The Flipped Classroom: A Course Redesign to Foster Learning and Engagement in a Health Professions School

Jacqueline E. McLaughlin, PhD, MS, Mary T. Roth, PharmD, MHS, Dylan M. Glatt, Nastaran Gharkholonarehe, PharmD, Christopher A. Davidson, ME, LaToya M. Griffin, PhD, Denise A. Esserman, PhD, and Russell J. Mumper, PhD

Abstract

Recent calls for educational reform highlight ongoing concerns about the ability of current curricula to equip aspiring health care professionals with the skills for success. Whereas a wide range of proposed solutions attempt to address apparent deficiencies in current educational models, a growing body of literature consistently points to the need to rethink the traditional in-class, lecture-based course model. One such proposal is the flipped classroom, in which content is offloaded for students to learn on their own, and class time is dedicated to engaging students in student-centered learning activities, like problem-based learning and inquiry-oriented strategies.

In 2012, the authors flipped a required first-year pharmaceutics course at the University of North Carolina Eshelman School of Pharmacy. They offloaded all lectures to self-paced online videos and used class time to engage students in active learning exercises. In this article, the authors describe the philosophy and methodology used to redesign the Basic Pharmaceutics II course and outline the research they conducted to investigate the resulting outcomes. This article is intended to serve as a guide to instructors and educational programs seeking to develop, implement, and evaluate innovative and practical strategies to transform students' learning experience.

As class attendance, students' learning, and the perceived value of this model all increased following participation in the flipped classroom, the authors conclude that this approach warrants careful consideration as educators aim to enhance learning, improve outcomes, and fully equip students to address 21st-century health care needs.

In recent years, colleges and universities in the United States have faced considerable scrutiny for their apparent failure to adequately educate students. Studies suggest that a significant portion of students are not learning the critical thinking, written communication, and complex reasoning skills thought to be at the core of higher education.[1] In addition, college graduates with smaller gains in critical thinking skills have higher unemployment rates, report lower lifestyle satisfaction, and amass higher credit card debt than their more accomplished peers.[2] Ongoing concerns about the quality of higher education have prompted numerous calls for reform,[1,3,4] drawing attention to the need to transform traditional curricula to better prepare students for success in today's global economy.

Medical, nursing, and pharmacy schools all have been challenged to better prepare their students to meet the evolving health care needs of society.[5–8] Since the 1910 Flexner report,[9] the amount of information about health and medicine has grown significantly, the health care system has become increasingly complex, patients have become more engaged in their care, and educational innovations in technology and pedagogy have grown rapidly. Yet, little has changed in the way that education is structured and delivered to aspiring health professionals, and in-class lectures continue to prevail in the vast majority of classrooms across the country.[10]

A growing body of literature consistently points to the need to rethink what is taking place in the classroom. Research shows that students' attention declines substantially and steadily after the first 10 minutes of class[11,12] and that the average attention span of a medical student is 15 to 20 minutes at the beginning of class.[13] Although students' attention returns in the last few minutes of class,[14] they remember only 20% of the material presented during that time.[15] Furthermore, passive learning in hourlong lectures often bores students and can deprive them of rich educational experiences.[16] Students can read and learn information on their own, but they need instructors to act as coaches and mentors to stimulate and challenge their thinking, guide them in solving problems, and encourage their learning and application of the material.[17]

Active learning exercises, such as teamwork, debates, self-reflection, and case studies, that prompt students' engagement and reflection encourage them to explore attitudes and values, while fostering their motivation to acquire knowledge and enhance skills.[18] Evidence shows that engaging students in active learning enhances their learning outcomes and improves their motivation and attitudes.[19–21] Moreover, active learning stimulates higher-order thinking, problem solving, and critical analysis while providing feedback to both the student and instructor.[21,22]

Developments in active learning pedagogy, coupled with advancements in instructional technology, have prompted some educators to implement a radical, yet intuitive, educational

Please see the end of this article for information about the authors.

Correspondence should be addressed to Dr. Mumper, UNC Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, CB 7355, 100G Beard Hall, Chapel Hill, NC 27599-7355; telephone: (919) 966-1271; e-mail: mumper@email.unc.edu.

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model called the flipped classroom.[17,23] In the flipped classroom (also known as the reverse, inverse, or backwards classroom), instructors prerecord lectures and post them online for students to watch on their own so that class time can be dedicated to student-centered learning activities, like problem-based learning and inquiry-oriented strategies.[17,23–25] This approach provides instructors with opportunities to engage a wide range of learning styles and implement pedagogies that encourage problem solving during dedicated class time. In addition, flipping the classroom empowers instructors to develop different learning experiences appropriate for each student.[17]

Most important, the flipped classroom model is student-centered. Each student is responsible for coming to class with a basic understanding of the material, so that she or he can fully participate and engage in class discussion. Content acquisition then is self-paced and self-guided, enabling students to control when and how much content they view. To facilitate learning, instructors guide students to the content, organize interactive experiences, challenge students to think creatively, and provide expert insight and feedback. Rich, open-ended experiences within the classroom equip students for success by fostering critical cognitive development and promoting innovation through collaboration.[17]

In spring 2012, in the highly collaborative Project 4-1-1 Flip, we flipped a graduate-level health professions course in pharmaceutics required for first-year pharmacy students. The purpose of this article is to describe the philosophy and methodology used in the course redesign and to outline the research we conducted to investigate the outcomes of this project. This article is intended to serve as a guide to instructors and educational programs seeking to develop, implement, and evaluate innovative and practical strategies to transform the learning experience in a large cohort of students within a health professions learning environment and beyond.

Course Redesign

Our course redesign was inspired by a desire to transform the educational experiences of our students and to meet students' requests for enhanced in-class active learning exercises.[26,27] At the time, an increasing number of classroom innovations were permeating the University of North Carolina (UNC) Eshelman School of Pharmacy as the result of a collective awareness that the methodologies employed in our classrooms, which consisted mainly of traditional lectures, had remained largely unchanged for decades. The goals of our course redesign were to (1) improve students' learning and develop students as critical thinkers, problem solvers, and team players; (2) fully engage students and instructors throughout the learning process; and (3) stimulate higher-order thinking through the use of creative technologies and applied learning.

Course description

The UNC Eshelman School of Pharmacy four-year professional program requires six semesters of course work in the classroom and 10 months of experiential practice. The approximately 120 full-time faculty and 620 doctor of pharmacy students are housed on three campuses (the main UNC campus in Chapel Hill and satellite campuses in Elizabeth City and Asheville).

Basic Pharmaceutics II (PHCY 411) is the second course in a yearlong sequence required for first-year professional students. Whereas Basic Pharmaceutics I (PHCY 410) covers the physicochemical principles underlying drugs, PHCY 411 pertains to the science and engineering of the delivery of drugs to the body via complex, specialized, and novel dosage forms intended for administration to the human body by various routes of administration.

In the nine years prior to this course redesign, the course coordinator (R.J.M.) delivered PHCY 411 using a traditional lecture format (see Supplemental Digital Figure 1, http://links.lww.com/ACADMED/A177), which consisted of a 75-minute lecture and an occasional 15-minute active learning activity (quiz or pair & share activity).[28,29] To assess students' knowledge, instructors used examinations—approximately 75% of the questions were multiple-choice, while the remaining were short-answer and essay questions.

New course format

As shown in Figure 1, in the PHCY 411 flipped classroom, we offloaded all in-class lectures to self-paced online videos and filled the scheduled class time with

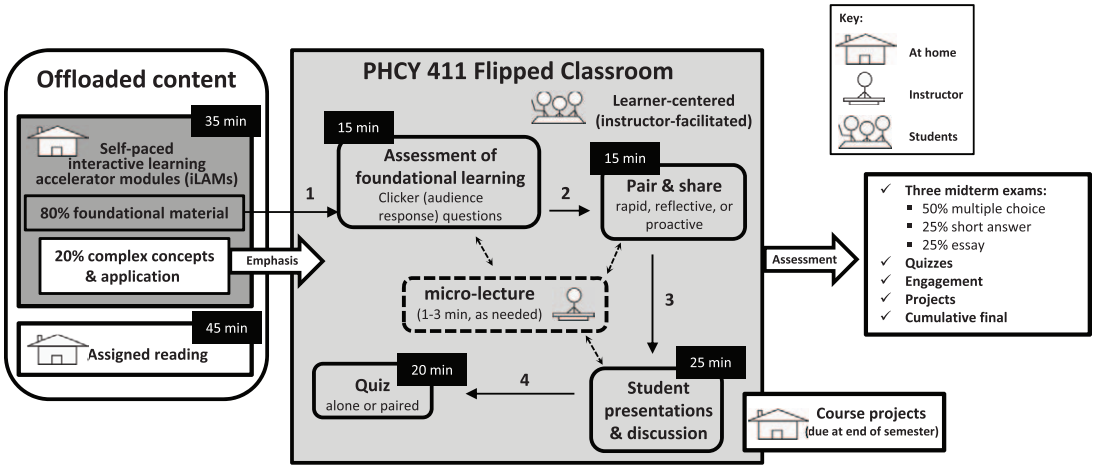

Figure 1 Flipped classroom format for the Basic Pharmaceutics II (PHCY 411) course offered in 2012 at the University of North Carolina Eshelman School of Pharmacy. Important features included offloaded content and student-centered learning which were designed to align with Bloom's Taxonomy of Learning.[33,34]

four active learning exercises. Assessment in the flipped classroom included a rich mixture of instruments designed to encompass more critical thinking and problem-solving exercises. The goals were to provide students with fundamental concepts prior to class, create opportunities for them to apply these concepts through course activities, assess their understanding and application of course concepts, and instill in them a desire to learn more.

Following an extensive literature review and consultations with experts in educational technology and pedagogy, we focused on three essential elements in our PHCY 411 flipped classroom: offloaded content, student-centered learning, and appropriate assessment.

Offloaded content. At the UNC Eshelman School of Pharmacy, we refer to offloaded course content as an integrated learning accelerator module (iLAM).[26,27] We prerecorded 25 content-focused iLAMs using Echo360 Classroom Capture[30] and offloaded them to a Web site embedded in Sakai,[31] a Web-based learning management system that students could access at any time on any computer or Internet-enabled device.[31] Students had the ability to pause, rewind, and fast forward the videos and were allowed to view each iLAM multiple times, which enabled students to learn at their own pace. We adapted the iLAMs from PowerPoint slides used to deliver PHCY 411 in 2011 and designed them to emphasize only critical concepts, information, and illustrations.

One particular challenge in developing the final content-focused iLAMs was consolidating about 29 hours of lectures used in previous years. However, we deemed this step necessary both to minimize students' out-of-class preparation time and to emphasize only the critical concepts students needed to learn prior to coming to class. The average length of each iLAM was 34.6 minutes (range of 21–55 minutes), with a total viewing time for all 25 lectures of 14.4 hours.

Student-centered learning. With prerecorded iLAMs and assigned textbook and background readings designated as preparatory tools for students prior to class, every in-class period was devoted to student-centered learning exercises designed to assess their knowledge, promote critical thinking, and stimulate discussion. In general, each 75-minute class accommodated the following activities (see Figure 1).

Activity #1 (audience response and open questions).[28,29] We assessed students' understanding of the basic concepts presented in the assigned iLAMs and readings at the beginning of class using clicker (or audience response) questions and open questions. The UNC Eshelman School of Pharmacy requires that all students purchase a clicker on acceptance into the program. During class, the instructor gave students approximately 30 seconds to respond to each of 7 to 10 questions. The instructor then analyzed the responses and provided immediate feedback and perspective. Following the clicker questions, the instructor invited questions from students that addressed content provided in the iLAMs, readings, or other related sources.

Activity #2 (pair & share activities).[28,29] Each class included one of three different types of pair & share activities: rapid, reflective, or proactive. In rapid pair & share activities, the instructor presented a discussion question in class and gave students time to pair together and share ideas with one another. The students then presented their ideas to the class as requested by the instructor, who then followed up with feedback, perspective, and expanded discussion. In contrast, the instructor posted reflective pair & share questions online 24 to 36 hours before class in the forum section of the course Web site, and students were required to provide a structured and well-thought-out answer (<400 words, with references if needed) prior to the next class. The instructor selected certain responses to reflective pair & share questions and presented them for discussion during class. Finally, student volunteers prepared proactive pair & share questions. In this exercise, one or two students, with input from the instructor, were responsible for designing, preparing, and moderating a discussion related to the class topic. In essence, they functioned as the instructor during the corresponding in-class exercise. Total execution of the proactive pair & share exercise took 5 to 7 hours.

Activity #3 (student presentations and discussion). In this activity, one group of four or five students was responsible for presenting a summary and interpretation of the assigned readings and answering other students' questions about material related to that class's topic. For each class, up to three groups were asked to prepare and submit presentation materials. By a dice roll, the instructor randomly selected one of those three groups to present and lead the in-class discussion. All groups were graded on their presentation materials regardless of whether they were selected to present, and all students in each group received the same grade. Groups were required to prepare presentation materials twice during the semester, and the average total work for each student was three to five hours for each preparation. The majority of groups presented once; only two groups were chosen to present twice.

Activity #4 (individual or paired quiz). At the end of each class, the instructor administered a 10-question multiple-choice quiz on paper; then, he selected the quizzes from eight classes to grade based on overall student workload and exam schedule. At the time the quiz was administered, the instructor notified the students whether it would contribute to their final grade. Each quiz covered only that class's material, and, in some cases, students were permitted to work in pairs and openly discuss the questions. This activity encouraged students to stay current with the course content and learn from one another, and provided valuable feedback to the instructor as the course progressed.

Microlectures.[32] A critical component of the PHCY 411 flipped classroom was the microlecture, used by the instructor to reinforce and, if needed, redirect students' learning. These microlectures were typically one to three minutes in length and were incorporated when needed on the basis of classroom dynamics. Not only did the microlectures provide an opportunity for the instructor to bring the students back to a "good place" from the chaos of an active learning environment but they also reinforced the idea that students could, in fact, explore and extend themselves knowing that the instructor would provide clarity and perspective when confusion ensued.

Appropriate assessment. Appropriate assessment was a central tenet of the course redesign. Active engagement activities, like clicker questions and pair & share activities, enabled instructors to make real-time, formative assessments of students' learning and provide immediate feedback concerning misconceptions or gaps in students' knowledge. Students' presentations (worth 1.6% of the final grade), eight graded quizzes (worth a total of 12.9%), three scheduled examinations (each worth 16.1%), and one comprehensive and cumulative final examination (worth 32.3%) assessed students' understanding of the course content and measured students' ability to achieve desired learning outcomes and objectives.

Two projects assigned at the beginning of the semester provided additional practice opportunities, encouraged higher-order thinking, and assessed students' ability to analyze, synthesize, and evaluate material, consistent with the top of Bloom's Taxonomy of Learning.[33,34] The first project (package insert analysis, worth 4.8%) required students to apply the concepts they learned in PHCY 410 and PHCY 411 to the prescribing information of a Food and Drug Administration–approved product. The second project (clinical pharmaceutics proposal outline) asked students to identify a clinical shortcoming, design a dosage form for treatment, and write a three-page research proposal outline. However, prior to the end of the course, we converted this second project to an optional bonus exercise worth up to an additional 3.2%. At the beginning of the course, the instructor posted examples of both projects to the course Web site.

Finally, students received bonus points for responding online to reflective pair & share questions (worth up to an additional 1.6%) or facilitating a proactive pair & share activity (worth up to an additional 3.2%).

Course implementation

In 2012, the redesigned PHCY 411 was delivered to 162 students. Twenty-two students attended the course synchronously via video teleconference from two satellite campuses (15 from Asheville and 7 from Elizabeth City) while the remaining 140 students met in a large lecture hall in Chapel Hill. The course met over 13 weeks on Monday and Wednesday mornings for a total of 25 classes (each lasting 75 minutes), not including four additional classes for the three midterm exams and a cumulative final exam. The instructors facilitated 23 classes from the Chapel Hill campus, 1 class from the Asheville campus, and 1 class from the Elizabeth City campus. The course coordinator (R.J.M.) was responsible for facilitating 19 classes and for offloading the majority of the course content, using the Echo360 Classroom Capture software.[30] Attendance in class was recommended but not required, and all classes were recorded using Echo360 for students to access at any time.

We recognized that the flipped classroom was likely a new experience for most students. To ease their transition, we provided a comprehensive syllabus that included a thorough description of the course and an explanation detailing our motivation for the redesign. In addition, we provided a guide with tips for success in the course, which emphasized our expectations that the students would review the offloaded material prior to each class and would actively engage in the in-class exercises.

Throughout the semester, we closely monitored the students' ability to balance the course workload under this new format. We were committed to facilitating students' exploration of the course material in this new dynamic environment without burdening them or limiting their opportunities. We recognized that students had to invest time upfront and continuously during the semester, but we believed that this investment paid dividends as it required students to spend less time studying prior to exams. By routine, informal student polling, we ensured that the total out-of-class time per credit hour was consistent with UNC guidelines. In response to students' feedback, for example, we chose about three-quarters of the way through the semester to convert the clinical pharmaceutics proposal outline project into an optional bonus exercise to better balance students' workload.

When implementing the flipped classroom, we recommend that faculty time and resources also be taken into consideration. In 2012, faculty needed 127% more time to prepare the flipped classroom than they needed in 2011 to prepare the traditional classroom (see Supplemental Digital Table 1, http://links.lww.com/ACADMED/A177). We attributed this increase in time commitment (93% for the teaching assistant and 170% for faculty) to the extra time required to capture lectures, prepare active learning exercises, and grade projects and examinations. However, the ability to reuse resources and greater efficiencies incorporated into the course design will reduce these time commitments in 2013.

Our flipped classroom model required a highly trained teaching assistant, who, except for class facilitation, functioned at the level of efficiency and expertise of the instructor, especially as it related to providing thoughtful written feedback. Our model also required that the teaching assistant work full-time, committing 20 hours per week (or about 260–270 hours per semester) to the course. In both 2011 and 2012, the teaching assistant was a full-time PhD student in the Division of Molecular Pharmaceutics who attended classes, held office hours, communicated with students, and prepared and graded assignments (see Supplemental Digital Table 1, http://links.lww.com/ACADMED/A177).

Although faculty will see a significant drop in time commitment in 2013 compared with 2012, the teaching assistant's time commitment will be about the same. We realize that many medical schools do not employ teaching assistants. However, we offer that medical schools may address this gap by employing senior medical students who already have completed the course and/or PhD students who are enrolled in graduate medical programs and have expressed a desire for teaching experience.

Course Outcomes

Examining how students perform in and perceive the flipped classroom is imperative for understanding the impact of this innovative approach to classroom education. Following approval from the UNC institutional review board, we administered a survey prior to the start of PHCY 411 in 2012 to collect students' demographic information, perceptions of active learning activities, preference for

delivery format, and typical engagement behavior. We administered another survey examining the same constructs at the end of the course. That year, we also collected data on the number of times each student logged into the course Web site, the number of times each student accessed the iLAMs, the number of iLAMs each student reported watching, and the number of times each student completed the three optional extra credit exercises. In addition, in 2011 and 2012, we tracked the final exam grades and standard end-of-semester course evaluation scores.

Participation in the pre- and postcourse surveys was voluntary; however, participation in the course evaluation was required to receive a grade in the course. Because we did not collect identifiers and demographic information on the course evaluations, we could not link students' responses to any other collected data. We conducted all quantitative data analysis in SPSS, version 20 (IBM, Armonk, New York). Here, we present continuous data as mean ± standard deviation (SD). We used paired *t* tests to compare pre- and postcourse survey responses, independent *t* tests to compare course evaluation responses and final exam scores for the 2011 and 2012 students, and Pearson rho to investigate correlations between continuous variables. We established statistical significance at $\alpha = .05$.

In 2012, 150 of the 162 students completed the pre- and postcourse surveys; 104 were female, 111 were white, 121 held at least a bachelor's degree, 131 came from a science, technology, engineering, or mathematics (STEM) background, and the mean age was 23.91 ± 4.00 years (see Table 1 for complete 2011 and 2012 demographics). All students completed the course evaluations (162 in 2012 and 153 in 2011).

Of survey respondents in 2012, 82.0% reported listening to all 25 iLAMs, while an additional 15.3% reported listening to 20 to 24 iLAMs. Next, 79.3% reported watching iLAMs more than once a week, with an additional 19.3% reporting watching one iLAM per week. On average, students accessed the course Web site 194.09 ± 90.02 times and the iLAM site 39.37 ± 16.84 times throughout the semester. All correlations between online engagement measures and final exam performance were weak ($r_p = -0.04$ to $r_p = 0.20$). The correlation between the number of completed extra credit activities and raw final course grade was moderate ($r_p = 0.34$).

Students from the flipped classroom were more likely than students from the traditional classroom to agree that active student engagement was consistently encouraged by the instructor ($P < .001$) and that preparation for class was necessary to be successful ($P < .001$, see Table 2). On the 2012 course evaluation, 91.2% of students agreed or strongly agreed that learning materials and resources were helpful, 93.1% agreed or strongly agreed that teaching and learning methods in the flipped classroom promoted understanding and application of key concepts, 95.6% agreed or strongly agreed that they were confident in their ability to apply the knowledge and skills they developed, and 98.1% agreed or strongly agreed that the knowledge and skills they developed would be relevant for the future. Furthermore, attendance was higher in the flipped classroom ($P = .03$), and an independent *t* test showed a statistically significant difference ($P = .001$) between final exam grades (out of 200 points) in 2012 (165.48 ± 13.34) compared with those in 2011 (160.06 ± 14.65).

Table 3 details changes in students' perceptions of educationally purposeful activities prior to and following participation in the flipped classroom. Paired *t* tests revealed a significant increase in students' responses to the following items: prerecorded iLAMs greatly enhanced my learning ($P < .001$); learning key foundational content prior to coming to class greatly enhanced learning of course material in class ($P < .001$); interactive, applied in-class activities greatly enhanced my learning ($P < .001$); I participated and engaged in discussions in class ($P < .001$); and in-class discussions of course concepts with my peers greatly enhanced my learning ($P < .001$). In contrast, we found significant decreases in students' responses to items measuring learning enhancement from assigned readings ($P < .001$) and completing the assigned readings prior to coming to class ($P < .001$).

When students were asked on the postcourse survey to select up to three ways that the availability of iLAMs provided the most benefit, 90.0% indicated that the iLAMs "helped me prepare for each class session," 58.0% indicated that the iLAMs "allowed me to learn at my own pace," 47.3% indicated that the iLAMs "helped me prepare for the exams," and 47.3% indicated that the iLAMs "improved my overall learning." Ninety-one percent of students strongly agreed or agreed that the overall course format of the flipped classroom greatly enhanced their learning. Preference for the traditional lecture format decreased from 109 students (72.7%) in the precourse survey to 23 students (15.4%) in the postcourse survey, while preference for the flipped classroom format increased from 41 students (27.3%) to 126 students (84.6%)

Table 1

Demographic Characteristics of Students Who Completed the Basic Pharmaceutics II Course in 2011 and 2012 at the University of North Carolina Eshelman School of Pharmacy*

Characteristic	2011 (n = 153)	2012 (n = 162)
Incoming GPA, mean (SD)†	3.45 (0.33)	3.46 (0.32)
PCAT, mean (SD)†	82.31 (11.23)	79.94 (10.78)
Gender, %		
Male	38%	31%
Female	62%	69%
Ethnicity, %		
White	68%	74%
Other	32%	26%

*GPA indicates grade point average; PCAT, Pharmacy College Admission Test; SD, standard deviation.
†No significant differences found between years.

Table 2

Comparison of Course Evaluation Responses Between Students Who Completed the Basic Pharmaceutics II Course in 2011 (Traditional Format) and 2012 (Flipped Classroom Format) at the University of North Carolina Eshelman School of Pharmacy*

Course evaluation response	2011 (n = 153) mean ± SD	2012 (n = 162) mean ± SD	*P* value
Active student engagement was consistently encouraged by instructors.	3.51 ± 0.59	3.78 ± 0.46	<.001
Learning materials and resources were helpful.	3.27 ± 0.80	3.37 ± 0.68	.25
Teaching and learning methods promoted understanding and application of key concepts.	3.58 ± 0.57	3.54 ± 0.70	.54
I had to prepare for class in order to be successful.	3.32 ± 0.69	3.75 ± 0.54	<.001
The instructor encouraged active student participation in class.	3.66 ± 0.57	3.82 ± 0.39	.005
I believe that the knowledge and skills developed in this course will be relevant for me in the future.	3.49 ± 0.59	3.54 ± 0.56	.44
I am confident in my ability to apply knowledge and skills developed in this course.	3.33 ± 0.55	3.46 ± 0.62	.07
Approximately what percentage of class did you attend?†	3.87 ± 0.50	3.96 ± 0.19	.03
What is your overall rating of this course?‡	3.56 ± 0.61	3.61 ± 0.67	.47

*SD indicates standard deviation. Likert scale items measured on a four-point scale ranging from (1) strongly disagree to (4) strongly agree, unless otherwise noted.
†Likert scale items measured on a four-point scale: 1 = less than 25%; 2 = 25%–50%; 3 = 51%–75%; 4 = 76%–100%.
‡Likert scale items measured on a four-point scale: 1 = poor; 2 = fair; 3 = good; 4 = excellent.

($P < .001$, see Figure 2). No students changed their preference from the flipped to traditional format.

On the 2012 course evaluation, students articulated the value of the iLAMs and active learning experiences despite their initial apprehension (see Supplemental Digital List 1, http://links.lww.com/ACADMED/A177). However, many students also recommended changes to the format, primarily focusing on the assigned readings and specific active learning exercises. Student feedback along with faculty experiences will be used to inform future course changes.

Table 3

Students' Perceptions of Learning Enhancement and Engagement Activities Prior to and Following Participation in the 2012 Basic Pharmaceutics II Flipped Classroom at the University of North Carolina Eshelman School of Pharmacy*

Survey question	Precourse mean ± SD	Postcourse mean ± SD	*P* value
Lectures greatly enhance my learning/Prerecorded lectures greatly enhanced my learning.	3.29 ± 0.62	3.67 ± 0.53	<.001
Learning key foundational content prior to coming to class greatly enhances(d) my learning of course material in class.	2.85 ± 0.68	3.57 ± 0.63	<.001
Interactive, applied in-class activities greatly enhance(d) my learning.	2.80 ± 1.08	3.39 ± 0.72	<.001
I participate(d) and engage(d) in discussions in class.	2.66 ± 0.71	2.97 ± 0.63	<.001
In-class discussions of course concepts with my peers greatly enhance(d) my learning.	2.53 ± 0.93	3.05 ± 0.76	<.001
I read assigned readings prior to coming to class.†	2.29 ± 0.77	1.67 ± 0.89	<.001
Assigned readings from textbooks/articles enhance(d) my learning.	2.53 ± 0.71	2.17 ± 0.79	<.001

*Data based on 150 pre- and postcourse survey responses. SD indicates standard deviation. Likert scale items measured on a four-point scale ranging from (1) strongly disagree to (4) strongly agree, unless otherwise noted.
†Likert scale items measured on a five-point scale: 1 = never; 2 = rarely; 3 = some of the time; 4 = most of the time; 5 = all of the time.

Next Steps

We believe that offloading content, engaging students in active learning, and appropriately assessing performance are essential for enhancing students' learning experiences in the flipped classroom. Improved outcomes in the flipped classroom can be explained, in part, by self-determination theory, which identifies autonomy, relatedness, and competence as the innate needs for intrinsic motivation.[35] By offloading content, our flipped classroom encouraged students to explore the material and develop new skills on their own, with the understanding that they would apply this new knowledge through various active learning exercises during class. Active learning in the form of applied activities and in-class discussions with peers and the instructor emphasized relatedness. Furthermore, competence was fostered through robust assessments and feedback that enabled students to identify their own strengths and weaknesses in mastering the content. Improved exam performance and high levels of confidence in their ability to apply knowledge and skills reflect students' enhanced competency.

Although we have specifically described our course redesign approach, we recognize that various offloading, active learning, and assessment approaches are available. For example, offloading may instead use high-level animated eBooks with built-in assessment tools after chapters or modules, captured video, instructor handouts, or textbooks. In addition, a plethora of different tools are available to engage students in active learning in the classroom.[28,29] We believe that the actual practice of offloading content and engaging in active learning in the classroom is far more important than the specific methods we used.

As with any classroom, creating a sustainable, reproducible, and manageable flipped classroom requires adaptation and adjustments. On the basis of our

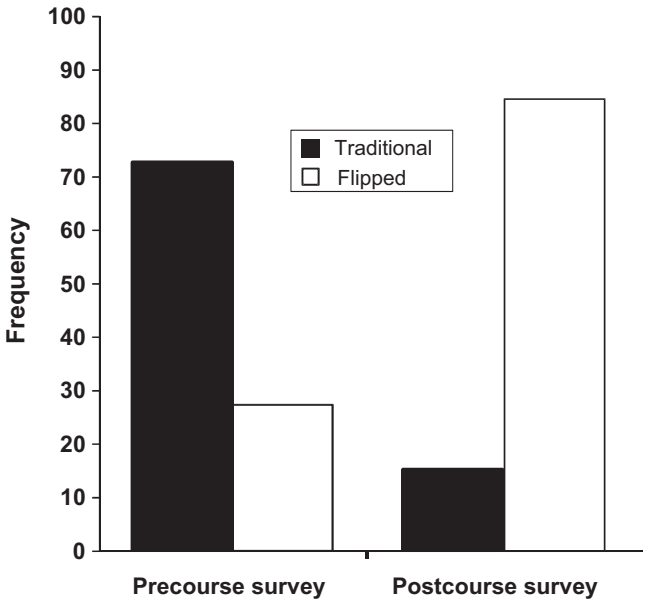

Figure 2 Comparison of students' preferences for the traditional lecture format and the flipped classroom format of the Basic Pharmaceutics II (PHCY 411) course offered at the University of North Carolina Eshelman School of Pharmacy in 2012 before and after participation in the course ($P < .001$).

experiences and the feedback of our students, we have identified a number of new strategies that we believe will enhance students' learning and further foster their motivation. To the spring 2013 PHCY 411, we made the following substantive changes:

1. We no longer considered the textbook to be required reading, because many students found it to be redundant, if not outdated.
2. We replaced the student presentations and discussion with a new 30-minute active learning exercise based on group discussions of 12 contemporary research articles that best apply concepts learned in the course.
3. The instructor administered and graded 20-minute quizzes (taken alone or paired) online outside of class time via the course Web site.
4. The package insert analysis remained a required project; however, on the last day of class, all students reviewed and graded three other students' projects as a learning experience.
5. We developed an online *411 Pharmacopedia* to be used as an information portal for expanding concepts, new technologies, breaking news, current clinical trials, new drug products, and Web links.

Conclusions

In our experience, flipping the traditional classroom is both a feasible and necessary move to educate a large cohort of students on multiple campuses. We believe that fostering meaningful learning is a shared responsibility between students and instructors and that implementing creative solutions can facilitate academic excellence and better prepare our future leaders. We hope that instructors at other schools will use the flipped classroom described here to reinvent their classrooms in a way that empowers students to develop higher-order cognitive skills and to engage in meaningful learning that will ultimately improve the delivery of health care.

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Dr. McLaughlin is assistant professor and associate director, Office of Strategic Planning and Assessment, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina. She was a postdoctoral fellow at the time of the redesign.

Dr. Roth is associate professor and director, Office of Strategic Planning and Assessment, and executive director, The Academy, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina.

Mr. Glatt is a PhD student, Division of Molecular Pharmaceutics, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina. He was teaching assistant for the Basic Pharmaceutics II course at the time of the redesign.

Dr. Gharkholonarehe is a pharmacy resident, REX UNC Health Care, Raleigh, North Carolina. She was a student in the Basic Pharmaceutics II course two years before the redesign.

Mr. Davidson is director, Office of Educational Technology Research and Development, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina.

Dr. Griffin is teaching assistant professor, Brody School of Medicine, East Carolina University, Greenville, North Carolina. She was a postdoctoral research fellow, Office of Educational Technology Research and Development, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina, at the time of the redesign.

Dr. Esserman is instructor in public health, Yale University, New Haven, Connecticut. She was research assistant professor, Departments of Medicine and Biostatistics, University of North Carolina at Chapel Hill School of Medicine, Chapel Hill, North Carolina, at the time of the redesign.

Dr. Mumper is vice dean and professor, Division of Molecular Pharmaceutics, and course coordinator for the Basic Pharmaceutics II course, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina.

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