INSTRUCTIONAL DESIGN AND ASSESSMENT

An Advanced Cardiovascular Pharmacotherapy Course Blending Online and Face-to-Face Instruction

Michael A. Crouch, PharmD

South University School of Pharmacy

Objective. To assess the effectiveness of online instruction in a cardiology pharmacotherapy elective.

Design. Eight drug-focused lectures and 6 introductory presentations were added to a cardiology pharmacotherapy course. Students completed an online quiz after each online drug-focused lecture and scores were compared to quizzes taken at the beginning and end of the course, as well as on a cardiology advanced pharmacy practice experience (APPE). For online introductory presentations, students completed a quiz at the beginning of the next face-to-face session. A survey was conducted at the end of the course to obtain student feedback.

Assessment. Compared to baseline scores, student learning was demonstrated after online drug-focused lectures by higher quiz scores attained immediately after completing the lecture, at the end of the course, and at the beginning of the APPE. Furthermore, students performed better on quizzes at the beginning of face-to-face sessions if they first completed an online introductory presentation. Students expressed strong support for the online components of the course.

Conclusions. A blended learning environment with online and face-to-face instruction is an effective way to teach a cardiology pharmacotherapy elective. The online component of this course was well received by students, improved student preparation before attending class, and appeared to enhance long-term cardiovascular drug knowledge.

Keywords: cardiology, pharmacotherapy, Internet

INTRODUCTION

An elective cardiovascular pharmacotherapy course can be taught in various ways. The classic approach is face-to-face instruction that includes didactic lectures, case discussions, and/or active-learning techniques. An alternative method is providing all course material online, which may or may not adapt face-to-face instructional techniques. A third and still evolving format, which has not been well documented in the pharmacy literature, is the blended (or hybrid) course design using a combination of online and face-to-face instruction.

In a blended course, significant instruction occurs online. Traditional classroom time is reduced to account for the online activities, but face-to-face time is not eliminated. There is no accepted ratio of time spent face-to-face to online to classify a course as blended. The balance of time depends on instructional styles as well as the

course content, size, and overall goals.[1] In general, if the time spent either face-to-face or online exceeds 90% of the total course allotment, it is not a blended learning environment. Furthermore, having online support for a predominately face-to-face course (eg, Blackboard or eCompanion) is not sufficient on its own to classify it as blended teaching.

There are various potential advantages of the blended learning environment compared to an exclusively face-to-face or entirely online course. The blended approach allows course coordinators to take advantage of online activities unique to this medium, while also having face-to-face discussions with students. Despite having less face-to-face time in a blended course, faculty survey results, outside of pharmacy, support increased interactions between students and faculty members.[1] Moreover, the literature suggests student knowledge retention using the blended approach is better than that observed in fully online courses and comparable to completely face-to-face "classroom-based" courses.[2,3] Blended courses may enhance the flexibility and efficiency of a faculty member to meet the course learning objectives as well as enhance the degree of student-led learning, skill acquisition, and student achievement.[1,4-6] Students in

Corresponding Author: Michael A. Crouch, PharmD, FASHP, BCPS (AQ Cardiology), Professor and Chair, South University School of Pharmacy, Department of Pharmacy Practice, 709 Mall Boulevard, Savannah, GA 31406-4805. Tel: 912-201-8126. Fax: 912-201-8153. E-mail: mcrouch@southuniversity.edu

other disciplines have indicated high satisfaction with blended courses.[2,3,7-9] Students appreciate the greater use of technology and they perceive courses as being more convenient and flexible.[1-3]

There is a paucity of information on the blended approach published in the pharmacy literature. One overseas study evaluated a blended learning environment for microbiology in which virtual laboratory modules were used to teach non-manual skills such as data recording, calculations, and results interpretation.[10] By combining different learning scenarios, students achieved grades in the virtual laboratory similar to those achieved in a traditional setting. Recently, an elective course in acute care medicine evaluated the hybrid approach.[11] The course was modeled after activities that students encounter on an internal medicine advance pharmacy practice experience (APPE) and linked pre-class lectures and assignments, classroom discussion, and projects to promote active learning. Overall, the course increased students' exposure to the inpatient setting and provided additional opportunities to communicate and think critically.

The purpose of this article was to assess the effectiveness of the online component of a blended learning environment used to teach a cardiology elective course for doctor of pharmacy (PharmD) students. In addition to qualitative assessment, this study placed emphasis on quantitative outcomes.

DESIGN
Educational Environment

Advanced Cardiovascular Pharmacotherapy is an elective course available to PharmD students who have completed the general cardiology course. Approximately 25% of the face-to-face classroom time was replaced with online activities. For the remaining face-to-face instruction, a multipurpose, high-technology classroom was used in which students sat at 1 of 4 tables (8 seats per table). The tables were positioned to allow students to see both the instructor in the center of the classroom and a table-specific white board and LCD projection screen. Each table, LCD screen, and whiteboard could be divided into 4 self-contained units, to allow for group work.

The online component of the course was provided via the Blackboard education system (Blackboard, Inc.; Washington DC). In addition to general course information, the Web site had all course content in electronic form. The program Articulate (Articulate Global, Inc; New York, NY) was used to develop online lectures (drug-focused and introductory presentations). This course builds on previous experience using the Internet to enhance student learning.[12]

Pedagogy/Andragogy

The course utilized a learner-centered environment. Additionally, adaptation of the blended classroom, as compared to only face-to-face instruction, was chosen for 4 main reasons: to efficiently augment student knowledge regarding cardiovascular drugs; to enhance student preparation before attending class; to improve and develop unique interaction among students; and to economically provide the elective course (from both a time and resource standpoint) twice yearly.

Before implementing the blended environment, students expressed concern that they did not have sufficient basic cardiovascular drug knowledge. There was substantial time between the required general cardiovascular course and the elective course. Incrementally, drug-focused online lectures were developed, first piloting a beta-blocker lecture. Student feedback was positive, and 7 additional online drug-focused lectures were developed for a total of 8.

Another concern, discussed among faculty members, was that students did not seem adequately prepared for face-to-face interactive discussions. Although students reviewed materials from the previous cardiology course beforehand, in addition to readings assigned by the faculty member, these activities did not seem sufficient. As a result, online introductory presentations were developed, starting with cardiovascular hemodynamics. Based on positive feedback, this approach was expanded to include 5 additional online introductory presentations.

Students also expressed apprehension regarding class participation in the course. The first step to encourage participation was to make it a component of the final course grade. After this change, students inquired about ways to achieve credit other than face-to-face discussions. As a result, 3 additional opportunities for class participation were developed. During face-to-face time, students could receive class participation credit by taking active roles as part of group cases (ie, serving as the recorder or presenter). Additionally, if there was an unanswered question from class (a lingering question), a student could provide a 3-minute presentation to answer the question during the next face-to-face class. Related to the online component of the course, online discussion boards were developed and interactions within these forums counted toward the students' class participation grade.

To create an active-learning environment in this elective, the class size was limited to 32. Starting in the fall of 2004, the course offering was increased to twice yearly to meet annual demand. Since this change represented a significant increase in faculty workload, options for delivering the course in a more efficient manner were considered. The blended approach was an attractive option

since at least one fourth of the course material would be reusable online content.

Content

The elective course used a variety of teaching approaches and forums. Table 1 provides an example course schedule. The first day of class entailed a course overview and extensive discussion regarding the logistics of learner-centered teaching and the blended learning environment. Activities in the course could be categorized globally into 5 types: (1) faculty-led face-to-face discussions; (2) online introductory presentations completed before face-to-face time; (3) online drug-focused lectures that replaced face-to-face time; (4) face-to-face group cases; and (5) face-to-face major presentations (case or topic).

Face-to-face discussions led by faculty members included traditional didactic lectures, drug-focused games (ie, Jeopardy, Are you Smarter than a Cardiologist, and Who Wants to be a Millionaire Pharmacist), and interactive activities that followed an online introductory - presentation. Cases were used to support face-to-face discussion.

There were 6 online introductory presentations, each 25 minutes or less in length that were recorded directly into PowerPoint, converted to Shockwave files via Articulate, and uploaded to the course Web site. The Shockwave files provided a slide-based presentation with audio, music, and active hyperlinks. These presentations began with learning objectives that addressed disease definitions, epidemiology, etiology, pathophysiology, clinical presentation, and disease classification. At the end of the presentation, there was a brief treatment overview as well as an assignment for students to complete before the face-to-face discussion. The assignments included developing an assessment and plan for a case, reading specific sections of a guideline statement, or analyzing a contemporary journal article. The face-to-face time that followed an introductory presentation began with a 10-question quiz.

During face-to-face discussions, there were 5 types of activities that followed an online introductory presentation. These activities were: (1) a didactic lecture with slides and case vignettes; (2) multiple paper cases with limited technology; (3) cases completed by student groups submitted via e-mail that replaced face-to-face time; (4) a single case discussed in-depth with moderate technology, such as slides; and (5) multiple oral cases with "hands-on" activities (eg, human simulation).

There were 8 online drug-focused lectures, each 35 minutes in length that were recorded directly into PowerPoint and converted to Shockwave files via Articulate. Drug-focused lectures began with a brief history of the drug class and subsequently addressed drug mechanisms of action, pharmacologic and pharmacokinetic variables, key therapeutic differences, and ended with students developing a personal formulary. Intermixed among the discussion were case vignettes that highlighted reasons to select one agent over another. Handouts for the slides were provided to the students with missing information that could only be obtained by listening to the presentation. Upon completion of each online drug-focused lecture, students completed an online 10-question quiz. They could choose when to take the quiz, but it had to be taken before the next face-to-face meeting. To discourage students from collaborating on the quizzes, the questions and answers were randomized. Additionally, quizzes were timed and the course Web site provided a timestamp of when each quiz was submitted.

Throughout the course, there were sessions during which students addressed short cases as a group. Students were aware of the topics before attending class so they could prepare beforehand. These cases were basic reviews of common cardiovascular conditions (eg, heart failure) to help students refresh their knowledge from the general cardiovascular module. These cases prepared students for subsequent higher-level cases (eg, heart failure exacerbation). During face-to-face discussions, students divided into respective groups (up to 8 students per table) and 2 students served as leaders. One student was the group leader, managing the case discussion, and presenting the assessment and plan to the remainder of the class (5-minute presentation). The second leader was the recorder, who developed the slide set with input from the group.

The final component of the course was the major group presentation. On the first day of class, students divided into groups of 4 or fewer and chose whether to provide a topic or case presentation. Groups with a case presentation visited the hospital and followed a patient identified by the course coordinator. Groups that chose to do a topic presentation did not have this requirement. Before preparing for and delivering the topic or case presentation, students reviewed an online lecture entitled "Delivering a Professional Presentation" and individually took a required online quiz. The subsequent case or topic presentation was limited to 50 minutes (30 minutes for the presentation, 10 minutes for discussion, and 10 minutes for the quiz, which had to be approved by the course coordinator). All group members gave their presentation with the time equally distributed among the group.

Assessment Methods

Quantitative and qualitative assessments were performed to describe and evaluate the online component

Table 1. Example Course Schedule for Advanced Cardiovascular Pharmacotherapy

Session No. and Topic/Activity
1. Course overview and design
2. Online lecture: beta-blockers[a]
3. Introduction to cardiovascular testing
4. Introduction to cardiovascular testing
5. Online lecture: renin-angiotensin-aldosterone system (RAAS) inhibitors[a]
6. Jeopardy: beta-blockers and RAAS inhibitors[b]
7. Online lecture: diuretics[a]
8. Cardiovascular infections[c]
9. Cardiovascular infections
10. Online lecture: calcium-channel blockers[a]
11. Are you smarter than a cardiologist?: diuretics and calcium-channel blockers[b]
12. Group cases: hypertension and heart failure[d]
13. Group cases: hypertension and heart failure[d]
14. Major topic presentation: hypertensive emergency[e]
15. Overview of cardiothoracic surgery
16. Cardiothoracic surgery: a patient's perspective
17. Major topic presentation: pericarditis[e]
18. Hemodynamic monitoring, shock, and the use of intravenous vasoactive agents[c]
19. Hemodynamic monitoring, shock, and the use of intravenous vasoactive agents
20. No class; time offset for online introductory presentations (CV infections and hemodynamics)
21. Major topic presentation: pulmonary hypertension[e]
22. Acutely decompensated heart failure (ADHF)[c]
23. Acutely decompensated heart failure (ADHF)
24. Major case presentation: ADHF[e]
25. Online lecture: agents for dyslipidemia[a]
26. Online lecture: antiplatelet agents[a]
27. Jeopardy: dyslipidemics and antiplatelets[b]
28. Group cases: dyslipidemia and stable ischemic heart disease[d]
29. Group cases: dyslipidemia and stable ischemic heart disease[d]
30. Online lecture: anticoagulants[a]
31. Major topic presentation: pulmonary embolism[e]
32. Acute coronary syndromes (non-ST-elevated acute coronary syndromes)[c]
33. Acute coronary syndromes (non-ST-elevated acute coronary syndromes)
34. Major case presentation: non-ST-elevated acute coronary syndrome[e]
35. Acute coronary syndromes (ST-elevated myocardial infarction)
36. Major case presentation: ST-elevated myocardial infarction[e]
37. No class; time offset for online introductory presentations (ADHF and ACS)
38. Online lecture: antiarrhythmic agents[a]
39. Who wants to be a millionaire pharmacist?: anticoagulants, antiarrhythmic agents[b]
40. Cardiac arrhythmias[c]
41. Cardiac arrhythmias
42. Major case presentation: arrhythmia[e]
43. Cardiopulmonary resuscitation (CPR)/emergency cardiovascular care (ECC)[c]
44. Cardiopulmonary resuscitation (CPR)/emergency cardiovascular care (ECC)
45. No class; time offset for online introductory presentations (arrhythmias and CPR/ECC)

[a] Exclusively online; students complete a required online lecture and quiz; a discussion board supports the topic

[b] Before class, students review questions and answers posted on respective discussion boards

[c] Students complete a required online introductory presentation before class; class begins with a 10-question quiz; a discussion board supported the topic

[d] Group work (eight students); each student brings his or her laptop to class (internet access required)

[e] Group presentation (four students); supported by an online lecture/quiz (Delivering a Professional Presentation)

of the blended course and included data from 158 students. For the drug-focused online lectures, data were retrospectively evaluated for classes that occurred between fall 2004 and spring 2008. Data related to online introductory presentations came from classes occurring between fall 2006 and spring 2008. This analysis was reviewed and approved by the University's Institutional Review Board.

For the online drug-focused lectures, students independently completed quizzes throughout the course. Figure 1 provides a timetable showing when quizzes were performed related to the online instruction. Students enrolled in the spring course completed an unannounced baseline assessment that consisted of the same 80 questions later encountered as part of 8 individual online quizzes. For students enrolled in the fall, there was an unannounced end of the course quiz that included the same 80 questions. To preclude students from becoming familiar with the questions, students were given the 80-question quiz only once during the cardiology elective course. The 80-question, unannounced assessment was done in a manner to hide that it occurred on an annual basis.

Students who took the cardiology APPE received the same unannounced 80-question quiz at the beginning of the clerkship (Figure 1). Not all students who enrolled in the cardiology APPE completed the elective course, which allowed for a comparison of APPE quiz grades between students who did and did not complete the online drug-focused lectures. After completion of the 80-question quiz on the APPE, students were given access to the online drug-focused lectures for review.

Related to online introductory presentations, students completed a 10-question quiz at the beginning of the next face-to-face meeting. There were 6 introductory presentations throughout the semester. Since this process has evolved over the years, a single topic (cardiovascular hemodynamics) was chosen for quantitative assessment because it was consistently offered with the same quiz questions. Using an assessment at the beginning of the class period, preparation techniques (reading alone versus reading and the online introductory presentation) were compared. Additionally, student knowledge after instruction was assessed. Three approaches were considered: (1) reading only before class and the discussion of cases face-to-face, (2) reading plus an online introductory presentation before class and the discussion of cases face-to-face, and (3) reading plus an online introductory presentation before class and online cases completed as groups.

Students anonymously completed a survey instrument at the end of each elective course offering. In addition to standard questions related to delivery and content, students were asked what they liked most about each approach, and in a separate question, what they liked least. Students were surveyed regarding the pace of the online lectures (both drug-focused and introductory), time for completion, and suggestions regarding how the online instructional approaches should be used in future course offerings. Since there were various activities used during face-to-face meetings after an online introductory presentation, students also were surveyed regarding their thoughts on the different face-to-face activities.

Statistical Analysis

Descriptive statistics characterize the sample and report students' perceptions of the online instructional strategies. ANOVA was used to compare sequential quiz grades related to online drug-focused lectures (baseline, immediately after single online lectures, end of the course, and start of the APPE). ANOVA also was used to compare quizzes at the end of instruction following an online introductory presentation. Post-hoc testing (Tukey) followed ANOVA, where appropriate. A *t* test was used to compare quiz grades on the APPE between students who did and did not take the cardiology elective course. Sample size analysis for the *t* test revealed 8 students were necessary in each group to determine whether a statistical difference existed between clerkship quiz grades (sigma = 7%, 10-point expected difference between groups, alpha = 0.05, beta = 0.80). A *t* test was also used to compare quiz grades at the beginning of class between students who did and did not complete an introductory presentation.

EVALUATION AND ASSESSMENT
Online Drug-Focused Lectures

The results of surveys taken by students who completed the online drug-focused lectures are given in Table 2. For all listed survey questions, over 97% of students agreed or strongly agreed with the provided statements. According to students, this approach stimulated interest in the respective topics, enhanced understanding, and was easy to use. A majority (99%) of students agreed or strongly agreed with the statement that online drug-focused lectures should continue as part of this course.

Students also were surveyed regarding the pace of online lectures (35 minutes), with 62.1% stating the pace was "just right." Of the remaining students, some felt the pace of the lectures might be too quick, with 29.1% stating they were "a little too fast" and 1.9% commenting "much too fast." Conversely, 6.8% stated the lectures were "a little too slow." To the question of how long it took to view each online lecture and complete the assignment, 64.5% stated it took 1-2 hours, 23.4% indicated it took

Table 2. Survey Results Related to Online Drug-focused Lectures (n = 145)[a]

Question	Strongly Agree, %	Agree, %	Disagree, %	Strongly Disagree, %
The online drug-focused lectures had clearly stated objectives	82.5	17.5	0	0
The method of instruction stimulated my interest in the respective topics	62.1	37.2	0	0.7
The practical application of subject matter is apparent	86.4	13.6	0	0
The online drug-focused lecture method of instruction enhanced my understanding of concepts and principles related to the topics	73.1	26.2	0.7	0.0
I was able to keep up with the workload of the online drug-focused lectures	68.9	31.1	0	0
The online quizzes related to the drug-focused lectures were reasonable in length and difficulty	54.4	45.6	0	0
The online drug-focused lecture instruction method was easy to use	74.5	23.4	2.1	0
The online drug-focused lecture should continue as part of this course	82.5	16.5	0	1.0

[a] Each online drug-focused lecture was limited to 35 minutes. Upon completion of the lecture, students complete an online 10-question quiz before the next face-to-face meeting. Time for the lecture and quiz replaced one classroom period.

less than 1 hour, 10.5% indicated it took 2-3 hours, and 1.6% said it required 3-4 hours.

When asked how faculty members should use online drug-focused lectures in the future, 70.9% of students indicated the same number should be used, 26.2% wanted more, and 2.9% suggested fewer online lectures. No students selected the response that no lectures should be provided in this way.

In students' written comments, a common theme was they enjoyed that the lectures could be completed at their convenience and pace. Moreover, students liked the option to pause and review slides a second time. They commented having fill-in-the-blank handouts and embedded hyperlinks were a good way to keep students engaged. Students also stated that the online lectures broke up the monotony of traditional face-to-face lectures and they liked the immediate feedback related to online quizzes.

Students expressed concern over technical problems that occurred such as slides "locking up" and fragmented audio. Students also expressed concern that they could not ask immediate questions related to the material provided. One student commented they would have learned more if they had been given a transcript of the lecture.

Student knowledge regarding the online drug-focused lectures was assessed 4 times (Figure 1 and Table 3). Three assessment points occurred during the blended elective (at the beginning of the course, after each individual lecture, and at the end of the course). The fourth assessment was at the start of the cardiology APPE. For students who completed the cardiology elective course, mean scores after each online lecture (92.4%), at the end of the course (71%), and on clerkship (73.1%) were significantly higher than at baseline (46.1%; $p < 0.0001$). Eight students who took the quiz on clerkship did not take the cardiology elective course; hence, they did not review the online drug-focused lectures during the didactic portion of the curriculum. When comparing the start of APPE assessments, quiz scores of students who completed the online drug-focused lectures were significantly higher than grades of students who did not (73.1% vs. 60.1%, $p < 0.001$).

Introductory Presentations

Table 4 provides survey results related to the online introductory presentations. For all listed survey questions, except those related to quizzes, 98% of students agreed or strongly agreed with each statement. According to students, this approach simulated interest in the respective topics, enhanced understanding, was easy to use, and should continue as part of this course. Regarding quizzes
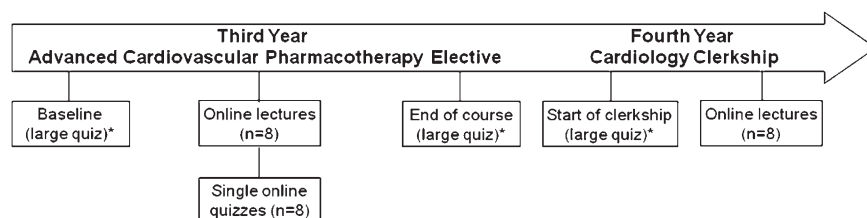

Figure 1. Timeline of quizzes related to online drug-focused lectures in a blended learning course in Advanced Cardiovascular Pharmacotherapy.

Table 3. Mean Quiz Scores Related to Online Drug-focused Lectures (n = 158)

Quiz	Score, %
Elective course students	
Baseline (n = 51)	46.1[a]
Post-online (n = 150)	92.4 [a]
End of course (n = 94)	71.0 [a]
APPE (n = 18)	73.1 [a,b]
Students not taking the cardiology elective	
APPE (n = 8)	60.1[b]

Abbreviations: APPE = advanced pharmacy practice experience
[a] $P < 0.0001$
[b] $P < 0.001$

at the start of class, 16% of students disagreed or strongly disagreed that the questions were reasonable in length and difficulty.

Regarding the pace of the online lectures, 64.2% of students stated the pace (25 minutes) was "just right," 30.9% stated they were a "little too fast," and 1.2% stated they were "much too fast." Conversely, 2.5% stated they were a "little too slow" and 1.2% felt they were "much too slow." An additional question asked was how long it took to view each online lecture and complete an assignment. Each lecture was 25 minutes or less in length. Of those surveyed, 35.7% of students stated it took less than 1 hour and 57.2% commented it took 1 to 2 hours, 5.9% stated it took 2-3 hours, and 1.2% of students stated it took 4 hours.

When asked how faculty members should use online introductory presentations in the future, 81% of students stated the same number of presentations should be used, 8.3% suggested more be employed, 9.5% suggested less be used, and 1.2% selected that none be provided.

The survey also asked students to give written comments regarding what they liked and did not like about the online introductory presentations. Many commented they had a better understanding of the subject before face-to-face meetings than that achieved with only a reading assignment. Students mentioned it helped them get more out of the face-to-face time and became more comfortable speaking up during classroom discussion. Numerous students commented they felt everyone was on the same page at the beginning of class. Similar to the online drug-focused lectures, students liked the opportunity to complete online introductory presentations at their leisure and the prospect to review the material again, if necessary.

Technology concerns were similar to those observed with the online drug-focused lectures. Students occasionally had access problems and expressed anxiety about not being able to connect to the site if they waited until the last minute. The written section provided more detail regarding students' concerns with the length and difficulty of the quiz at the beginning of class. Students felt they spent excessive time preparing for the quizzes. They were concerned that online material was not revisited during face-to-face meetings and they suggested a quick review and discussion before taking the quiz. Overall, students commented they felt the introductory presentations increased workload.

During face-to-face instruction, there were various types of activities that followed an online introductory presentation. Students favored a didactic lecture with slides and short case vignettes (43.2%), or a single case discussed in depth with moderate technology, such as slides (20.5%). When asked which instruction approach created the best active-learning environment, students felt multiple oral cases with a "hands-on" activity was best (56.7%), followed by a single case discussed in depth with moderate technology, such as slides (22.4%). When asked about other activities that could follow an online introductory presentation, 76.3% of student agreed or strongly

Table 4. Survey Results Related to Online Introductory Presentations (n = 84)[a]

Question	Strongly Agree, %	Agree, %	Disagree, %	Strongly Disagree, %
The online introductory presentations had clearly stated objectives	67.9	30.9	0	1.2
The method of instruction stimulated my interest in the respective topics	39.3	59.5	1.2	0
The practical application of subject matter is apparent	66.1	33.9	0	0
The online introductory presentation method enhanced my understanding of concepts and principles related to the topics	57.2	42.8	0	0
I was able to keep up with the workload of the online introductory presentations	44.0	54.8	1.2	0
The in-class quizzes (start of class) related to online introductory presentations were reasonable in length and difficulty	13.6	70.4	13.7	2.3
The online introductory presentation instruction method was easy to use	58.3	41.7	0	0
The online introductory presentations should continue as part of this course	53.5	45.3	0	1.2

[a] Introductory presentations were limited to 25 minutes; students completed the introduction presentation before attending class and took a 10-question quiz at the beginning of the next face-to-face session.

agreed that discussing a contemporary journal article in depth should be used as an instructional method.

In written comments, some students emphasized that the face-to-face time provided a "real world" discussion since basic material had already been reviewed. Since online presentations maximized technology, students recommended that use of technology be minimized in the classroom. Many students liked the interactive case discussions and appreciated when faculty members used cases and therapeutic dilemmas observed in clinical practice. Several students commented that face-to-face time should include group work.

Table 5 provides quiz scores related to cardiovascular hemodynamics. Cardiovascular hemodynamics was chosen for this assessment because the material has not changed and the same 10-question quiz was given for all assessments. The baseline assessment compares 2 methods of preparation: (1) reading only (traditional approach) and (2) reading plus the online introductory presentation. When comparing the 2 methods, students scored better on the beginning-of-class quiz if reading was supplemented with an online introductory presentation (77.3% vs. 62.5%, respectively; $p = 0.02$).

With regard to the effect of the role of face-to-face teaching, no difference in quiz scores was found between students who had face-to-face discussion, irrespective of whether they did or did not have the online introductory presentation (88.1% vs. 90.8%, respectively; $p = $ NS). Conversely, scores after instruction were significantly lower if online group cases were used rather than face-to-face cases (79.1%; $p < 0.05$).

DISCUSSION

The purpose of this article was to describe and evaluate the online component of a blended cardiology elective course for PharmD students. Online instruction consisted of 8 drug-focused lectures, which replaced face-to-face time, and it was well received by students. Additionally, quiz scores at the end of the course and months later on a cardiology APPE supported overall cardiovascular drug knowledge had improved compared to the baseline assessment.

For the online drug-focused lectures, the 35-minute duration was chosen because it along with the quiz equaled a 50-minute class period. Based on survey results, the online lecture time will be increased to 40 minutes with 10 minutes to complete the online quiz. An accounting of "replaced" course hours is an important step when describing and implementing the blended course design. Since online drug-focused lectures replaced classroom time, it was believed that all work on each online lecture should be no more than 3 hours (an hour of class time and 2 hours outside of class). Student surveys supported this approach.

The concern of technical problems (ie, slides "locking up") was resolved by adapting Articulate as the chosen platform to develop and deliver the presentations. The concern that students could not ask immediate questions related to the material was alleviated with individual discussion boards and the fact the Articulate platform allows students to e-mail faculty members during the presentation and ask questions. Faculty members were asked to respond to e-mails within 24 hours. Finally, the student comment regarding the desire to have transcripts for the lecture was resolved by adding lecture notes to each presentation.

The second component of online instruction was 6 introductory presentations used to prepare students for face-to-face discussions. Students liked this approach and felt better prepared for face-to-face discussions. Quiz grades at the beginning of class demonstrate students were better prepared when required reading was supplemented with an online introductory presentation. Although students were better prepared for the discussion, the use of online introductory presentations did not improve quiz scores at the end of instruction. However, students fared better when preclass preparation (reading alone or reading plus the online presentation) was supplemented with face-to-face case discussion rather than online cases.

For the introductory presentations, the 25-minute maximum duration was chosen because 2 presentations would replace a 50-minute class period. Additionally, a legitimate concern was longer presentations might be less engaging. Since time for the introductory presentations replaced approximately half of a class period, it is expected that work on each online lecture should be

Table 5. Mean Quiz Scores Related to Cardiovascular Hemodynamics

Quiz	Score, %
Baseline quiz (n = 43)	
Reading only	62.5[a]
Reading plus online introductory presentation	77.3[a]
End of instruction quiz (n = 66)	
Reading only and face-to-face cases	90.8[b]
Reading plus online introductory presentation and face-to-face cases	88.1[b]
Reading plus online introductory presentation and online group cases	79.1[b]

[a] $P = 0.02$
[b] $P < 0.05$

no more than 1.5 hours (one-half hour of classroom time and one hour outside of class). Overall, student survey responses support this online approach was reasonable in this respect, but this requires continued evaluation given concerns of increased workload.

This study did not directly compare the blended classroom to traditional classroom instruction. As such, this investigation cannot indicate whether the outcomes with respect to student learning are better, as good as, or inferior compared to a completely traditional classroom course. Two components of this study, however, provide some comparison to traditional teaching.

In 1 comparison, some students on the cardiology APPE only completed the required curriculum (traditional approach) whereas others reviewed the online drug-focused lectures (blended course) in addition to the required curriculum. When evaluating APPE scores on the 80-question unannounced quiz related to cardiovascular drug knowledge, scores were higher among those students who completed the blended approach. Although the ideal comparison would be a traditional elective versus the blended elective, these data provide support regarding the effectiveness of the blended learning environment. Additionally, when contrasting grades after an online introductory presentation, there is a direct comparison of the traditional approach (reading only) compared to the blended environment (reading plus the introductory presentation). These data indicate the introductory presentation helped prepare students for the subsequent face-to-face discussion. Overall, this evidence supports the blended approach is a reasonable way to teach material related to cardiology.

Although this study documents the students' perspective regarding this approach, the study does not formally evaluate faculty time. In previous research, instructors report that blended courses may require more course development time compared to traditional courses.[1] The initial time commitment for the cardiology elective was extensive. Long-term, however, time has been saved by reusing online materials, although sections of these lectures must be updated annually, where necessary.

SUMMARY

This study found that blended instruction with online and face-to-face components is an effective method to teach a cardiology elective course for PharmD students. The online component of the course was well received by students, improved preparation before attending class, and enhanced long-term cardiovascular drug knowledge. Additional study is warranted to better define the outcomes of a blended approach compared to a completely traditional, face-to-face learning environment.

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