

Student Utilization of an Asynchronous Learning Environment to Supplement an On-Campus Course in Pharmacokinetics¹

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An asynchronous learning environment including informational pages, review problems and a web-based conferencing forum, was developed to supplement instruction in an on-campus course in pharmacokinetics. The purpose of this communication is to report student utilization and acceptance of the web-based resource. Ninety-five percent of current students surveyed stated that they accessed the web site during the semester. The most commonly reported purpose for access of the web site was to obtain review problems for quizzes and exams. For the majority (59 percent) of students, frequency of access was consistent with preparation prior to examinations. Overall, student feedback was positive. The majority of respondents reported that the resources facilitated their learning in the course, and 21 percent and 39 percent of students reported increased communication with instructors and other students, respectively. Interactivity in problem-solving was not a highly utilized feature. Although web-based conferencing was also not highly utilized, several students commented on its potential usefulness. Consequently, we propose to maintain and further expand the web site as a repository for review problems that can be utilized by students for exam and quiz preparation and to employ strategies to foster student participation in discussions of pharmacokinetic concepts using web-based conferencing.

BACKGROUND

Pharmacokinetics (PHAR400) is a core course offered each year to first year students entering the professional Doctor of Pharmacy program. The course requires that students synthesize physiological, pharmacological and pharmaceutical concepts in order to understand the processes that influence the fate of medications in the body. These concepts are further integrated and applied to clinical problem-solving in advanced core therapeutics courses offered in the second and third years of the program.

In the PHAR400 course, pharmacokinetic principles are presented conceptually, mathematically and graphically using a team teaching approach. In this approach, the teaching faculty consists of faculty from this institution as well as guest lecturers from other academic institutions and from industry who teach aspects of the course that are related to their field of expertise. The course material is delivered as a series of didactic lectures (two hours per week). Each lecture topic is linked to a recitation session, the format of which includes student discussion, peer teaching and independent and small group problem-solving. Students are assessed through three problem-solving quizzes and three multiple-choice examinations. Mathematical and graphical manipulations are an integral component of all quizzes and examinations.

For many students, the PHAR400 course is the first time that mathematics has been applied to describe biological processes. Thus, emphasis is placed on providing students with a rationale for the correct use of mathematical equations and to associate equations with pharmacokinetic theory so that problem-solving is less abstract.

Because students differ in their comprehension of pharmacokinetic principles, our experience has been that student

demand for supplemental review materials varies substantially. In the past, we had found that delays in real-time (due to printing and distribution) and the increasing costs associated with printing of problem sets for exam review have limited how much of these materials could be provided to students in a timely manner. A solution to this problem was to establish an asynchronous learning environment, which included a repository for review materials including interactive problems, and a forum for discussion in order to facilitate student-driven self-study.

OBJECTIVES

The purpose of this project was to more completely integrate classroom learning with self-study. Our goals were to develop an interactive environment to foster learning of pharmacokinetic principles and to evaluate student utilization and acceptance of the resource. The specific aims were to:

- construct a web site for the dissemination of information relevant to the PHAR400 course;
- develop a template for interactive problem-solving in pharmacokinetics;
- implement supplemental web-based tutorials, including problem sets and review questions;
- provide a forum for discussion of pharmacokinetics problems via conferencing software;
- evaluate the perceived usefulness of the web-based learning environment by surveying current students; and

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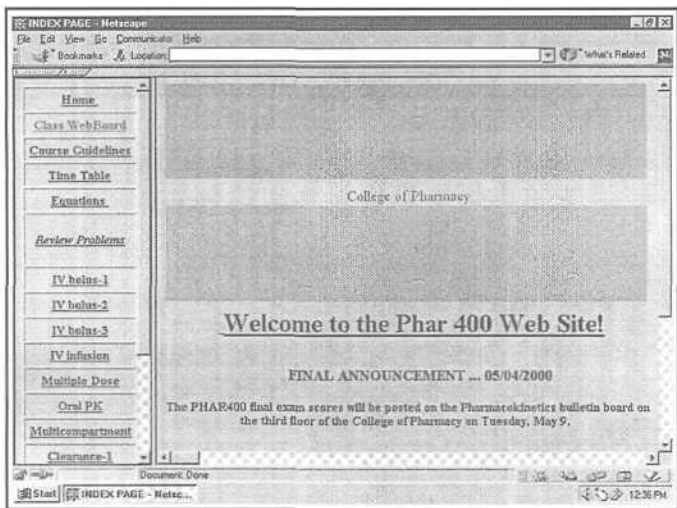


Fig. 1. Course homepage.

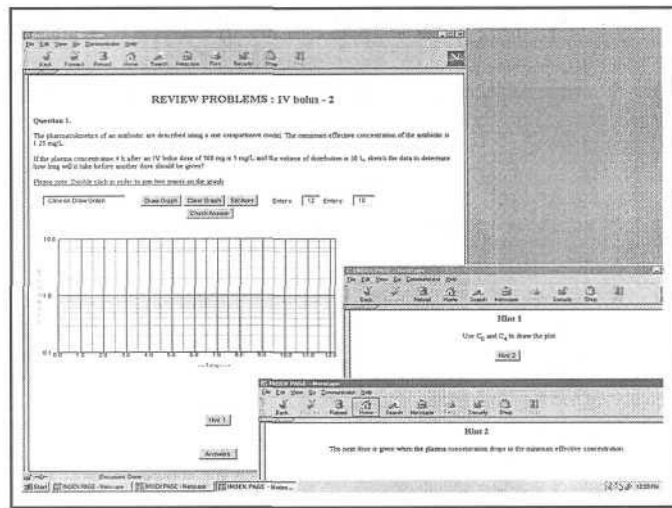


Fig. 2. Example of a review problem.

- based on student feedback, determine future directions for developing web resources for the PHAR 400 course.

METHODS

Features of the Web Site

Web Site Layout. The PHAR400 web site was developed using Microsoft Front Page 98². Frames were used to divide the browser window into separate areas, each of which can display a separate scrollable page. A scrollable navigation frame, with links to the class conferencing software, WebBoard³, informational pages and review problem sets, was placed to the left of the information frame (Figure 1).

Homepage. The homepage was used to post class announcements, such as changes to the lecture schedule, reminders of upcoming exams and grading information. Announcements were updated throughout the semester.

Informational Pages. The informational pages included the class timetable, a comprehensive equation list and course guidelines. Within each page, navigation was facilitated by the use of links to subheadings within the text. The course guidelines included the course description, course objectives, a list of teaching faculty together with their contact information and office hours, the examination schedule, examination policies and the proposed grading scheme, expectations for attendance and participation in class, procedures for missed examinations and a policy on academic dishonesty. Print copies of the equation list and course guidelines were provided to all students as part of the introductory materials provided for the course. The hard copy of the guidelines included a subsection entitled Class Web site that referenced the URL and purpose of the web site as a bulletin board for class announcements and repository for review problems.

Review Problem Sets. Eleven sets of supplemental review problems were developed. Besides supplementing weekly homework and recitation assignments, it was intended that these problem sets would provide a convenient review of the PHAR400 course content as the semester progressed. In

developing these problem sets, it was intended that the student would solve the problems while sitting at the computer terminal. Therefore, the page layout included spaces for typing in values (and units) appropriate to solving the problem. Internet resources, including Java applets, were employed to develop problems requiring graphical manipulations, including plotting of data and performing calculations based on graphical representation of data (Figure 2). Selecting the “answer” button on the screen links to a separate web page displaying the answers to the problems, while clicking on a “reset” or “clear” button clears the screen.

In addition, “extra problem sets”, similar in format to upcoming quizzes, and “practice exam questions” consisting of true/false and short answer questions, were posted two weeks prior to problem-solving quizzes and multiple-choice examinations, respectively. In anticipation of generating discussion among students, answers were not provided for practice exam questions.

WebBoard. A forum for discussion was implemented using WebBoard, a web-based conferencing tool that only requires a browser to access it. Conferencing is a collection of messages and attached files that are posted by students and faculty participating in the course. The course coordinator has access to a menu of features in the WebBoard software to maintain control over the conferencing environment. Thus, the course coordinator sets up “conferences” or topics where users can post and read messages. For the PHAR400 course, two conferences were established: one entitled “PHAR400” that was accessible by registered students and faculty and a separate “TA” conference to which access was restricted to teaching faculty only. Teaching faculty used the TA conference for dissemination of information relating to the curriculum, to discuss content and scheduling of meetings and exams and to highlight student queries that had arisen in a class or recitation session. A useful feature of WebBoard that was used by teaching faculty enables email notification whenever a new message is posted to a WebBoard conference to which the user is registered. Within the body of the email message there is a link to the WebBoard allowing easy access to the discussion forum.

The PHAR400 WebBoard conference was accessed by typing in the URL using a world wide web browser or by clicking on a link on the PHAR400 homepage. During the first week of classes, an email was sent to each registered PHAR400 student

² Front Page 98, Microsoft Corporation, <http://www.microsoft.com>.

³ WebBoard, version 3.5, O'Reilly Software, <http://www.webboard.com>.

Table I. Summary of responses to student evaluation

	Students	Percent
Responders	140	91.5
Nonresponders	13	8.5
Section 1: General		
Did you access web site or web board?		
Yes	133	95.0
No	7	5.0
How did you find out about web site or web board?		
Instructor/TA	99	74.4
Another student	13	9.8
By yourself	8	6.0
Various	11	8.3
Other: email	2	1.5
Where did you access web site or web board?		
Computer lounge in COP	83	62.4
Public computer site on campus	9	6.8
Personal computer	28	21.1
Various	11	8.3
Other	2	1.5
Effect on interaction with instructors/TAs:		
Decrease	8	6.0
Increase	28	21.1
No Change	94	70.7
No response	3	2.3
Effect on interaction with other students:		
Decrease	1	0.8
Increase	52	39.1
No Change	72	54.1
No response	8	6.0
Section 2: Web Site		
Frequency of web site access:		
Not at all	1	0.8
Once or twice	79	59.4
Once a week	44	33.1
Several times a week	3	2.3
Other: before exams or quizzes	6	4.5
Main purpose for web site access:		
Course information / Announcements	3	2.3
Quiz / Exam review problems	83	62.4
Both information and review problems	46	34.6
Blank	1	0.8
For exam or quiz review problems:		
Answer and check problems on web site	13	9.8
Download problems, try now and check answers	25	18.8
Download problems and answers, try later	82	61.7
Other	12	9.0
Blank	1	0.8
Did information and review problems help learning?		
Yes	130	97.7
No	2	1.5
Blank	1	0.8
Web site organization rating:		
Good	111	83.5
Fair	21	15.8
Poor	0	0.0
Blank	1	0.8

inviting them to make use of the WebBoard for discussion of pharmacokinetic concepts. A second notification was sent after first accessing WebBoard to summarize login information and to direct students to the WebBoard. Because detailed WebBoard support pages, including a users guide and frequently asked questions site is available on-line, no further instruction on the use of WebBoard was provided within the PHAR400 course.

STUDENT EVALUATION

Institutional Review Board approval was obtained to survey students' evaluations of the web-based resources using a modified version of a previously developed survey form(1). The survey form was divided into three sections. Questions in section 1 were aimed at obtaining general information about accessibility to the resource and the students' overall perceived

Table I. Summary of responses to student evaluation (con't)

	Students	Percent
Section 3: Web Board		
Frequency of web board access:		
Not at all / Blank	51	38.3
Once or twice	59	44.4
Once a week	18	13.5
Several times a week	5	3.8
Have you previously used web board?		
Yes	54	65.9
No / Blank	28	34.1
Rate the ease of use of web board:		
Easy	77	93.9
Somewhat Difficult	5	6.1
Difficult	0	0.0
Did web board help learning?		
Yes	69	84.1
No / Blank	13	15.9

impact of it. In section 2, questions were directed towards understanding how, why and when students' utilized the web site and to obtain feedback on the overall organization of the web site. Importantly, students were asked to evaluate whether, in their opinion, the information and review problems on the web site helped their learning in the course. In the third section, students' perception of the value of the WebBoard was similarly evaluated.

The evaluation form was distributed to all students two weeks before the end of the semester, following completion of the final problem-solving quiz. Evaluation forms were separated from the assessable component of the quiz at the time of collection so that they were anonymous.

RESULTS

The web site was constructed during the Summer and Fall semesters of 1999 and implemented for the first time during the Spring 2000 PHAR400 course offering. The course coordinator managed the web site and was responsible for timely posting of announcements. Approximately 200 hours (10 hours per week for 20 weeks) was spent in project development and the course coordinator spent an additional 1-2 hours each week managing the web site. Students were informed of the PHAR400 web-based resources, including the URL and login information, verbally throughout the semester and in a printed copy of the course guidelines that was distributed on the first day of class.

Within the first two weeks, it was brought to the attention of the course coordinator that some of the posted answers to problem sets were incorrect. Although these problem sets related to topics that had not yet been reviewed in lectures and/or recitation, a number of students were aware of the errors. Errors were immediately corrected and the corrected answers were reposted.

Out of 153 students enrolled in the PHAR400 course, 140 (91.5 percent) students completed the student evaluation. Results of the evaluation are summarized in Table I. Ninety-five percent of respondents stated that they accessed the PHAR 400 web site or WebBoard during the semester. Approximately 35 percent of students regularly accessed the web site while for the majority of students (64 percent) web site usage coincided with exam and/or quiz preparation.

Table II. Comments relating to improvement of the web site

Comment	# students
Request for more problems / more difficult problems	26
Request for answers to review questions	22
Correct errors in posted answers	9
Provide online lecture notes / recitation handouts	4
Allow graph paper to be printed from the web site	3
Provide a chat room/online TA	2
Link problem sets with specific quizzes / exams	2
Change the format to more closely resemble exam format	2
Graph function was difficult to use	1
Difficult to find answers	1
Post grades on the web	1

Students accessed these resources most commonly from the computer lounge in the College of Pharmacy (62 percent) and via modem from a personal computer approximately 20 percent of the time. As a result of their usage, 21 percent of students reported increased communication with instructors and 39 percent of students reported increased communication with other students.

As anticipated, the most commonly reported purpose for accessing the web site was to obtain review problems for quizzes and exams. Interestingly the majority of students did not make use of the interactive template developed for problem-solving, preferring instead to print the problems, together with the answers, and try them later (Table I). Indeed, one student commented that the graphing function was difficult to use (Table II).

Comments on the organization and content of the web site were positive and students indicated that it was a valuable supplemental resource that facilitated their learning in the course. In response to a question asking how the web site could be improved, 49 percent of students provided feedback. The most requested improvements were for more problems and posting of answers to review questions (Table II).

Student utilization of the PHAR400 WebBoard was substantially less than that of the PHAR400 web site. Although 62 percent of respondents indicated that they had accessed the WebBoard, user login records showed access by only approxi

mately 47 percent of students. Of those students that stated that they accessed the WebBoard, the majority of students had previously used WebBoard (66 percent), found it easy to use (94 percent) and beneficial in helping their learning in the course (84 percent). On the other hand, the most commonly cited reasons for not utilizing this resource were ignorance ("did not know about it") and inability to login to the WebBoard.

Similarly to the web site, utilization of the WebBoard peaked prior to exams. Because answers were not provided to exam review questions, the most common usage of the WebBoard was as a forum for obtaining answers. In their comments, several students noted that they underutilized this resource and suggested that an effort should be made to improve participation; one potentially useful suggestion was to include a question of the week to increase discussion among students.

DISCUSSION

Computer-assisted tutorials, and more recently, web-based tutorials in this and other fields have been shown to be effective educational tools(2-4). In this project, we incorporated web-based tutorials into an interactive asynchronous learning environment to supplement instruction in an on-campus course in pharmacokinetics. Based on our experience that students learn at different rates, it was our contention that a readily-accessible, interactive environment would facilitate learning of pharmacokinetic principles. We were interested in evaluating whether students found this to be a useful educational resource. Thirty-five percent of students stated that they made regular use of the web-based resource. For the majority of students, frequency of access was consistent with preparation prior to examinations. Our finding is consistent with "intense exam-oriented study behavior" observed by others who have attempted to implement innovative electronic teaching techniques to supplement student learning⁴.

A primary purpose of this project was the development of a repository of supplemental review problem sets that would allow students to participate in interactive problem-solving while seated at the computer terminal. However, the majority of students chose not to make use of the interactive feature. Instead, students were most likely to print the problem sets and the answers by accessing the web site from computer terminals located in the computer lounge of the College of Pharmacy. Students would then attempt the problems at a later time. It is likely that some students printed the entire series of problem sets at the start of the semester since several of the students commented that they found errors in the solutions to later problem sets although these had been corrected and reposted earlier in the semester. The disadvantageous finding that students prefer to make print copies of electronic materials has also been observed by others(5). A number of factors may have contributed to this finding. Some educators speculate that with greater acceptance by students of their active role in the learning process, rather than as passive recipients of knowledge, they will more effectively utilize resources, including computer-based and web-based resources, for retrieval and storage of knowledge(5). A more practical explanation may have been

one of convenience. Since only 21 percent of respondents reported that they accessed the web site from a personal computer, it may have been more convenient for students to make print copies in the computer lounge and attempt the problems later while studying at home.

Although approximately 30 percent of respondents requested answers for exam review (true/false and short answer) questions, our intention in omitting these was to foster discussion of pharmacokinetic concepts among the students. While only a few students utilized the WebBoard as a discussion forum, increased discussion was likely to have occurred, as reflected by a reported increase in verbal communication among students and between students and instructors. It is also possible that increased interaction among students could account for an apparent discrepancy between the number of WebBoard users obtained by student self-report compared with login records obtained by the WebBoard moderator. Although 15 percent greater usage was reported by students than was shown by login records, access by groups of students working together could account for the discrepancy.

Students who did use the WebBoard were in favor of its use to promote student participation in discussions of pharmacokinetic principles. It was evident from comments submitted by students who did not use WebBoard that the greatest impediment to utilization of this resource was not knowing how to access and/or use this conferencing tool. Clearly, information on accessing and using WebBoard should have been provided to students on entry into the program. In future, this limitation may be overcome by providing students with the necessary information in the course guidelines. In addition, the welcoming email message will be modified in future to include login details and the URL at which more information on WebBoard can be obtained.

Although we were unable to directly evaluate the impact of the resource on student performance in the PHAR400 course, we surveyed current students for their impressions of the utility of the web-based learning environment. Student feedback was positive with the majority of respondents (97 and 84 percent for web site and WebBoard, respectively) reporting that the resource facilitated their learning in the PHAR400 course.

The cost of the project can be measured in terms of the time that went into resource development - approximately 200 hours were invested for this purpose, primarily for web page development. Such a venture would not be feasible without the strong institutional commitment to enhancing teaching and learning resources which underpinned the undertaking and funding of this project. Even with institutional support, the time commitment required for development of such a resource may be deemed prohibitive, especially for junior, tenure-track faculty. Some of the time commitment may be defrayed by utilization of services provided by individuals with expertise in education and computer-based resources and who are employed by many institutions to assist in or implement computer-based learning projects. However, content must still be developed and the time savings may be offset by financial costs in obtaining these services.

Our project development team included two faculty members (one of whom, JE) has extensive experience in the development of web-based resources, who were responsible for developing the problem sets, designing the layout and content of the web site, overseeing the development of the web site, managing the web site during its implementation, and provid

⁴ Hawley D, Hood A, Orris B, Corsaro A, Sloffer C., "Patterns of student use of electronic educational resources. Poster presented at Electronic Trends in Medical Education Symposium," Indiana University School of Medicine, September 24, 1999.

ing software and financial support for graduate assistants. A rudimentary knowledge of hypertext markup language (HTML), access to the server to upload files for the web site and the ability to navigate the server file system were prerequisites for the project. In addition, in each semester of the project development phase, we employed a graduate assistant with expertise in web page development and applets (for interactive problem development). Our finding that the interactive problems were underutilized led us to conclude that this aspect was the least cost effective component of the project. On the other hand, positive feedback on the impact of the resource on student learning and requests to expand the web site to enhance student learning were useful indicators that the design and content of the web site were appropriate for its purpose and constituted a useful learning resource.

Based on student feedback, we propose to develop the asynchronous learning environment primarily by expanding the repository to include more problem sets and exam review questions. However, less emphasis will be placed on developing interactive problem-solving in favor of providing more detailed (step by step) solutions to problems. Since quizzes and exams are changed each year as the course is updated, previous years' problem sets will be utilized. These additions will be structured into the weekly task of managing the web site. In addition, we shall attempt to increase participation in the discussion forum by increasing student awareness and utilization

of the WebBoard via written, verbal and electronic media, and periodically posting thought-provoking topics for discussion. In conclusion, we developed an asynchronous learning environment to supplement instruction in an on-campus course in pharmacokinetics. The resource provided students with real time access to course announcements, review materials and a discussion forum. Based on favorable feedback indicating that students found the resource to be useful in supplementing their learning, we propose to maintain and further expand the web site to allow increased access to review problems and to implement techniques to foster student participation in discussions of pharmacokinetic concepts.

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