

RESEARCH ARTICLES

Impact of Distance Learning Using Videoconferencing Technology on Student Performance

Eric J. MacLaughlin, PharmD, Robert B. Supernaw, PharmD, and Kellee A. Howard, MSc, MEd

School of Pharmacy, Texas Tech University Health Sciences Center

Objectives. To compare outcomes of distance education using interactive videoconferencing vs on-site education in pharmacotherapy courses.

Methods. Four third-year required pharmacotherapy courses (*Integumentary, Bone and Joint Disorders, Neurology, and Psychiatry*) were offered locally (Amarillo, Tex) and at a distance (Lubbock, Tex, and Dallas, Tex) by interactive videoconferencing. To assess if students at distant sites are at a disadvantage, grade point averages (GPAs) before course enrollment and final grades attained were compared among all sites using one-way ANOVA.

Results. Seventy-eight students were enrolled; 32 local (Amarillo) and 46 distant (Lubbock, $n = 19$; Dallas, $n = 27$). There were no significant differences in mean GPA before fall semester (precourse) enrollment (Amarillo = 83.5, Lubbock = 83.0, Dallas = 83.0; $p = 0.91$). There were no significant differences in student performance in the pharmacotherapy courses between local and distant sites ($p > 0.05$ for all comparisons). Student performance in each course correlated with GPA.

Conclusions. There was no difference in learning outcomes in pharmacotherapy courses between local and distant students using videoconferencing.

Keywords: distance learning, videoconferencing, student performance, pharmacotherapy, pharmacy

INTRODUCTION

Distance learning is defined as a program in which enrolled students may receive part or all of their education at a geographic location different from the point of content organization and for which the final award (ie, degree) is “equivalent in standard and content to an award program completed on campus.”¹ Distance learning technologies in higher education are being increasingly used and continue to evolve. In 2002, ~84% of 4-year colleges offered distance learning courses.² This represented an increase of 22% from only 4 years prior. This may be due in part to the continued growth of the Internet and other technologies (eg, satellites, improvements in high-speed data transfer lines, development of internet-based course management programs, and home broadband internet access). Approximately 66% of United States adults (133 million) and 90% of college students access the Internet.² With continued investment and improvement in web-based technologies, this trend of increased Internet access and, hence, greater availability of distance-education programs will likely continue.

Corresponding Author: Eric J. MacLaughlin, PharmD.
Address: Texas Tech School of Pharmacy, 1300 Coulter Dr,
Amarillo, Texas 79106-1712. Tel: 806-356-4000, ext.264.
Fax: 806-356-4018. E-mail: eric.maclaughlin@ttuhsc.edu.

Various types of technology are used to facilitate distance education. Depending upon the level of technology used, distance education can be described as either synchronous or asynchronous. Asynchronous methods generally involve significant delays in time between message transmission and receipt (eg, E-mail, videocassette, discussion forums), whereas synchronous programs allow for “live” interaction between the instructor and student (eg, audioconferencing, videoconferencing, web chats).³

There are several advantages of distance learning technology. First, for “bricks-and-mortar” institutions that have students at different geographic locations, it alleviates the need for instructors to travel to different sites and present the same lecture material multiple times. Second, depending upon the technology used (eg, Internet-based program, videocassettes), it often allows students greater scheduling flexibility, particularly if the student has other obligations such as work or family life that would otherwise prohibit them from attending a “traditional” instructional institution.⁴

Although the advantages of distance-learning methodologies are often readily apparent, particularly with regard to student access and availability, there are some perceived disadvantages. Students may not develop some of the socialization and interpersonal skills that usu-

ally accompany traditional learning methods. For pharmacy students, the daily interaction with faculty members and peers who assist in the development of professionalism may also be lost.⁴ Although there is no difference in student outcomes between distance learning and traditional educational methods for a variety of higher education programs,⁵⁻⁸ few data exist describing the effects of distance technology on pharmacy curricula.^{9,10}

The Texas Tech School of Pharmacy utilizes interactive videoconferencing to deliver a large portion of the curriculum. The objective of this study was to compare outcomes of distance learning using interactive videoconferencing technology as a function of student location in pharmacotherapy courses.

METHODS

Background Information

The Texas Tech School of Pharmacy Doctor of Pharmacy (PharmD) curriculum is delivered over a 4-year period. During the first 2 years of education, students attend didactic classes at the main pharmacy campus in Amarillo (local site). During the third and fourth years, students have the opportunity to complete the program at either the local site or a regional campus (distant site) in Lubbock or Dallas.

The third-year PharmD curriculum consists of clinical rotations in the morning followed by didactic classes in the afternoon. Synchronous videoconferencing technology is used to deliver content to off-site students. During the fall 2001 semester (August 2001 to December 2001) students at all sites (local and distant) were required to take 4 pharmacotherapy courses: *Integumentary* (PHAR 4159; 1 credit), *Bone and Joint Disorders* (PHAR 4161; 1 credit), *Neurosensory* (PHAR 4261; 2 credits), and *Psychiatry* (PHAR 4262; 2 credits). Each pharmacotherapy course was team taught, using a Pharmaceutical Sciences faculty member to teach the pathophysiology, epidemiology, and pharmacology of drugs used to treat a particular disease, and a Pharmacy Practice faculty member to teach the practical application of drug therapy (ie, pharmacotherapy) for that disease state. Each lecture was 70 minutes in duration (~12 lectures = 1 credit hour).

Technology Used

In order to facilitate the delivery of didactic lectures to all 3 sites and alleviate the need for instructors to travel to distant campuses and present the same lecture multiple times, live (synchronous) videoconferencing technology (*HealthNet*) was used. *HealthNet* is a private network that was developed in-house and is operated by the

Information Technology Department. This system uses high-speed T1 phone lines (1.54 mB communication line) to deliver real-time video and audio. It consists of an instructor microphone and video camera, whereby students at distant sites could view and listen to the lecturer. Each instructor podium has the capability to broadcast lecture material via several different modalities (eg, *PowerPoint* presentation, videocassette recorder (VCR), motion picture expert group (MPEG), portable document format (PDF), and document camera). Student seats contain remote touch-sensitive microphones. When a student microphone is activated, a video camera focuses on the student asking the question, and the video image and audio source switch from the instructor to the student asking the question. All students can view each other at multiple campuses when asking questions or during discussion periods.

In addition to live audio/video conferencing technology, web-based tools were used to facilitate delivery and communication of course materials. All course syllabi were available on the Internet. Each syllabus used the same structured format (eg, course description, goals and objectives, required text, attendance requirements, grading method, lecture schedule). Supplemental learning material (eg, handouts) were available in several different formats of the instructor's choosing, including MS Word (.doc), PowerPoint (.ppt), and Adobe Acrobat Reader (.pdf). Thus, both local and distant students had the opportunity to download all course material at any place or time.

An Internet-based messaging system (WebBoard) was also used in all courses to facilitate communication. The Webboard contained a discussion forum that allowed communication between students and the instructor 24 hours a day, 7 days a week, regardless of location (asynchronous communication). Additionally, it allowed the instructor to answer student questions or concerns at a time that was convenient, and provided information regarding course subject material (eg, handouts, supplemental readings, etc) or logistics that could be shared with the whole class rather than by individual e-mails (one-to-many vs one-to-one communication). It also allowed student grades/assessments to be posted (using student's secret number and randomly sorted) in a timely manner with accessibility from any location. Additionally, the messaging technology allowed students the capability to study as a group if desired, regardless of geographic location, by using chat rooms.

Study Methodology

This was a retrospective study of academic performance of third-year professional students enrolled in the

Table 1. Baseline Student Demographics by Site

Characteristic	Amarillo Campus (n = 32)	Dallas Campus (n = 27)	Lubbock Campus (n = 19)	Comparison for all Sites	Local Site (Amarillo) vs. Distant Sites (Dallas and Lubbock)
Age (years), Mean ± SD	28.8 ± 7.2	26.0 ± 3.4	25.0 ± 2.2	F(2,75)=3.92, p=0.02*†	t(38)=2.41, p=0.02‡
Gender, Male,§ n (%)	19 (59.4%)	13 (48.1%)	10 (52.6%)	χ ² (2)=0.76, p=0.69	χ ² (1)=0.67, p=0.41
GPA before fall 2001 enrollment mean ± SD	83.5 ± 3.7	83.0 ± 4.6	83.2 ± 4.3	F(2,75)=0.09, p=0.91*	t(76)=0.35, p=0.73‡

* One-way ANOVA.

† Scheffe' post hoc for mean age in Amarillo differs from Lubbock (p=0.04).

‡ Independent samples t test.

§ Chi-square test.

School of Pharmacy at the Texas Tech University Health Sciences Center. Seventy-eight students were enrolled in 4 long-distance education pharmacotherapy courses (*Integumentary*, *Bone and Joint Disorders*, *Neurosensory*, and *Psychiatry*) in the fall 2001 semester. Students were enrolled at 3 campuses (Amarillo [n = 32]; Dallas [n = 27] and; Lubbock [n = 19]). All courses were team taught and consisted of at least one faculty member from each department. Specifically, there were 3 team members for *Integumentary* (1 pharmaceutical science faculty member, 2 pharmacy practice faculty members), 2 for *Bone and Joint Disorders* (1 pharmaceutical science faculty member, 1 pharmacy practice faculty member), 3 for *Neurosensory* (2 pharmaceutical science faculty members, 1 pharmacy practice faculty member), and 3 for *Psychiatry* (2 pharmaceutical science faculty members, 1 pharmacy practice faculty member). All lectures were delivered from Amarillo, Tex (local site).

Student performance (mean numeric grade attained) in each of the 4 pharmacotherapy courses delivered by live videoconferencing technology in the fall of 2001 was compared between all campuses (Amarillo, Dallas, and Lubbock) and between local (Amarillo) and distant (Dallas and Lubbock) sites. In order to assess the possibility of unequal distribution of high- and/or low-performing students between the local and distance sites, the pre-enrollment mean numeric grade point averages (GPAs) of all students were compared. Additionally, student age and gender were also compared. Correlations between student GPA and final course grade attained in each course were performed. Study approval was obtained from the Institutional Review Board.

Statistical Analysis

Data were obtained from the Office of Student Services at Texas Tech School of Pharmacy and converted from Microsoft *Excel* to SPSS Version 11.0 (Chicago, Ill). One-way analysis of variance (ANOVA) was used for mul-

iple comparisons of student GPA and mean grade attained among all groups (ie, Amarillo, Dallas, and Lubbock). When comparing only 2 groups (ie, local and distant) we used the independent samples *t* test. The chi-square test was used to assess the relationship between gender and location. Correlations between GPA and grades attained were calculated using Pearson's correlation.

RESULTS

Baseline student demographics and GPA before fall 2001 enrollment at each campus are shown in Table 1. The overall mean age of the students was 26.9 ± 5.3 years. The data on age and GPA distributions were approximately normal. The only variable that was found to show a significant difference between the 3 locations was age, and that difference was between students in Lubbock and Amarillo (P = 0.04). All sites appeared well matched with regard to students' GPAs prior to fall 2001 enrollment. There was no statistically significant difference in students' mean GPAs among all 3 campuses (see Table 1).

Comparisons of student performance in each pharmacotherapy course between all sites and between local and distant sites are shown in Table 2. There was no statistically significant difference in student performance in each pharmacotherapy course across all campuses (P > 0.05 for all comparisons). Additionally, there was no statistically significant difference between the local site (Amarillo) and distant sites (Lubbock and Dallas) for each pharmacotherapy course (P > 0.05 for all comparisons). Figure 1 displays the comparison of student performance (mean grade attained [%]) in each pharmacotherapy course per site of enrollment).

Student performance in each pharmacotherapy course correlated with student GPA prior to fall 2001 enrollment and was statistically significant. The Pearson's correlation coefficient for each course was: *Integumentary*, r = 0.520, p = 0.01; *Bone and Joint Disorders*, r = 0.593, p = 0.01; *Neurosensory*, r = 0.395, p = 0.01; *Psychiatry*, r = 0.277, p = 0.05.

Table 2. Comparison of Student Performance in Each Pharmacotherapy Course

Pharmacotherapy Course	Comparison Across Campuses*		Comparison of Local vs Distant Sites†	
	P Value	F (2,75)	t Value	P Value
Integumentary	0.16	1.895	t(76)=1.55	0.13
Bone and joint disorders	0.08	2.575	t(76)=0.77	0.44
Neurosensory	0.42	0.875	t(76)=1.08	0.29
Psychiatry	0.72	0.325	t(74)=-0.18	0.86

* One-way ANOVA.

† Independent samples *t* test.

DISCUSSION

The goal of all health professions educational institutions is to achieve effective student learning and produce qualified graduates. Whether this is accomplished via traditional classroom format or distance learning technologies (eg, interactive videoconferencing, web-based/online learning), student learning and application of knowledge are the ultimate outcomes.

In order to produce optimal learning, there must be a balance between the 3 main types of learning; the cognitive, affective, and psychomotor domains.¹¹ The cognitive domain involves development of knowledge, comprehension, application, analysis, synthesis, and evaluation. The affective domain deals with student emotions. This includes students' feelings, appreciation, enthusiasms, motivations, values, ethics, and attitudes. The psychomotor domain involves the development of motor activities such as physical movement and coordination.

The current study assessed student learning in the cognitive domain, and found that there was no difference in academic performance in pharmacotherapy courses as assessed by final course grades between students who attended class either in person (ie, local) or by interactive videoconferencing ($p>0.05$ for all comparisons).

The results of the present study confirm earlier find-

ings in pharmacy academia by Chisholm et al,¹⁰ who evaluated the effects of interactive videoconferencing on pharmacy students' academic performance and pharmacy instructors' teaching evaluations. Academic outcomes and instructor evaluations of 61 students enrolled in clinical pharmacokinetics and pharmacotherapy courses in the spring of 1998 were compared. Lectures were given live at the main campus by synchronous television transmission to satellite campuses. At the conclusion of the study there was no difference in student performance when lectures were received locally or by interactive videoconferencing ($p>0.05$ for all course comparisons). Interestingly, there was a difference in teaching evaluation scores (higher at the local site) in ~27% ($n = 4$) of instructors.

In another study specific for pharmacy, the impact of student performance and evaluations of faculty teaching in an advanced pharmacokinetics course taught by 3 methods of instructional delivery was assessed.⁹ In that 3-year study, student performance was compared when lecture material was provided by instructors physically present for the entire course, when half of the material was presented by distance learning and the other half live, and when all lectures were given via distance learning. They found no significant difference in final course grades or on student evaluation scores of faculty teach-

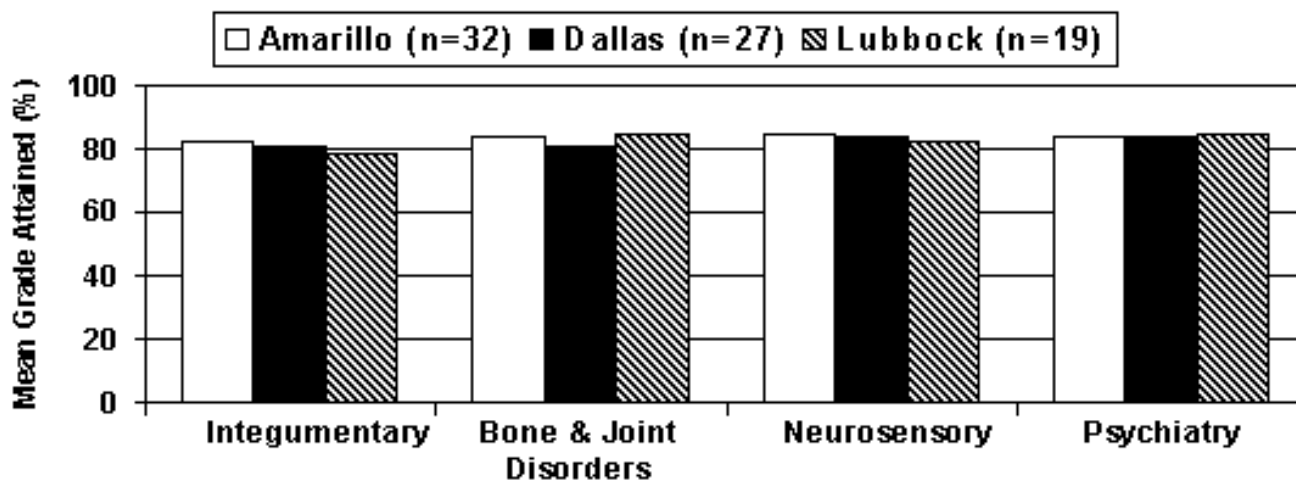


Figure 1. Comparison of student performance in each pharmacotherapy course per site of enrollment.

ing performance over the 3-year study period.

An assumption that is often made regarding distance education is that students prefer live instruction significantly more than distance learning. However, this may not be the case. In a meta analysis comparing student satisfaction with distance education to that with traditional classrooms, after deletion of 3 outliers (which achieved homogeneity), Allen et al found only a slight student preference for the traditional educational format over distance learning (average $r = 0.031$, $k = 25$, $N = 4702$).¹²

One strength of the present study is that all lectures were delivered at one site (locally) and broadcast to off-site campuses. Thus, by having all lectures originate from the main campus (Amarillo), there is less potential for confounding variables such as differences in technology support or equipment.

Another strength of this study is that students were evenly distributed across local and distance-learning sites with respect to previous academic performance. There was no difference in pre-enrollment GPA (before deployment to distant sites) between all campuses or between local and distant sites ($p = 0.91$ and $p = 0.73$, respectfully). If more students with greater intelligence or academic ability (as assessed by GPA) had been located at distance learning sites than at local sites, the finding of no difference in outcomes could be explained by this confounding variable. However, since students were evenly distributed, this does not appear to be the case.

While specific steps were taken to minimize potential confounding errors, there are limitations in the current study. First, because of the low number of students ($n = 32$ at the local site, $n = 46$ at distant sites), it is possible that the study lacked the power to detect any difference that may have existed (ie, type II error). Second, it is not known whether student learning for both onsite and off-site students would have been better if faculty members had not used distance-learning technology. Interactive videoconferencing can be quite taxing on the instructor. It often requires modification of teaching techniques (eg, being “tied” to the podium, adaptation of handouts, strong interaction with offsite students so they are involved in the course)¹³ and multitasking (eg, operating instructional podiums, interacting with more than one classroom), which can be extremely distracting for the instructor and potentially decrease their effectiveness.

Another possible limitation of this study is that it may not be generalizable to other types of courses (eg, pharmacy management, calculations). Student evaluations of the instructors stratified according to site of origination (eg, local vs distant) were not available. Thus, while no difference in student performance was found, it

is not possible to say whether the same holds true for instructor evaluations. Lastly, while the cognitive domain (eg, student academic performance) was assessed, the affective and psychomotor domains were not. Thus, while there appears to be no difference in academic performance, whether distance-learning technology using live videoconferencing produced equivalent student learning in all 3 learning domains is not known.

CONCLUSIONS

There was no significant difference in student outcomes at local and distant sites as assessed by final course grades in pharmacotherapy courses that used interactive videoconferencing technology. This information is valuable considering the increased use of this distance-learning technology in pharmacy school curricula. Future studies should be done that assess (1) the effectiveness of this technology in other types of pharmacy courses and its equivalence with other types of learning (ie, affective domain); (2) the satisfaction of instructors and students with distance learning; and (3) the impact of distance learning on student performance on national pharmacy licensure examinations.”

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