INSTRUCTIONAL DESIGN AND ASSESSMENT

Effectiveness of Human Anatomy Education for Pharmacy Students via the Internet

Aimee L. Limpach, PhD, Parham Bazrafshan, PharmD, Paul D. Turner, PhD, and Michael S. Monaghan, PharmD

School of Pharmacy and Health Professions, Creighton University Medical Center

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Objective. To evaluate the overall effectiveness of a human anatomy course taught to distance-based and campus-based pharmacy students.

Design. A retrospective analysis of students' grades and course evaluations from 2003 through 2006 was conducted.

Assessment. No significant differences in student performance by pathway were found for the 2003-2005 academic years ($p > 0.05$). However, distance-based students' percentage and letter grades were significantly higher in 2006 ($p = 0.013$ and $p = 0.004$ respectively). Comparison of course and instructor evaluations showed that students in the distance course held similar or more positive perceptions of the course than their campus peers.

Conclusions. Similar performance by campus and distance students enrolled in a human anatomy suggests that a distance-based course can be used successfully to teach human anatomy to pharmacy students.

Keywords: human anatomy; distance education; Internet

INTRODUCTION

Distance learning has been widely used to teach continuing pharmacy education courses and non-traditional doctor of pharmacy (PharmD) programs,¹⁻⁴ however, its effectiveness in teaching basic science courses such as human anatomy as part of a professional PharmD degree program has not been thoroughly documented. A search of recent health education literature yielded reports that have documented the use of the Internet for facilitating student learning that include human anatomy as one component of clinical education, but none of the published manuscripts document the effectiveness of teaching human anatomy to both campus and distance students in pharmacy.⁵⁻¹¹

In fall 2001, Creighton University School of Pharmacy and Health Professions initiated the first entry-level, distance-based PharmD program. During the application process, students have an option of selecting either the campus or distance pathway. Students in each pathway start at the same time and are scheduled to complete the program in 4 years. Distance students come to campus for

approximately 2 weeks each summer to complete all laboratory courses. Both pathways are accredited as a single degree program and have the same admission and graduation requirements. Students in the program are physically located throughout the United States and Canada.

Human anatomy is a required course in the first semester of the PharmD curriculum. The first objective of this study was to compare student performance between the distance and the campus pathways for this course in order to determine if distance students performed similarly to their campus peers. The second objective of the study was to compare student perceptions of the course, using their responses to evaluations administered at the end of the semester. A comparison of both academic performance and student perceptions provided insight into the overall effectiveness of Internet-based learning for teaching of a human anatomy course.

DESIGN

From 2003 through 2006, 110 students per year enrolled in the campus pathway and 55 to 60 students per year enrolled in the distance pathway. All PharmD students leased a standard notebook computer, the cost of which was included in tuition. Campus students were allowed to use the computer during class as all seats in the classroom had high-speed Internet access. Distance

Corresponding Author: Aimee L. Limpach, PhD, Assistant Professor, Pharmacy Sciences, Creighton University Medical Center School of Pharmacy and Health Professions, 2500 California Plaza, Omaha, NE, 68178. Tel: 402-280-2147. Fax: 402-280-1883. E-mail: alimpach@creighton.edu

students used the notebook computer as their primary tool for accessing Internet-based courses. All students received computer skills assessment and training prior to the start of the program. This training included basic computer use and program-specific training such as accessing e-mail, course Web sites, and other computer resources commonly used by pharmacy students. Both campus and distance students were given an overview of the features of the human anatomy course Web site by the instructor as part of the student technology training. Identical notebook computers and mandatory technology training provided a control factor for comparing campus and distance students within a particular year.

The instructor for the human anatomy course used the Blackboard learning management system (Blackboard, Inc, Washington, DC, www.blackboard.com) to generate a course Web site. All course material for campus and distance students was accessed through the Blackboard course web site. Campus and distance students interacted with faculty members and classmates in both asynchronous and live discussions through the course web site. Each semester, course mentors, who were either pharmacists or scientists with a background in anatomy, served as teaching assistants in the course. Campus and distance students interacted with the course mentors via the asynchronous discussion board on the course web site and via e-mail. In addition to Blackboard, Questionmark Perception (Questionmark Computing, Ltd, Stamford, Conn, www.questionmark.com) was used to administer student examinations and end-of-semester course evaluations to both campus and distance students. Students in each pathway were expected to complete the course at a fixed pace, including interactions with peers in the classroom or online. In other words, the course did not allow a "self-study" or "self-paced" model of interaction.

Each campus class consisted of a group of approximately 100 students that met as a single section twice a week for 50 minutes. A typical class session included a review of the course material and discussion of the clinical application of human anatomy in the practice of pharmacy. The face-to-face course environment used active-learning methods that encouraged student learning and interaction.¹²⁻¹⁴ For example, an instructor-developed guided-note fill-in-the-blank Microsoft *PowerPoint* presentation was used for note taking and campus students also participated in a "word of the week" activity which required them to pronounce and spell various medical terms. Campus students completed 6 online open-book, non-proctored quizzes in the Blackboard course web site on their own time approximately every 2 weeks throughout the semester. They also completed 3 proctored examinations in class using their computer.

Each distance class was a single section of approximately 50 students. Each campus class lecture was recorded and the audio file uploaded to Blackboard the same day the lecture was given. Distance students were expected to listen to each class lecture as well as participate in asynchronous and live discussions on Blackboard. The Microsoft *PowerPoint* presentation that was used for the active "guided" note taking in the campus environment was also made available to distance students each week so they could participate in this learning activity as they listened to class lectures. Distance students participated in "word of the week" activities using the online asynchronous discussion board in Blackboard. In addition, the instructor held weekly optional live text- and voice-based discussions. The transcript of each live discussion with the instructor was archived in Blackboard so that students who were unavailable at the time of the discussion could view the transcript later. Distance students completed the same 6 unproctored, online Blackboard quizzes as the campus students and were required to complete each of the same 3 course examinations at a pre-approved testing site overseen by a proctor within 24 hours of the campus students' testing time.

Both the final course percentage grades and letter grades were used to analyze student performance. Overall student performance in the course was measured by performance on quizzes and examinations and completion of weekly short-answer assignments. Examinations included multiple-choice and fill-in-the-blank items, diagram labeling, and 2 or 3 essay questions in which students' applied relevant topics in anatomy to clinical scenarios. Essay questions were graded online by the instructor using a predetermined rubric. Quizzes consisted of multiple-choice questions based largely on assigned textbook readings. Quizzes and examinations were formulated using a large pool of questions to decrease the likelihood that students would benefit if answers were shared. In addition to quizzes and examinations, students were required to complete weekly short-answer assignments covering clinical application discussions and/or medical terminology for credit. The weighting of each assessment of student performance varied from year to year; therefore, the authors did not compare performance between years. The grading scale used was the standard faculty-approved grading scale for the pharmacy program at Creighton University: A = 100%-90%; B+ = 89%-85%; B = 84%-80%; C+ = 79%-75%; C = 74%-70%; D = 69%-60% and F = below 60%. The University uses a 4-point scale for letter grades with A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0, and B+ and C+ grades = 3.5 and 2.5, respectively.

Students' perceptions of the course were measured using end-of-semester course and instructor evaluations. All Likert-scaled questions were worded positively; in other words, a higher score indicated a more favorable response. School policy required that students complete course and instructor evaluations in required pharmacy courses; therefore, the response rate for these evaluations was 100% for all 4 academic years.

All statistical tests were analyzed with SPSS, version 14.0 (SPSS, Chicago, Ill). Separate independent *t* tests were used to compare the mean final percent grades of campus-based and distance-based students for each year of the study. A non-parametric approach, the Mann-Whitney rank-sum statistic, was used to compare final letter grades for each year. Both approaches (*t* test and Mann-Whitney test) were appropriate for comparing interval data (ie, letter grades on a 4-point scale), but the Mann-Whitney test is preferred when the distribution of the dependent variable violates the normality assumption. Both percent grades and letter grades were skewed to the left (ie, more students with A's and B's than C's and D's), but the magnitude of the skewness was determined to be ignorable for percent grades and non-ignorable for letter grades. Thus, *t* tests were used to compare percent grades and Mann-Whitney tests were used to compare letter grades. An *a priori* level of significance of $p = 0.05$ was selected for all statistical tests.

Course and professor evaluation data were collected via a single questionnaire. Due to significant negative skewness, divergent sample sizes, and the ordinal nature of Likert-scale items, a Mann-Whitney U test was employed in lieu of an independent *t* test. The Mann-Whitney U test required the removal of the "neither agree nor disagree" response, in that this response portrayed "no opinion" and was unable to be rank ordered along a continuum. The section assessed 2 hypotheses. The first hypothesis stated results would fail to indicate significant differences between the campus and distance pathway,

suggesting parity. The second hypothesis stated that if significant differences did indeed exist, the distance pathway would favor the course significantly more than their campus counterparts. To test this hypothesis, an inflated *a priori* significance level of $p = 0.10$ was elected for all statistical testing to reduce the incidence of Type II error, in that, we were assessing nonsignificance.

ASSESSMENT

Table 1 shows the demographics of the campus and distance students entering the program from 2003-2006. Students who successfully waived the human anatomy course requirement were included in the program demographics in Table 1 but excluded from other comparisons. From 2003 to 2006 there were no students who repeated the anatomy course in either pathway.

The final percent scores for each of the 4 years are summarized in Table 2. Distance-based students performed better than campus students in 2006 (campus mean percent = 88.9 and distance mean percent = 91.4), but no significant difference was found in 2003, 2004, or 2005. Student performance, as measured by final letter grades, is also shown in Table 2. As with the final percentage scores, there was no difference found between performance in 2003, 2004, and 2005. In 2006, distance-based students performed better than campus students (campus mean grade point = 3.6 and distance mean grade point = 3.8).

The course and instructor evaluation results are summarized in Tables 3 and 4, respectively. Course and instructor evaluations from 2003 were not included in this comparison because the questions on the 2003 evaluations were not the same as those used in the following years. Course and instructor evaluations from 2004 to 2006 were rated the same as or more positively by distance students compared to campus students in each year. Results of the Mann-Whitney indicated 7 significant differences between the 2 pathways; however, all instances

Table 1. Student Demographics for Campus and Distance Students Entering from 2003 to 2006

Variable	2003		2004		2005		2006	
	Campus	Distance	Campus	Distance	Campus	Distance	Campus	Distance
Total enrollment	110	60	110	55	110	55	110	55
Male, No. (%)	36 (33)	20 (33)	40 (36)	19 (35)	47 (43)	27 (49)	46 (42)	14 (25)
Female, No. (%)	74 (67)	40 (67)	70 (64)	36 (65)	63 (57)	28 (51)	64 (58)	41 (75)
Average GPA ^a	3.47	3.40	3.40	3.34	3.46	3.41	3.46	3.42
Average age, y	23	32	25	34	23	29	22	29
Students entering with a bachelor or higher degree, No. (%)	37 (34)	44 (73)	47 (43)	46 (84)	47 (43)	44 (80)	48 (44)	44 (80)

Abbreviations: GPA = grade point average

^aAverage GPA is cumulative GPA for all undergraduate course work

Table 2. Comparison of Final Percent and Letter Grades Between Campus and Distance Students in Human Anatomy for 2003 - 2006

Year	No.	Campus-Based Students		No.	Distance-Based Students	
		Final Percent Grade, Mean (SD), %	Final Letter Grade, Mean (SD), %		Final Percent Grade, Mean (SD), %	Final Letter Grade, Mean (SD), %
2003	94	92.2 (5.1)	3.8 (0.4)	52	93.0 (5.5)	3.8 (0.4)
2004	97	87.3 (6.1)	3.5 (0.6)	50	88.5 (6.8)	3.6 (0.6)
2005	102	88.9 (6.5)	3.6 (0.6)	49	88.05 (8.1)	3.5 (0.7)
2006	101	88.9 (5.8) ^b	3.6 (0.5) ^c	47	91.4 (5.4) ^b	3.8 (0.4) ^c

^aGrade point scale conversion: F = 0, D = 1, C = 2, C+ = 2.5, B = 3, B+ = 3.5, A = 4

^bDifference in mean final percent grade between campus- and distance-based students was significant ($p = 0.013$)

^cDifference in mean final letter grade between campus- and distance-based students was significant ($p=0.004$)

resulted from the distance pathway students rating their experience more positively. Analysis of Table 4 displays parity between the 2 pathways more clearly.

DISCUSSION

Both campus and distance students performed well in all 4 years. The distance students performed better based on the final percent score and letter grade in 2006. Final letter grade information is important to include because external reviewers of a course (eg, curriculum committee, program assessment committee, accrediting agencies) may only have access to aggregate student letter grade information and not percent scores when evaluating a course or a program. It is clear from comparing both final percent and letter grade, that distance students are able to perform at least as well or better than campus students in the human anatomy course.

A brief review of the demographics showed that the distance students were older and that a larger percentage held a bachelor's degree or higher upon entering the program. It is possible that more of the distance-based stu-

dents than campus students may have taken a college-level anatomy course prior to entering the pharmacy program. Previous college-level coursework, including both general science and anatomy coursework, may introduce a bias in student performance, especially in an entry-level course that assumes students have no previous experience in the subject. A small number of students each year request a waiver of the human anatomy course based on previous coursework. It is not known how many students in this study had taken human anatomy but did not request a course waiver. Future studies comparing performance between campus and distance students should consider differences in demographics that could impact student performance, if these data are available.

Student perception of the course and instructor in both the campus and distance pathways was favorable. Course and instructor evaluations from each year were rated the same as or higher by distance students compared to campus students, but these results should be viewed with caution due to ceiling effects. Distance-based student perception of the course may be impacted by the

Table 3. Course Evaluation Comparison Data by Year

Item		2004(SD) ^b	2005(SD) ^b	2006(SD) ^b
The course content is consistent with the syllabus	Campus	4.7 (0.5)	4.7 (0.5)	4.6 (0.5)
	Distance	4.8 (0.4)	4.7 (0.7)	4.6 (0.7)
	<i>p</i>	0.286	0.350	0.887
The course assessments (exams, quizzes, papers, homework, activities, etc) are consistent with the syllabus	Campus	4.7 (0.5)	4.7 (0.5)	4.6 (0.5)
	Distance	4.6 (0.9)	4.6 (0.8)	4.5 (0.)
	<i>p</i>	0.670	0.413	0.791
The course prepared me to think like a healthcare professional	Campus	4.3 (0.8) ^c	4.3 (0.7) ^c	4.07 (1.0) ^c
	Distance	4.5 (0.9)	4.5 (0.9)	4.4 (0.9)
	<i>p</i>	0.051	0.008	0.039
The course included opportunities for me to actively participate in my learning	Campus	4.5 (0.6) ^c	4.6 (0.5)	4.5 (0.7)
	Distance	4.8 (0.4)	4.6 (0.9)	4.4 (1.0)
	<i>p</i>	0.021	0.611	0.900

^a1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree

^bN values, 2004, campus = 97, distance = 50; 2005, campus = 101, distance = 48; 2006, campus = 101, distance = 47. The sample sizes used in analyses excluded "Neither Agree nor Disagree" responses and vary by question

^c $p < 0.10$

Table 4. Instructor Evaluations Comparison Data by Year

Item ^a	2004(SD) ^b	2005(SD) ^b	2006(SD) ^b
The course instructor related to me and / or other students in a manner that promoted mutual respect			
Campus	4.8 (0.5) ^c	4.8 (0.4) ^c	4.7 (0.7)
Distance	4.9 (0.3)	4.9 (0.6)	4.6 (0.8)
<i>p</i>	0.055	0.032	0.215
The course instructor demonstrated interest in my success			
Campus	4.7 (0.56)	4.7 (0.5)	4.6 (0.6)
Distance	4.8 (0.7)	4.8 (0.7)	4.6 (0.7)
<i>p</i>	0.205	0.125	0.894
The course instructor demonstrated professionalism in interactions with me and/or other students			
Campus	4.7 (0.5)	4.6 (0.7) ^c	4.6 (0.7)
Distance	4.7 (0.8)	4.8 (0.7)	4.6 (0.8)
<i>p</i>	0.166	0.015	0.458

^a1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree

^bN values, 2004, campus = 97, distance = 50; 2005, campus = 101, distance = 48; 2006, campus = 101, distance = 47. The sample sizes used in analyses excluded "neither agree nor disagree" responses and vary by question

^c*p* < 0.10

fact that students who choose the distance pathway might prefer Internet-based learning over an on-campus learning environment. Students in the distance pathway expect active involvement in the discussions and other activities in the course. These online discussions are, in fact, the distance students' primary connection to their peers and faculty members.

In addition, course evaluations composed primarily of Likert-scaled questions is only one tool for measuring student perceptions of a course. Though student evaluations are widely used in higher education, future studies looking at comparisons between different courses or instructors could also include objective evaluation by faculty peers or other external reviewers, if these data are available.

CONCLUSION

A similar overall performance among distance-based and campus-based students measured by final percent score in 2003, 2004, 2005, and higher level of performance for 2006 distance-based suggests that an Internet-based approach may be used successfully to teach human anatomy to pharmacy students. Students in the distance course held similar or more positive perceptions of the course than their campus peers. The similar or higher level of academic performance and more favorable course evaluations by distance students indicate that a human anatomy course can be at least as effective as a campus course in the first professional degree PharmD program.

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