent, full integration of health care delivery with technology has led the International Medical Informatics Association to recommend educational tracks and learning outcomes for health professional presently in practice, as both information technology users and health and medical informatics experts (Anonymous, 2000).

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Another trend is the general use of computers in our society for early primary and secondary education. The United States Department of Education estimates that there are presently 200 computers for every 1000 pupils being educated nationwide, and 75% of public school classrooms are connected to the Internet. A Department of Commerce study recently demonstrated that in U.S. households reporting an annual income less that $30,000, 20% of pre-college students have computer access at home. As the income rises to greater than $75,000, more than 80% of these students have home access. These recent trends might suggest that many students entering professional programmes today are likely to expect to learn using the computer as a primary tool and are well prepared to use computers in this capacity. As we look toward the future, students entering our professional programmes would seemingly be increasingly "computer literate". The future suggests that computer literacy is essential for basic professional practice.

Computer uses in education have rapidly expanded to include cognitive learning of content using multimedia approaches, communication via e-mail and conferencing, obtaining information and literature searching through Internet accessible sites, data display, analysis, the development of professional writing skills and assessment and testing (Kidd *et al.*, 1993; Birx *et al.*, 1996; Asgari-Jirhandeh and Haywood, 1997; Austin, 1999; Hollander, 1999; Jerant and Lloyd, 2000). Classroom environments are increasingly moving from paper to paperless methods of teaching and learning, using electronic access to resources and multimedia technologies to display learning materials. Simultaneously, a shift from the teacher-centered approach to a model where teachers integrate, guide and facilitate learners to achieve desired learning outcomes has been adopted by educators. This shift places a greater emphasis on teaching students the skills of information identification, access, prioritization, use and communication of findings. Computers have provided the ready access to information and a highly efficient means of communication, the impact of which is unprecedented by traditional information sources and communication methods.

Early professional education begins in the classroom where we first begin teaching professionals to use tools to efficiently practice pharmacy. The Doctor of Pharmacy programme at Creighton University began requiring laptop computers for entering students in the latter half of 2000 as a result of a faculty vote. Both faculty and students became equipped with this tool, along with the creation of a new high technology laptop computer oriented classroom. Several reasons ultimately contributed to support for the mandatory use of computers in the classroom. Near instant access to information via Internet, such as course websites, published electronic information, and information available primarily through the Internet was of interest. The use of computer-based testing and assessment was also of high interest. Identified student benefits included electronic note taking and storage, improved clarity of visual material through direct access on a computer screen and improved ability to see and use multimedia resources. The laptop was the computer format adopted initially because students could move the computer between their residence and the classroom, maximizing the potential use of this equipment and minimizing hardware expense. This also provided students maximum opportunity to store and retrieve class materials and notes electronically, and make information readily available from their personal computer. The equipment requirements were standardized and the costs for supporting laptop purchases were built into the tuition requirements of the programme.

With all that is known about the growing impact and role of computers and technology in both education and practice, little is known about the computer literacy of pharmacy students upon entry into the professional

programme or their ability to cope with this added dimension to the learning environment. As educators incorporate more interdependent classroom activities on computer technology, the demands on computer literacy increase. The entry-level skills of students are often presumed to be sufficient to cope with a substantial degree to technology incorporated into the learning process. A study was conducted on this student population to describe the students' skills, abilities and attitudes towards computers in learning, and the adaptation of students using computers as a substantial part of the experience in this classroom environment.

PURPOSE

The purpose of this study were to:

1. evaluate student self-reported knowledge, abilities, skills and attitudes toward computer use,
2. describe Internet accessibility of pharmacy students entering the professional Doctor of Pharmacy programme,
3. understand and describe student adaptation and development in computer technology throughout a semester long course that integrated computers and applications as teaching aids and tools when students have received minimal technology preparation.

The study was implemented as part of a school-wide programme evaluation of computer literacy carried out simultaneously across all programmes in the school, including occupational therapy and physical therapy. Under this auspice, the school-wide programme evaluation plan had received appropriate Institutional Review Board (IRB) approval for educational research, which is filed annually with the IRB. The project also contributes to meeting the essentials of educational research for programme accreditation.

Students were expected to use the computer to transfer instructor provided lecture materials stored as computer files on a course website to their own computers for personal use, turn in written assignments via e-mail, view multimedia presentations on their computers, complete computer-based assessments and access drug information resources via Internet. Students would be expected to perform the file creation, edit, transfer, and storage functions to participate successfully in completing assignments and maximizing the use of the computer as a tool. Knowledge of computer terminology, hardware and software was necessary in order to be self-sufficient in management of both professional studies and the computer equipment.

METHODS

Study Design

A single group, pre- and post-test design was employed to meet the study purposes (Campbell and Stanley, 1963). The course instructor also maintained a journal of instructional experience and anecdotal descriptions of student encounters related to computer use while they were enrolled in the course. The pre-test was conducted as a survey of the students in early September at the time of orientation to the professional programme, and repeated 15 weeks later during the last week in December, at the end of the course. The primary course instructor designed introductory practical application exercises requiring students to be able to perform basic computer functions with the hardware, software applications, and Intranet/Internet e-mail systems.

Survey Design

The survey was developed with portions adapted from a 1997 questionnaire obtained from Temple University (Patrikas, 2000). The content of the survey assessed the following:

1. computer terminology knowledge,
2. ability to use computer hardware,
3. ability to use software and applications,
4. information and file management skills,
5. accessibility to the Internet form their personal residences,
6. self-reported experience and frequency of computer use prior to admission to the programme and at the end of the semester.

Additional questions were incorporated at the end of the course to access the basic attitudes toward technology integration during the course and students' overall educational experience related to technology in the course. Face validity of the survey content and format was established by having the co-authors review the survey instruments for appropriateness and relevance of content, ease of use and clarity of questions. An external panel of four technology experts also reviewed the instrument. The items were modified based upon this review.

Subjects

Entry level pharmacy students ($n = 104$) who were enrolled in a first semester course on the Doctor of Pharmacy programme participated in the study during Fall/autumn of 2000. The programme requirements had recently changed to require all entering students to purchase a "programme standard" laptop computer, issued upon arrival at programme orientation. A brief computer orientation programme provided students with an introduction to the laptop environment and the Creighton University computing network. This was an orientation intended to make sure that students received their laptops, had workable logins and passwords to the university computing network and to ensure that all software applications for the laptop were installed on each persons' computer. No training about the use of the computers or the installed applications took place. Students on the programme were told, by the admissions tutors, that the instructors might require the use of laptop computers for a variety of purposes. The students were encouraged to use their computers for computerized library searches, word processing, media presentations, communications, and any other school-related or personal uses. Evaluation data revealed the need for a more in depth student laptop orientation, which was instituted in the subsequent academic year (2001).

Learning Environment and Study Setting

The study setting consisted of a high technology supported classroom designed for student laptop computer use, allowing for Internet connectivity for every student in the class. The classroom seats a maximum of 120 students. The instructional podium is "technology ready", supporting audio connectivity to laptop or desktop computers with classroom speakers interfaced, and video connectivity through either videotape or computer generated video, with projection to large screens positioned at the front of the classroom, one on either side of the centre podium. Instructors may bring a laptop and connect to the audio and/or video projection system, may bring files on disk media and use the existing desktop computer that resides in the classroom permanently, or connect to files via Internet or Intranet and display the accessed media in the classroom through network access. Additional Internet access ports are integrated throughout the Creighton University campus, including the health sciences library and the student union.

Description of Course and Technology Integration

The course entitled, "Foundations in Pharmaceutical Care", was structured to be completed in 15 weeks. The class meets 1 h per week and all students are expected to attend in the classroom.

The course employs interactive learning strategies in the classroom, active writing assignments in and out of class and independent and small group assignments (Angelo and Cross, 1993). Three major content areas are emphasized in the class: drug information and evidence-based practice; therapeutic care plans and caring and professional behaviours. These areas are taught sequentially in modules with the knowledge, skills and abilities from the preceding module added into and reinforced into the next module. The final module of caring and professional behaviours integrates the content of the other two areas. The overarching instructional design of the course included the use of mini-didactic sessions, many short cases used to illustrate context and key teaching points, and two longitudinal cases that the students followed, applying their knowledge and skills, as each module is integrated into the learning plan. Each class session was structured with a 10–15 min presentation by the instructor, followed by an in-class activity to practice and assess the students' demonstrated competency for that activity. Examples of student activities included conducting on-line use of professional literature searching strategies for patient specific drug information needs, evaluation of patient cases using multiple information sources to develop a care plan, assessing the professional and caring behaviours of pharmacists demonstrated through multimedia presentations, or the preparation of written patient care plans using the subjective, objective, assessment, and plan ("SOAP") format. Classroom interaction was encouraged with the instructor and between students to optimise interactive learning opportunities during the classroom meeting time. In most classroom sessions, the students connected their own laptop computers to the classroom network, which in turn allowed each user Internet access.

To optimally participate in this course, students needed to become proficient in basic terminology, hardware use, software use, file management applications and Internet access. The course has an established website that serves as a repository of teaching materials in the form of lecture notes (Microsoft Word®), visual slides (Microsoft Powerpoint®), course exercises, and survey instruments (Microsoft Excel®). The website provided a location for students to observe notices and announcements. Students were asked to write papers, prepare patient care plans and provide critical literature evaluations as electronic files submitted using e-mail. Students also viewed digitized video clips of case scenarios and evaluated professional behaviours using standardized criteria completed on-line.

Faculty Experience Related to Course Revision to Incorporate Technology

Incorporating computers into the student–professor relationship and classroom experience was initially and exciting proposition. However, the trepidation caused by the high degree of uncertainty about our ability to successfully integrate technology as a teaching tool quickly took over. Substantial development hours were required to accomplish several important steps to convert the traditional course to a technology integrated course:

(a) The quality and value of the computer as a tool compared to traditional tools and methods currently employed into the class to accomplish the desired educational outcomes was determined. This process involved:

Identifying the specific learning objectives desired from the classroom activities traditionally completed.

Considering alternative instructional methods using the computer.

Comparing the present instructional method to the identified alternative methods to determine anticipated advantages and disadvantages to the student and instructor, ultimately

judging the anticipated impact on learning outcomes, in addition to successful course management.

(b) For example, a specific learning objective in the drug information skills module involves conducting a literature search using the correct searching strategy to answer a specific question. The traditional course involved sending students to the library to look in printed references, and following through to a primary literature search using the library computers. This objective was met by modifying the in-class experience to having the student use the same searching strategy, however, they did so in class accessing the electronic versions of the printed resources, and then conducting an on-line literature search from their laptop computers. The instructional method was switched from using out of class homework time to in-class experience. Greater success in achieving the learning outcome was anticipated by having the instructor and peer students interacting in class to improve understanding and technical ability to perform the assignment.

On the other hand, a specific learning objective also included conveying an effective oral response when providing an answer to request for drug information. The traditional course provided the students with a stimulated patient case, evidence from the literature for use with the case, and asked the students to work in pairs. One student would be the patient in the case, the other the pharmacist providing care for the patient. They switch roles in the simulation, completing it twice. The two students practice preparing their oral response as a pharmacist responding to the patient, and then actually role-play. The students are provided a checklist to evaluate their personal, face-to-face communication skills. After evaluating the objective and considering alternative instructional methods that would be employed on the computer, no change was made in how this activity was conducted in class. The computer was not used for this assignment. This evaluation process had to occur with every specific activity in each class session.

(c) Course re-development to include content structuring and presentation level and style occurred to complement the restructuring of the activities described above. As many of the course materials as possible were incorporated into a course website for student access during the semester. Hardware problems for individual students were anticipated and the methods, resources available, and processes to follow in order to solve these problems with students were determined. Problem identification was done by the primary course instructor by piloting several of the activities planned in the course, and listening to information technology specialists describe the capabilities of the classroom environment and anecdotal reports of experiences that other instructors had with technology.

(d) Similarly, anticipation of software problems for individual students and determining the methods, resources available, and processes to follow in order to solve these problems with students.

(e) Adjusting the classroom time to accommodate equipment set-up, assignment access, and delays caused by computing environment "gliches".

(f) Developing faculty proficiency with applications employed to accomplish the computer based teaching approach.

These steps were accomplished in preliminary form prior to course implementation. Once the course began, each step was further refined to achieve success.

Data Analysis

Data analysis was conducted using SPSS for Windows, version 7.5.2 (SPSS, Chicago). All pre- to post-comparisons were made using descriptive statistics and evaluated for significance of change using the chi–square test (Howell, 1999). Self-reported computer use and Internet accessibility was reported as frequencies. Attitudes toward technology use in the course were assessed by extent of agreement statements with five possible responses ranging from strongly agree to strongly disagree. The instructor's journal was evaluated for episodes of significance that reflected meaningful student experiences with technology.

RESULTS

One hundred and four students completed the survey. The average age of the respondents was 23.4 years (range: 19–44 years). Thirty-five percent of the students were male and 65% female.

Access to the Internet

Slightly more than half of the students (58.3%) had access to the Internet from their residence when they started the programme, and an additional 29% indicated that they obtained Internet access after they stated the course. Only 13% did not have Internet access from their residence by the end of the semester. The type of Internet access from their residence by the end of the semester. The type of the Internet access reported was 58% by dial-up and 28% through cable modem services (14% non responses).

Computer Experience of Students Prior to Entering the Programme Compared to the End of Course

Only 8% reported having little or no experience with computers prior to arriving to the programme. However, the frequency with which students reported using computers shifted from the beginning to the end of the semester. At the beginning, 14% reported use not more than once a week, 41% reported use several times a week, and 45% reported daily use. At the end of the semester, 4% indicated not more than once a week, 16% indicated several times a week, and 80% reported daily use. For those who had computer use experience during this past year, almost all (98%) reported using a desktop computer, 30% reported using a laptop computer, and 5% had experience with a personal digital assistant (PDA) such as a hand held device. Desktop computer use dropped in half by the end of the semester, being replaced by the laptop computer. Ten percent of the students reported adding the use of PDA during the semester as well.

Attitudes Toward Technology Integration

Students reflected back on the semester to evaluate how specific aspects of technology influenced their learning experiences. The results of the four items surveyed using an extent of agreement scale are shown in Table I.

The orientation programme was received reasonably well. However, substantial room for improvement was indicated by 25% of the students. The students generally felt that having access to course websites improve their educational experience. However, many felt that the level of difficulty encountered with a course website was unacceptable. Overall, the majority of students did not indicate that having the laptop computer in the classroom itself improved their educational experience.

How Students Expected to Use the Laptop Computer Compared to Actual Use Reported At End of Course

Most students expected to use the laptop for personal communications and as a learning

TABLE I Attitudes toward technology integration

Item	Response (%)				
	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
The laptop computer orientation met my needs	18.4	57.1	9.2	11.2	4.1
Having access to course websites improved my educational experience	17.3	60.2	11.2	8.2	3.1
The level of difficulty I encountered with course websites was acceptable	10.8	58.8	12.7	14.7	2.9
Reflecting on past courses, having a laptop in class improved my educational experience	9.8	35.3	29.4	22.5	2.9

resource by accessing the Internet and electronically provided information (93 and 98%, respectively). Others indicated they expected to perform presentations in class (63%) or take course notes while in class (48%). By the end of the semester, fewer students actually reported using their laptop for personal communication (80%). Ninety-eight percent reported accessing materials, however 27% actually prepared and performed presentations. More (73%) reported using the laptop to take course notes, a greater proportion of students than had anticipated doing so.

Self-reported Knowledge of Key Computer Science Terms Prior to and At End of Course

Students were asked to indicate if they knew what 48 different terms meant. Of these, 33 were considered by the course instructor to be basic terms that all the students should know about computer technology to participate in the course. No effort was made by the instructor to use class time to teach these terms. By the end of the course, natural adaptation to the learning environment resulted in 17 of these having their meaning known by greater than 75% of the class. Examination of the data in Table II revealed that terminology about some aspects of computer hardware and the web was already familiar to a large number of the students. Even with that, a significant increase in knowledge occurred by completion of this course. Although a significant improvement was observed in terms related to file types and data transmission—a substantial portion of the students reported not having this knowledge at the end of the semester.

Self-reported Ability to Use Common Computer Applications

Students were asked to indicate whether they knew how to use 21 different applications (Table III). Nine of these applications were considered essential for all students to be able to use. Of these nine, greater than 75% of the students reported being able to use five of these by the end of the semester. These included knowing how to use a browser (Internet Explorer™ or Netscape™), e-mail, a free dial-up service such as "Blue light™" or "Net Zero™", and Microsoft Word™ and Microsoft Excel™. Substantially fewer students reported ability to use the remaining applications (example Power Point, sound recorder, electronic bulletin board, etc.).

Self-reported Ability to Use Common Computer Hardware Components

Of the 13 hardware items identified, six were deemed important for all students to have the

TABLE II Self-reported knowledge of computer terminology

Computer term	Knowledgeable at baseline (count %)	Knowledgeable at end of semester (count %)	p value (chi^2)
Default HTM*†	16.3	84.6	<0.001
Website*†	83.7	94.2	<0.001
Internet*†	84.6	93.3	<0.001
World wide web*†	84.6	95.2	<0.001
http*†	76.9	84.6	<0.001
.doc*†	69.2	81.7	0.124
.txt*†	63.5	75.0	0.159
cd-ROM*†	88.5	91.3	<0.002
Zip drive*†	62.5	78.8	0.021
Hard drive*†	87.5	92.3	<0.001
cd-drive*†	83.7	91.3	<0.001
Megabyte*†	80.8	81.7	0.066
Software*†	91.3	91.3	0.008
Download*†	87.5	92.3	<0.001
Internet service provider*†	82.7	89.4	<0.001
Task bar*†	81.7	86.5	0.207
Tool bar*†	87.5	89.4	0.044
HTML*	48.1	72.1	<0.001
Intranet*	30.8	67.3	<0.001
.xls*	21.2	42.3	<0.001
IP address*	23.1	45.2	<0.001
Machine name*	46.2	48.1	0.28
File server*	54.8	59.6	0.333
Parallel port*	31.7	46.2	0.024
Serial port*	30.8	47.1	0.009
USB port*	26.0	40.4	0.017
Operating system*	46.2	54.8	0.006
RAM*	67.3	69.2	0.181
Internal memory*	63.5	69.2	0.334
High-density diskette*	62.5	62.5	0.132
Pixel*	52.9	52.9	0.174
ASCII*	13.5	23.1	0.041
MS-DOS 6.x or System 7*	44.2	51.9	0.262

* Deemed basic essential skill.
† Achieved by >75% of students at end of semester.

ability to use. Seventy-five percent or more of the students reported having the ability to use five of the six critical hardware components at the beginning of the course. No significant difference in additional learning occurred during the semester, as indicated by the data in Table IV for the essential areas identified. Less than 75% of students indicated they knew how to use an internal or external modem, scanner or zip drive.

Self-reported Ability to Use Common File Management Operations

Ten file management operations were surveyed, with seven of these deemed essential for students to know how to use (Table V). Only two of these operations were reported as being performed by >75% of the students at the end of the semester, although there was significant improvement indicated for 7 of the 10 operations.

Self-reported Expert Users in Entering Pharmacy Class

Students were asked at both the beginning and end of the semester if they believed they were experts at hardware, applications or file management operations. The faculty believed that student experts might be able to provide assistance to classmates in this challenging

TABLE III Self-reported knowledge of computer applications

Application	Knew how to use at baseline (count %)	Knew how to use at end of semester (count %)	*p* value (chi^2)
Internet explorer or Netscape*†	81.7	84.6	0.118
Microsoft word or Notepad*†	73.1	86.5	0.082
Microsoft Excel*†	70.2	80.8	0.224
McAfee Virus Scan*†	44.2	74.0	<0.001
Hot mail*†	69.2	83.7	0.053
Microsoft Access*	33.7	50.0	0.011
Microsoft Frontpage/Express*	14.4	31.7	0.001
Microsoft Powerpoint/Viewer*	46.2	64.4	0.006
Real Player*	52.9	61.5	0.256
Windows update*	39.4	51.0	0.094
Electronic bulletin board*	13.5	40.4	<0.001
e-mail*	77.9	71.2	0.003
Listserv*	34.6	51.9	0.007
AOL Instant Messenger†	46.2	81.7	<0.001
Net Zero or Blue Light	27.9	65.4	<0.001
Microsoft Sound Recorder	21.2	32.7	0.038
Real Slide Show	16.3	35.6	<0.001
Microsoft Photo Editor	15.4	29.8	0.006
Disk clean up	30.8	45.2	0.023
Disk defragmentation	26.0	38.5	0.037
Chat room	66.3	71.2	0.305

* Deemed basic essential skill.
† Achieved by >75% of students at end of semester.

technology-based environment. There were only a few self-reported experts at both the beginning and end of the semester.

Faculty Experience During Instruction

Best laid plans are essential but not sufficient for the first time computer classroom instruction experience. The pre-survey provided the faculty with important information about the extent of preparedness of the students for the laptop classroom experience. The survey did not reflect the impact on the teaching and learning experience that followed. The limited knowledge and ability indicated by the students at the beginning of the course served as a reasonable

TABLE IV Self-reported ability to use technology hardware

Application	Knowledgeable about use—baseline (count %)	Knowledgeable about use—end (count %)	*p* value (chi^2)
Monitor*†	74.7	78.9	0.174
Keyboard*†	74.7	81.7	0.052
Mouse*†	74.7	80.7	0.083
Printer*†	77.8	81.7	0.177
cd-rom drive*†	76.1	79.8	0.209
Internal modem*	47.5	53.2	0.147
Hub	22.2	42.2	<0.001
Scanner	53.2	74.7	0.054
Microphone	54.5	64.2	0.032
Headphones	72.7	76.1	0.221
Digital camera	27.3	44.0	<0.001
dvd drive	34.3	55.0	<0.001

* Deemed basic essential skill.
† Achieved by >75% of students at end of semester.

TABLE V Self-reported ability to conduct file management operations

Operation	Able to perform at baseline (count %)	Able to perform at semester end (count %)	p value (chi^2)
Select correct storage media*†	74.0	76.9	0.02
Format or initialize a blank diskette*	55.8	64.4	0.26
Copy file one loc to another*†	73.1	77.9	0.27
Delete a file without wp software*†	54.8	73.1	0.007
Find unused space without wp*	41.3	51.9	0.132
Create a new subdirectory*	24.0	46.2	<0.001
Protect a diskette*	25.0	42.3	0.003
Use a "wild card" (e.g. *,?)	6.7	50.0	<0.001
Find files without wp software	49.0	66.3	0.012
Print a disk or diskette directory	30.8	47.1	0.009

* Deemed basic essential skill.
† Achieved by >75% of students at end of semester.

predictor of the magnitude and type of problems encountered throughout the semester.

The first two weeks of the course proved to be exceptionally challenging, as several students were unable to log in and sign on the laptop computer, either at all or after a good portion of classroom time had passed. This was essential for students to be able to access web-based materials for the course. The instructor referred several students to information technology support, following the process planned in anticipation of these problems. However, some students were still not successful in learning and adapting to the login process. The primary instructor had three students make appointments for personal education until the students could successfully and predictably login and access web-based course materials. This problem alone generated so much student concern in the first two weeks that decisions were taken to provide duplicate written materials to ensure that students were not missing out on essential content.

Another challenge occurred after the first three weeks of teaching in the environment. Students had unrestricted Internet access. As a result, many decided to access and use alternative Internet sites and services for personal business and needs while in class. In response to this activity, the instructor reworked integration of active learning strategies more aggressively throughout the class hour to hold the attention of students on the material at hand. An unintended positive consequence of this was to increase in-class assessment, resulting in improved feedback for both the instructor and students.

A third challenge related to the perceived educational value of the laptop by the students. Students commonly complained about the inconvenience of carrying the laptop computer around and having to set up and put away the computer once class was finished.

Anecdotal evidence suggests the students were initially enthusiastic about computer use, and the time and location-flexibility laptop computers provided. Convenience of seeing the material before class from a course website and repeating this process at the student's discretion was regarded as a positive. From an instructional viewpoint, more classroom time was devoted to problem solving and active learning strategies.

DISCUSSION

The numerous hardware and software problems encountered during the course of the study were time-consuming and detracted from the time-saving potential of the technology. One student had to make special arrangements because of the unavailability of a computer because the course

was a repeat for the student. The software problems experienced by faculty and students primarily involved the use of Windows 2000 as an operating system. Problem resolution required the collaboration of pharmacy faculty with the appropriate university departments and committees in an ongoing effort to improve the university computer system interface with the classroom setting.

Cragg (1994) described extreme frustration with the technology for all of the students at the beginning of a course she implemented for pharmacy students using computer-mediated conferencing. As was the case in the current study, the source of the frustration was not only lack of computer knowledge and skill, but also actual hardware and software problems.

In a project using laptop computers to deliver pharmacy courses in rural areas, Williams and Benedict (1990) hired a full-time computer technician to work in the learning resource center to check computers in and out, to orient and assist students in using the computers and to install software. From our experience with the current study, this type of computer resource personnel would be essential for the effective and efficient integration of laptop computer technology into a pharmacy education programme. However, we did not have this support service sustained throughout the classroom meeting time. The high tech classroom experience, therefore, involved additional time for both faculty and students and required the faculty member to have adequate technical expertise.

Computers have been used in nursing and medical education to write care plans (Coates and Chambers, 1989), conduct computerized literature searches, use statistical packages, and learn nursing research (Thomas, 1990; Reis and Wright, 1992). In nursing education, computer-mediated conferencing was implemented and evaluated by Cragg using qualitative research methodology (Cragg, 1994). Despite initial difficulties and frustration with the technology, the students developed comfort and pride of mastering the use of the technology, camaraderie among classmates and a high level of discussion of course content.

Implications

Computing terminology related to hardware components, operating systems, applications, and basic functionality of computing which fulfils our teaching expectations, must be taught to students upon entry to the programme. Initial comfort with a laptop-computing device needs to be "built in" to faculty instruction upon intimation of students to the laptop classroom environment. Only a few students regard themselves as "experts" at any particular aspect of computers or computing, suggesting that student co-mentoring was not likely successful strategy to initiate with the incoming students. The study reinforces the importance of identifying requisite computer skills that students should possess prior to beginning the professional programme. Subsequent to this evaluation, a more substantive, focused, performance-based orientation programme for entering students was developed for the next incoming class. The orientation is intended to minimize student difficulties and develop some basic competency with technology prior to entering the classroom. The impact of the revised orientation will be further assessed after delivery. The same commitment must be made to the faculty and ongoing computer technology support provided to assure faculty competency and proficiency. This has not occurred at the time of writing. Finally, there is a need for a sustained and readily available technology support service to solve ongoing and spontaneous technology problems encountered by faculty and students.

CONCLUSIONS

There were both positive and negative aspects of this project integrating laptop computer

technology into an undergraduate pharmacy course. Computer skills were increased by the intervention and positive attitudes toward computers in pharmacy were maintained. However, there are many problems with hardware, software, and the availability of computer support services that need improvement before computer projects such as this can become a timesaving and value-added experience for pharmacy students and faculty. Pharmacy educators must continue to collaborate with computer experts to create an optimal learning environment so the potential of computer technology can contribute to pharmacy education and the profession.

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