INSTRUCTIONAL DESIGN AND ASSESSMENT

Electronic Integration of Prerequisite Course Content

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Objectives. To evaluate the effect of electronic integration of embedded prerequisite information (EPI) on student learning.
Design. Specific prerequisite information presented in a Chemical Basis of Drug Action course and important to understanding new topics presented in subsequent courses was identified and embedded in online course materials using pop-ups and hyperlinks. Students were encouraged to review the EPI.
Assessment. There was no significant difference ($P<0.05$) between student performance on examination 3, which covered embedded information, and student performance on examination 1 which did not. Employing the Likert scale, a cumulative average of 75% and 87% of the campus and distance students rated the impact of EPI slightly positive to positive, respectively.
Conclusion. Although student performance did not improve with the introduction of EPI, both campus and distance students viewed the EPI positively.

Keywords: medicinal chemistry, curriculum, integration, prerequisite

INTRODUCTION

Challenging students to recall key principles from previous courses and integrating that content into subsequent courses are major endeavors for faculty members. Several terms exist for integrated curriculum including *interwoven, connected, thematic, interdisciplinary, multidisciplinary, correlated, linked*, and *holistic*.[1-4]

For faculty members, true curricular integration is a professional responsibility considered critical in the design of instruction.[5] It is a teaching philosophy whereby course content is drawn purposefully from several subject areas to focus on a particular concept or topic.[4,6-10] For example, rather than studying pharmacology and medicinal chemistry in isolation, an integrated course studies key concepts that are shared between the 2 courses, with emphasis on specific concepts in each discipline reinforce the other discipline, eg, how the structure activity relationship (SAR) discussed in medicinal chemistry helps students understand the mechanism of action of a particular class of drugs, selectivity at different receptors, side effect profile, etc. This content can be integrated into therapeutic courses to explain therapeutic decisions in different clinical scenarios, requiring integration with concepts discussed in physiology, anatomy, and biochemistry. Thus, curricular integration assists students in understanding the interrelationship among all the disciplines (ie, understanding the "big picture").

Curriculum integration requires that students demonstrate knowledge, skills, and attitudes that transcend content or concepts previously taught, to those currently taught, and demonstrate how the concepts/content apply to future curriculum content.[6-11] Many examples of successful curriculum integration have been documented in the literature in a variety of disciplines, including in higher education.[10-19] From the faculty member's perspective, the rationale for curriculum integration includes: (1) helping the instructor to value the contribution of other faculty members and their respective disciplines to course content, (2) providing relevance to the prerequisite information taught, and (3) preparing students to meet the cognitive and affective challenges in subsequent courses.[12,14,20] For students, curriculum integration instills an appreciation of prior content learned and fosters the application of that knowledge in different contexts, including the workplace. When faculty members are cognizant of content covered in prior courses, they can augment it. Additionally, curriculum integration is an excellent mechanism to determine early on if the sequencing of the courses is appropriate and which teaching methods/approaches are successful and which are not, making curricular mapping a more effective and dynamic process. Curriculum integration is supported by brain research, which has shown that learning occurs faster and more thoroughly when information is presented in a meaningful context with an experiential component.[9-11,21-24]

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Although the curriculum at Creighton University School of Pharmacy and Health Professions (SPAHP) is not integrated, the Chemical Basis of Drug Action course has used several strategies to help students think about the "big picture" and value the importance of prerequisite courses. These strategies included identifying information taught in other courses, reviewing the content from other courses, searching the literature, updating course handouts annually, summarizing prior key topics or concepts in lesson handouts,[12,14,25-26] redirecting students to prerequisite course content,[12,14,25-26] challenging students to think about the big picture,[12,14] demonstrating a curriculum integration exercise based on the content of a prior lesson,[12,14] and requiring students to perform a curriculum integration exercise.[12,14,25-26] Despite these strategies, based on observation by the instructors of in-class interactions and student performance on some in-class course activities, students did not appear to demonstrate an appreciation for applying prior course content.

In 2001, Creighton University invested extensive resources to establish a distance learning doctor of pharmacy (PharmD) pathway. All pharmacy courses now are online, and each faculty member has taught his/her course for a minimum of 6 academic years. Many of the faculty members invested time and effort to integrate courses by providing links to supportive content on the Web. This study evaluated the effect of electronic integration of embedded prerequisite information (EPI) from earlier courses in the curriculum, into the online content of a second-year required course for campus-based and distance pharmacy students. Therefore, the objectives of this instructional design are to help the students appreciate the content from prior courses, to integrate the content with new content learned and to enhance overall student learning.

DESIGN

The Chemical Basis of Drug Action course is a 2-credit hour course (2 lectures per week) taught in the spring semester for campus and distance students in the PharmD program. Demographics for the campus and distance class for the spring semester 2008 when the study was conducted are shown in Table 1. All content in spring 2008 was made available online using FrontPage, Microsoft Office 2007, as the authoring tool. The course, was taught by 3 faculty members, and divided into 4 sections, with several topics in each section addressing a specific class of drugs. One of the authors taught 2 consecutive sections in this study. The first section of 5 weeks covered the antimicrobial class of drugs, and the second section (5 weeks) covered the benzodiazepine anxiolytics and the antidepressants (tricylics, monoamine oxidase inhibitors, serotonin selective reuptake inhibitors, second generation and newer agents) drug classes, both of which constitute the central nervous system (CNS) drug class. Each section was comprised of eleven 50-minute sessions. Although the 2 sections were dissimilar, they were taught by the same instructor, utilizing a standardized instructional model,[12,14] with the exception of the introduction of EPI into the online lesson handout in the second section. This provided the opportunity to compare the 2 sections based on the intervention. The campus and distance students took the course at the same time and utilized the same course Web site. No textbook was required; however, all enrolled students had access to the online learning materials and a lesson handout. The lesson handouts were written to be descriptive and comprehensive,[12,14] and students depended on them for all course content and course assessment, which consisted of 3 equally weighted examinations. The handout was divided into 6 sections to guide the students through the higher-level thinking skills required in the course: Introduction, Pharmacophore, Structure Activity Relationship (SAR), Apply the SAR, Common Clinical Decisions, and Predicting Clinical Activity.[12,14]

Table 1. Demographics of Pharmacy Students Enrolled in a Medicinal Chemistry Course Incorporating Embedded Prerequisite Information

Criteria	2007 Campus Students	2007 Distance Students
Grade point average	3.45	3.46
% with previous degrees	46	82
Average age, y	23	31
% Female	61	73
% Male	39	27

To help with electronic integration of prior content, SoftChalk (SoftChalk LLC, Richmond, VA, http://softchalk.com) was used. This software suite allowed us to embed prerequisite information (Figure 1) via pop-up windows (eg, definition of depression, figure of CNS components, helpful tips such as a trailer for the movie *Awakening* to encourage students to learn more about extrapyramidal side effects); hyperlinks (eg, a PowerPoint slide on antipsychotic or antiparkinson drugs from a pharmacology course; Figure 2); a PowerPoint slide from the anatomy course describing the anatomy of the blood-brain barrier); and inserting self-assessment "Quiz Me" questions in the online handouts (Figure 2). Although some of the "Quiz Me" questions were in the hardcopy handouts, several other questions were added online. The software was user friendly and allowed us to copy and paste the content from Microsoft Word documents into the lesson builder. Minor formatting

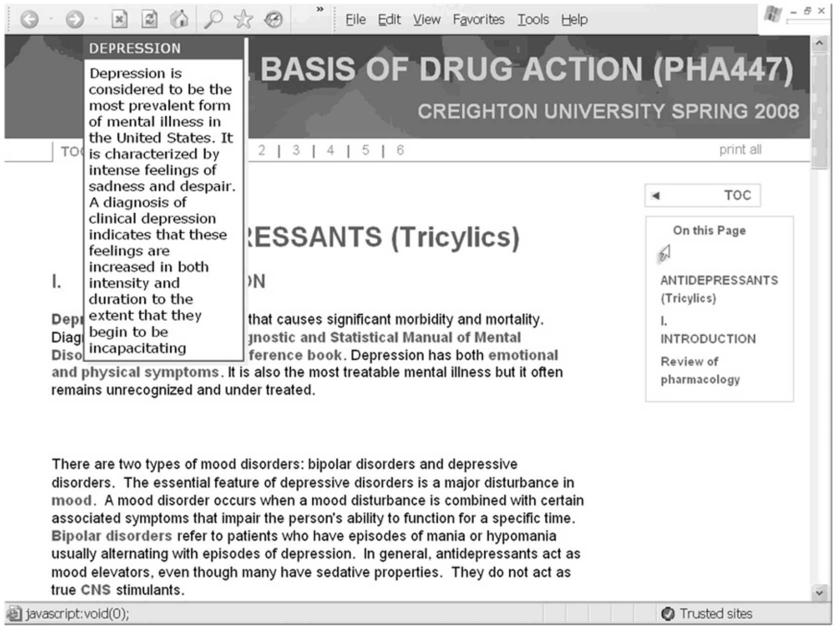

Figure 1. Capture of some of the ‘‘pop ups’’ in the tricylic antidepressant SoftChalk lesson: Introduction Section I. Example of a ‘‘pop up’’with a definition. Words highlighted in bold have ‘‘pop ups’’ with definitions, figures and helpful tips.

was needed to maintain organization of the lesson; however, the end result was professional looking (Figures 1 and 2).

Integration of course content began in January 2008 with the selection of 10 students, including 3 fourth-year pharmacy students, who completed an academic clerkship with the instructors. In addition, campus and distance students who had completed the course previously collaborated with instructors to identify specific prerequisite information important for understanding the CNS class of drugs. An exempt status for the project was obtained from the institutional review board (IRB) at Creighton University, and student consent was obtained at the beginning of the semester.

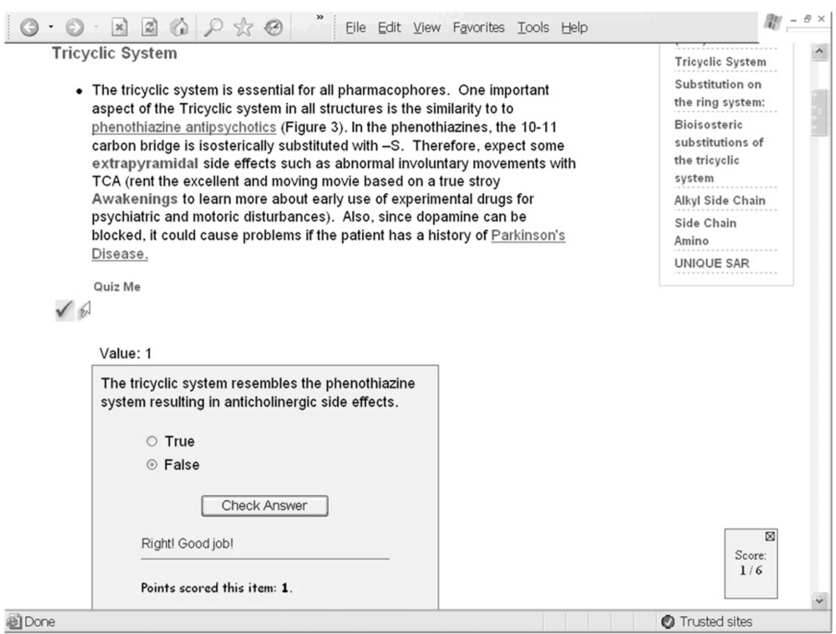

Figure 2. SAR section III: screen capture of the hyperlinks and Quiz Me questions in the tricyclic antidepressant SoftChalk lesson. The blue underlined text links the students to antipyschotic drugs and antiparkinson drugs from a pharmacology course PowerPoint slides. Example of a true/false ‘‘Quiz Me’’ question.

During February and March, the prerequisite content was accessible in the SoftChalk lesson via pop-up windows and hyperlinks to Microsoft Word documents and PowerPoint presentations from other online PharmD courses in our curriculum. The online handouts, covered earlier in the semester in the antimicrobial drug class, were presented as in prior years, without hyperlinks and pop-up information, but with 5 "Quiz Me" questions. Eight to 10 additional "Quiz Me" questions including 5 questions that were part of the original handout for the CNS section were included in the online handout for students to quiz themselves on prior and new information. True/false, multiple answer, multiple-choice, and matching questions were utilized and immediate feedback was provided when the quiz was answered online (Figure 2). From April 1 to May 1, campus and distance students completed the CNS class of drugs in 11 sessions. Upon completion of the course, students were asked the extent to which they used the online handout (Table 2). In addition, campus and distance students' average examination performance on the CNS drug class (embedded) was compared to the examination performance on the antimicrobial drug class (not embedded) and to students' performance who took the course in spring 2007 (not embedded) (Table 3). Also, a survey tool was developed with questions that alternated between positive and negative, seeking the students' perceptions of the value of the EPI (Table 4) and comparing the antimicrobial section (not embedded) with the CNS section (embedded; data not shown). Finally, students were asked to comment on the value of an extra credit assignment (Table 5) that asked them to embed the Word document handout for the last 2 CNS drug classes (second generation and newer agents) with content from previous courses, and from reputable Web sites. Student confidentiality was maintained throughout the study.

EVALUATION AND ASSESSMENT

A quantitative-qualitative mixed methods study design[27,28] was used to evaluate the effectiveness of EPI, including students' quantitative input of answers to the survey tool, their narrative comments, and the analysis of those comments. Student performance was expressed as the mean ± SD. The data were subjected to analysis of variance (ANOVA) for significance at $p < 0.05$. The response rate for the survey tool was 92% (101) for campus students and 89% (49) for the distance students.

Percent of Study Time Using Softchalk and its Impact on Learning

Table 2 summarizes the percent of their total study time students indicated they used SoftChalk. The cumu-

Table 2. Percent of Total Study Time for the Chemical Basis of Drug Action Course That Pharmacy Students Spent Using the Online SoftChalk Lesson With Embedded Prerequisite Information and Their Perception of its Impact on Learning

		Percent of Total Study Time Spent Using the Online Lesson With Embedded Prerequisite Information, %[a]					Impact on Learning Student Response, %				
Content Covered	**Pathway**	**0%**	**1%-25%**	**26%-50%**	**51%-75%**	**76%-100%**	**N**	**SN**	**NI**	**SP**	**P**
Benzodiazepine anxiolytics	Campus (n = 110)	14.9	55.4	16.8	6.9	5.9	0.0	1.0	26.5	48.0	24.5
	Distance (n = 55)	3.8	44.2	23.1	21.2	7.7	1.9	1.9	5.8	38.5	51.9
	Both (n = 165)	11.1	51.6	19.0	11.8	6.5	0.7	1.3	19.3	44.7	34.0
Tricyclics Antidepressants (TCA)	Campus (n = 110)	20.8	46.6	19.8	5.9	7.9	0.0	1.1	25.3	47.4	26.3
	Distance (n = 55)	3.8	38.5	25.0	26.9	5.8	2.0	0.0	5.9	33.3	58.8
	Both (n = 165)	15.0	43.1	21.6	13.1	7.2	0.7	0.7	19.2	42.5	37.0
Monoamine Oxidase Inhibitors (MAOI)	Campus (n = 110)	17.8	53.5	17.8	5.0	6.9	0.0	1.1	23.4	55.3	20.2
	Distance (n = 55)	5.8	42.3	25.0	21.2	5.8	2.0	2.0	4.0	34.0	58.0
	Both (n = 165)	13.7	49.7	19.6	10.5	6.5	0.7	1.4	16.7	47.9	33.3
Serotonin Selective Reuptake Inhibitors (SSRIs)	Campus (n = 110)	17.8	49.5	19.8	6.9	5.9	0.7	0.7	18.8	46.5	33.3
	Distance (n = 55)	7.7	42.3	23.1	19.2	7.7	0.0	1.1	25.5	53.2	20.2
	Both (n = 165)	14.4	47.1	20.9	11.1	6.5	2.0	0.0	6.0	34.0	58.0

Abbreviations: N = negative; SN = slightly negative; NI = no impact; SP = slightly positive; P = positive

[a] Percent of students indicating that they spent this percentage of time using the online SoftChalk lesson with embedded prerequisite information.

Table 3. Examination Performance of Pharmacy Students Enrolled in a Medicinal Chemistry Course Incorporating Embedded Prerequisite Information in Learning Materials, Mean (SD)

	Spring 2007 Campus		Spring 2007 Distance		Spring 2008 Campus		Spring 2008 Distance	
	Exam 1, n = 109	Exam 3, n = 109	Exam 1, N = 50	Exam 3, n = 50	Exam 1, n = 110	Exam 3, n = 55	Exam 1, n = 110	Exam 3, n = 55
Score	83.2 (7.1)	83.6 (6.9)	83.2 (6.3)	84.6 (6.1)	84.2 (7.3)	84.7 (7.1)	85.2 (6.3)	84.5 (6.8)

Student examination performance on exam 1 and 3 in the spring semester of the academic year 2006-07 and 2007-08. No significant difference is observed between campus (C) and distance (D) students' performance on exam 1 and exam 3 in the study year (spring 2008) or when compared to the previous year, spring 2007.

lative response for the 4 choices (1%-25%, 26%-50%, 51%-75% or 76%-100%) that students used the embedded online handouts for some percentage of their total study time in The Chemical Basis of Drug Action course was 82% and 95%, respectively, while 13% and 29%, respectively, indicated they used the handouts for 50% of their study (Table 2). Taking the responses of each student who utilized the embedded online SoftChalk lesson for any percent of their total study time, in our course, over the 4 content areas which included EPI (Table 2), a cumulative average over the 4 content areas of 75.4% and 87% of the campus and distance students, respec-

Table 4. Student Perception of the Impact of the Embedded Prerequisite Information (EPI)

		% Students[a]				
Evaluation Item	Pathway	SD	D	N	A	SA
The EPI helped me to appreciate the content of prerequisite courses in the curriculum	Campus (n = 101)	0.0	5.1	27.5	51.5	16.2
	Distance (n = 49)	2.0	2.0	5.9	66.7	23.6
	Both (n = 150)	0.7	4.0	20.0	56.7	23.4
The EPI did not help me to value the importance of science courses in the curriculum	Campus (n = 101)	14.1	48.5	25.3	11.1	1.0
	Distance (n = 49)	32.7	57.1	2.0	6.1	2.0
	Both (n = 150)	20.3	51.4	17.6	9.5	1.4
The EPI helped me to integrate prerequisite content with new content	Campus (n = 101)	0.0	3.1	21.4	57.1	18.4
	Distance (n = 49)	2.0	2.0	7.8	58.8	29.4
	Both (n = 150)	0.7	2.7	16.8	57.7	22.1
The EPI did not help me to better relate to the material presented in class	Campus (n = 101)	14.1	49.5	28.3	8.1	0.0
	Distance (n = 49)	39.2	49.0	3.9	5.9	2.0
	Both (n = 150)	22.7	49.3	20.0	7.3	0.7
The EPI helped me to see the big picture	Campus (n = 101)	0.0	7.1	26.3	42.6	18.2
	Distance (n = 49)	2.0	2.0	5.9	52.9	37.3
	Both (n = 150)	0.7	5.3	19.3	24.7	50.0
The EPI did not help me to apply the new content	Campus (n = 101)	13.1	50.5	27.3	9.1	0.0
	Distance (n = 49)	29.4	56.9	5.9	5.9	2.0
	Both (n = 150)	18.7	41.3	30.7	5.3	4.0
The EPI made the online handout more fun/enjoyable to read	Campus (n = 101)	3.0	1.1	33.3	41.4	16.2
	Distance (n = 49)	5.9	9.8	25.5	41.2	23.5
	Both (n = 150)	0.7	8.0	20.0	52.7	20.0
The EPI did not improve my performance on the third exam	Campus (n = 101)	3.0	12.1	72.7	11.1	1.0
	Distance (n = 49)	5.9	11.1	74.5	3.9	5.9
	Both (n = 150)	4.0	11.3	73.3	8.7	2.7
The EPI is well suited to this type of course.	Campus (n = 101)	2.0	0.0	19.4	53.1	25.5
	Distance (n = 49)	0.0	1.4	9.8	47.1	43.1
	Both (n = 150)	1.4	0.0	16.1	51.0	31.5
The EPI should not be included in every course in the curriculum	Campus (n = 101)	10.1	32.3	34.3	15.2	8.2
	Distance (n = 49)	15.7	39.2	21.5	15.7	15.7
	Both (n = 150)	12.0	34.7	30.0	15.3	8.0

[a] Scale responses: strongly disagree (SD), disagree (D); neutral (N); agree (A); strongly agree (SA).

Table 5. Student Perception of the Impact of the Extra Credit Exercise

Evaluation Item	Pathway	% Student[a] SD	D	N	A	SA
Helped me to value the importance of science courses in the curriculum	Campus (n = 88)	0.0	3.4	38.6	44.3	13.6
	Distance (n = 35)	0.0	2.9	28.6	51.4	17.1
Helped me to integrate prerequisite content with new content	Campus (n = 88)	0.0	4.6	35.6	41.1	18.4
	Distance (n = 35)	0.0	2.9	23.6	47.1	26.5
Helped me to apply the new content	Campus (n = 88)	1.2	3.5	34.1	48.2	12.9
	Distance (n = 35)	2.9	2.9	17.6	50.0	29.4
Improved my performance on the final exam	Campus (n = 88)	0.0	3.5	82.6	11.6	3.5
	Distance (n = 35)	0.0	0.0	88.2	8.8	2.9
Should be a required component of the course	Campus (n = 88)	4.7	25.6	52.1	14.0	3.5
	Distance (n = 35)	2.9	23.5	50.0	20.8	2.9

[a] Scale responses include: strongly disagree (SD), disagree (D); neutral (N); agree (A); strongly agree (SA).

tively, rated the impact of the embedded online handouts on their learning as slightly positive or positive (Table 2). An average of less than 2% of both student cohorts rated the impact as slightly negative or negative.

Student Performance

There was no significant difference ($P < 0.05$) in student performance on examination 3 (embedded) with student performance on examination 1 (not embedded). Performance on the 2 examinations was also comparable to student performance in spring 2007 (Table 3). This is also reflected in student responses that ''the EPI did not improve my performance on the third exam,'' where the majority of the campus and distance students were neutral (72.7% and 74.5, respectively), and only 15.1% of the campus students and 17% of the distance students disagreed or strongly disagreed (Table 4).

General Impact of the EPI

Table 4 summarizes students' perceptions of the impact of EPI based on the psychometric Likert scale that ranged from strongly disagree, disagree, neutral, agree, to strongly agree. In general, distance students viewed the impact of EPI more positively than campus students; despite that distance students had access to faculty members via e-mail, phone, and regular online conferencing. On the positively worded items, a cumulative average of 68% of campus students compared to 89.5% of distance students agreed or strongly agreed that EPI helped them value the content of prerequisite courses, integrate prerequisite content with current content, and see the ''big picture.'' Less than, a cumulative average of 4% of both student cohorts answered disagree or strongly disagree on the above evaluation criteria. For those items that were worded negatively, a cumulative average of 63.3% of campus students compared to 87.9% of distance students disagreed or strongly disagreed that EPI did not help to value the importance of science courses in the curriculum, did not help to better relate to the material presented in class, and did not help to apply the new content (Table 4). Further, 78.6% of campus students and 90% of distance students agreed or strongly agreed that EPI was well suited for this type of course, while only 23.4% of campus students and 31.4% of distance students answered the same to the item ''the EPI should not be included in every course in the curriculum,'' with the majority of both cohorts (42.4% and 54.9%, respectively) disagreeing or strongly disagreeing (Table 4).

Effect on Learning

With vs. without EPI. When asked to compare EPI sessions to those without EPI, 57% of the campus students and 73% of the distance students who completed the survey agreed or strongly agreed that the sessions on the CNS drug class with the EPI were more helpful than the previous sessions on the antimicrobial drug class without EPI (data not shown). In addition, 56% and 47%, respectively, perceived the EPI sessions easier to follow. Further, 92% of the campus and distance students indicated that they agree or strongly agree that EPI in this course encouraged them to use similar strategies for curriculum integration in other courses.

Student comments supported many of the above findings for both campus and distance students. Comments from both cohorts included: ''very beneficial,'' ''made me want to read the packets,'' ''helped to integrate/tie content from other courses,'' ''allowed [me] to go back to previous information that I could not remember,'' ''made me realize my strengths and weaknesses.''

''Quiz Me'' questions. When asked about the value of the ''Quiz Me'' questions in the online lesson handout, 63% of campus and 85% of distance students agreed or strongly agreed that the questions were helpful to their learning, while less than 5% of both cohorts disagreed or strongly disagreed. However, only 26% of campus students and 20% of distance students agreed or strongly agreed that the "Quiz Me" questions should include questions from prerequisite information. Approximately 42% and 61% of the campus and distance students, respectively, agreed or strongly agreed that the number of "Quiz Me" questions should be increased, while 20% of both cohorts disagreed or strongly disagreed. Students' comments on the "Quiz Me" questions were also positive, with many commenting on how it helped them to gauge their understanding of prior and new content, and how the immediate feedback reinforced their learning.

Extra credit. The perception of those students who completed the extra credit activity on the assignment's impact is summarized in Table 5. In general, campus and distance students who performed at all levels in the course elected to do this exercise. Campus (n = 88) and distance (n = 35) students who completed the extra credit agreed or strongly agreed that the extra-credit exercise helped them value the importance of science courses in the curriculum, integrate prerequisite content with the new content, and apply the new content (58% vs. 68.5%, 60% vs. 73.5%, 61% vs. 79%, respectively). However, when asked if the extra credit exercise improved their performance on the examination, the majority of both campus and distance students answered "neutral" (83% and 88%, respectively). Only 15% of campus students and 12% of distance students agreed or strongly agreed that the exercise improved their performance. Finally, 17.5% of campus students and 23.7% of distance students agreed or strongly agreed that the extra credit exercise should be a required component of the course. Several students expressed concerns about the amount of time involved in such an activity.

DISCUSSION

Although students' average examination performance did not improve on the third examination (with EPI) compared to the first examination (without EPI) and compared to examination 3 scores in spring 2007, the results of the survey at the completion of the class indicated positive perceptions of EPI by both campus and distance students.

It was rewarding to see the percentage of students who used EPI resources, even though it was not required and no examination questions were asked involving the embedded content. In the past, as previously discussed, several strategies were incorporated into the course to prompt students to review prior content, eg, inserting statements in the notes, such as "this would be a good point to go back and review your anatomy notes." EPI appears to accomplish curriculum goals more effectively than other strategies, as supported by research showing how different technologies are effective educational tools in curriculum integration, and helping students learn.[29-31] EPI also provided the opportunity to understand "in depth" what other faculty members were teaching and how that content complements other courses. This is important because the Accreditation Council for Pharmacy Education (ACPE) Guideline 10.2 states that the curriculum committee should strive for "awareness by the faculty of each other's courses, including content, depth, methodologies used and relationship to adopted curricular competencies and outcomes."[32] This project addressed some aspects of this mandate by using the technology infrastructure at the SPAHP; in the process, a greater awareness of what other faculty members were teaching was also discovered. Certainly, this mandate will be fulfilled further as additional faculty members utilize this technology. EPI helped identify why certain courses are, or should be, prerequisite to other courses. Further, it has provided us with a practical tool to shift the pedagogical paradigm to more emphasis on connections/integration rather than separation and discontinuity, prompting students to do the same, as supported by 92% of both student cohorts indicating that they would integrate such strategies in other courses. Although scores from the first to the third examination did not improve, students have been performing generally at a higher level over the last few years. Students' examination percentage scores have averaged in the low-80s for the last few years compared to the mid-70s range in previous years.[12,14] Several strategies have been incorporated over the last 4 years to transition students to the higher level of thinking required in this course, which also may have contributed to enhanced performance.[12,14]

Distance students viewed the impact of EPI on their learning more positively than campus students. The difference in ages (31 vs. 23 years of age), and the percent of distance students with degrees (82% vs. 46%), may explain this. This viewpoint may also be a reflection of how distance students learn, and their dependence on technology, while campus students may put more emphasis on classroom presentations. Several of the campus students commented that they depend more on lectures and printed notes, although some of them still commented that EPI was "useful" and was a "good idea." The overall positive response by both campus and distance students indicates that the students perceived value in EPI to help them appreciate prerequisite content, science courses, and see the "big picture." This is important because ACPE standards and guidelines stress the need to revisit science courses later in the curriculum because the relevance of courses may not be as apparent when students take them early in the curriculum.[32]

Based on students' overall responses, 2 students were recruited as part of a research summer grant to embed the content from all courses in fall and spring semesters with prerequisite online content from other courses taught earlier, and with content to be taught later. In addition, the "Quiz Me" questions were increased to 10 per lesson, and 2 more questions were added about prerequisite content. The preliminary response of students from the fall semester of 2008 cardiovascular drug class was very positive.

Undertaking this project was well planned. The SoftChalk software was intuitive, easy to master, and compatible with 2 online Learning Management Systems, FrontPage and ANGEL (ANGEL Learning, Indianapolis, IN, http://angellearning.com). The time invested upfront was extensive and certainly seeking students to assist with the process was very helpful. The process was standardized so that all the linking and pop-up windows were consistent. For example, during the summer of 2008, we made a decision that all links to prior lesson handouts or PowerPoint presentations in prerequisite courses will be made after downloading them to a designated folder on the instructors' computer. This was deemed important because the links may not be accessible if the prerequisite courses Web sites are not up or if our learning management system changes. Also, all trade names of drugs in the online handout were linked to the package insert, while the generic name was linked to an audio file pronouncing the name of the drug.

Approval of faculty members from prior and subsequent years of the curriculum was obtained. This was not an easy process. A meeting with all faculty members teaching in prior years was held, and a detailed e-mail of project goals and rationale was also sent to all faculty members, including those teaching in subsequent years. Although the majority of faculty members agreed to provide access to their course content, some faculty (mainly those contracted from the medical school to teach science pharmacy courses) felt strongly that this promoted complacency among students; other faculty members cited academic freedom. For those courses for which links were not provided, governmental Web sites, library resources, and other reputable sites were included to make the handout more complete. Although students did not comment negatively about these sites, the preference was and is that students have access to content from courses taught by faculty experts in our curriculum. To educate the faculty about our experience, results were shared with the college's SPAHP curriculum and assessment committees, with faculty at department meetings, and through a university-wide seminar presentation. More faculty members are interested in utilizing the software, and 4 have incorporated it into their courses. Our goal is that all faculty members will be willing to share online resources to fully integrate the curriculum electronically.

This project has many implications for pharmacy education and education in general. It challenges faculty members to think about innovative ways to present course content, integrate content with other disciplines, and assess how their teaching methodology, including the use of technology, is contributing to student learning. Technology in higher education is increasing; therefore, research in how technology can help address issues such as accreditation guidelines and standards, curriculum mapping, and curriculum integration is of great importance and should be vigorously pursued.

CONCLUSION

The embedded prerequisite information (EPI) pedagogy has been a rewarding experience for both faculty members and students. EPI has the potential to serve as a model for embedding prerequisite information in courses throughout the PharmD program, providing a mechanism to (1) map our curriculum vertically and horizontally; (2) optimize sequencing of content; and (3) reiterate and integrate critical knowledge. As part of the current curricular renovation to ensure that educational outcomes are congruent with contemporary pharmacy practice, this model can also provide a mechanism for the next step of curricular renovation: redesigning courses within the curriculum to ensure that all educational outcomes are covered, sequenced appropriately, and integrated at progressively higher cognitive levels as the students progress through the program. In addition, EPI opened communication with other faculty members within the school, leading to discussion of key concepts regarding our curriculum. Further, the model contributed to collaboration among faculty members within and outside of the school and opportunities for better understanding and for joint scholarly activities/efforts.

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