Articles

The Flipped C...

A Course Red... ...ment in a Health Profes...

McLaughlin, Jacqueline... ...rkholonarehe, Nastaran PharmD; Dav... ...nise A. PhD; Mumper, Russell J. PhD

[Author Information](#)

Dr. McLaughlin is as... ...ng and Assessment, UNC Eshelman School o... ...fellow at the time of the redesign.

Dr. Roth is associate p... ...t, and executive director, The Academy, ...

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.

Your Privacy

To give you the best possible experience we use cookies and similar technologies. We use data collected through these technologies for various purposes, including to enhance website functionality, remember your preferences, show the most relevant content, and show the most useful ads. You can select your preferences by clicking the link. For more information about cookies, please review our **Privacy & Cookie Notice**

Manage Cookie Preferences

Reject All Cookies

Accept All Cookies

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.

- Free
- SDC

Metrics

Abstract

Recent calls for educati   nt curricula to equip aspiring health care pro   posed solutions attempt to address appa   of literature consistently points to th   odel. One such proposal is the flipped c   heir own, and class time is dedicated to eng   m-based learning and inquiry-oriented st

In 2012, the authors flip   of North Carolina Eshelman School of Pha   l used class time to engage students in activ   sophy 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 ... learning enhances their learning outcomes ... ive learning stimulates higher-order ... eedback to both the student and instructor.

Developments in active ... echnology, have prompted some educato... the flipped classroom.[17,23] In the fl... s classroom), instructors prerecord le... that class time can be dedicated to student-... uiry-oriented strategies.[17,23–25] This ... e range of learning styles and implement p... time. In addition, flipping the classroom e... propriate for each student.[17]

Most important, the flip... sible for coming to class with a basic under... d engage in class discussion. Content acq... ontrol when and how much content they view... 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, https://links.lww.com/ACADMED/A177), which consisted of a 75-[...] ty (quiz or pair & share activity).[28,29] To a[...] oximately 75% of the questions were multiple[...] ons.

New course form[...]

As shown in Figure 1, in[...] s to self-paced online videos and filled the sch[...] in the flipped classroom included a ri[...] inking and problem-solving exercises. The g[...] class, create opportunities for them [...] erstanding and application of course co[...]

F1-17
Figure 1:
Flipped classroom [...] in 2012 at the University of Nort[...] luded offloaded content [...] Bloom's Taxonomy of Lear[...]

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 _____ th feedback, perspective, and expan_____ share questions online 24 to 36 hours be_____ ts were required to provide a structured an_____ l) prior to the next class. The instructor sel_____ resented them for discussion during class._____ ions. In this exercise, one or two stu_____ ing, preparing, and moderating a discussion_____ ructor during the corresponding in-class _____ k 5 to 7 hours.

*Activity #3 (student pre_____ ive students was responsible for presenti_____ swering other students' questions abo_____ groups were asked to prepare and submit p_____ cted one of those three groups to present _____ presentation materials regardless of _____ oup received the same grade. Groups we_____ nester, and the average total work for e_____ ority of groups presented once; only tw_____

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 implemen

In 2012, the redesigned   tended the course
synchronously via vide   d 7 from Elizabeth
City) while the remainin   se met over 13 weeks
on Monday and Wedne   ot including four
additional classes for th   ors facilitated 23
classes from the Chapel   the Elizabeth City
campus. The course coo   r offloading the
majority of the course c   ance in class was
recommended but not r   s to access at any
time.

We recognized that the   To ease their
transition, we provided   the course and an
explanation detailing ou   ith tips for success in
the course, which emph   led material prior to
each class and would ac

Throughout the semest   e 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, https://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, https://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 ea[...] t reported watching, and the number of time[...]. In addition, in 2011 and 2012, we tracked th[...]ion scores.

Participation in the pre-[...] the course evaluation was required [...]fiers and demographic informatic[...]s to any other collected data. We cond[...]nonk, New York). Here, we present contin[...]sts to compare pre- and postcourse survey r[...]nses and final exam scores for the 2011 and [...]n continuous variables. We establishe[...]

In 2012, 150 of the 162 [...]nale, 111 were white, 121 held at least a bache[...] mathematics (STEM) background, an[...]2011 and 2012 demographics). All stud[...]11).

T1-17
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[*]

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).
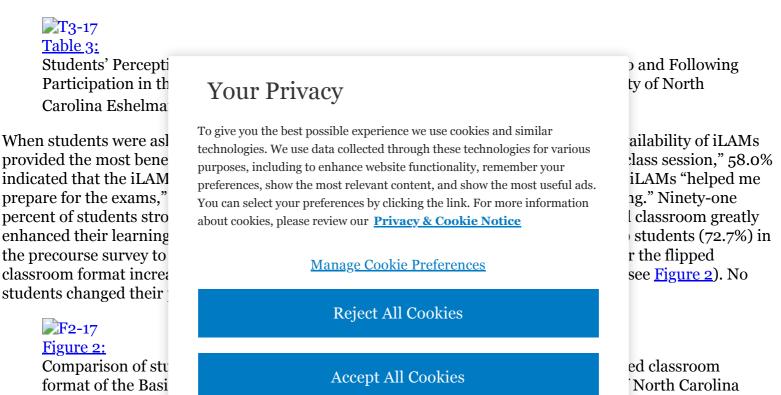
Students from the flipped classroom were more likely than students from the traditional classroom to agree that active student engagement was consistently encouraged by the instructor ($P < .001$) and that preparation for class was necessary to be successful ($P < .001$, see Table 2). On the 2012 course 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).

T2-17
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[*]

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 ($P < .001$).

Table 3:
Students' Percepti[...]o and Following Participation in th[...]ty of North Carolina Eshelma[...]

When students were asl[...]ailability of iLAMs provided the most bene[...]lass session," 58.0% indicated that the iLAM[...]iLAMs "helped me prepare for the exams,"[...]ng." Ninety-one percent of students stro[...]l classroom greatly enhanced their learning[...] students (72.7%) in the precourse survey to[...]r the flipped classroom format increa[...]see Figure 2). No students changed their [...]

Figure 2:
Comparison of stu[...]ed classroom format of the Basi[...] North Carolina Eshelman School [...] $P < .001$).

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, https://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.

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 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 ...
4. The package inser... ... f class, all students reviewed and grad...
5. We developed an ... ... expanding concepts, new technologies, ... b links.

Conclusions

In our experience, flippi... ... e to educate a large cohort of students on m... ... s a shared responsibility between s... ... s can facilitate academic excellence an... ... her schools will use the flipped classroom d... ... s students to develop higher-order cognitive s... ... prove the delivery of health care.

Acknowledgments: The ... ... acy Class of 2015 for their willingness to part... ... azers and epitomized the attributes that we s... ... the other PHCY 411 instructors, including Professors Michael Jay, Leaf Huang, and Richard Kowalsky, as well as Anthony Emekalam and Mollie Scott for their efforts facilitating the course at the Elizabeth City and Asheville campuses, respectively, and Casey Emerson and other educational technology staff for providing critical technology and expertise.

References

1. Arum R, Roska J Academically Adrift: Limited Learning on College Campuses. 2010 Chicago, Ill University of Chicago Press

- Cited Here

2. Arum R, Cho E, Kim J, Roska J Documenting Uncertain Times: Postgraduate Transitions of the Academically Adrift Cohort. 2012 New York, NY Social Science Research Council

- Cited Here

3. Christensen CM, Eyring HJ The Innovative University: Changing the DNA of Higher Education From the Inside Out. 2011 San Francisco, Calif Jossey-Bass

- Cited Here

4. Taylor MC Crisis on Campus: A Bold Plan for Reforming Our Colleges and Universities. 2010 New York, NY Knopf

- Cited Here

5. Berwick DM, Finkelstein JA. Preparing medical students for the continual improvement of health and health care: Abraham Flexner and the new "public interest." Acad Med. 2010;85(9 suppl):S56–S65

- Cited Here

6. Greiner AC, Knebel E Health Professions Education: A Bridge to Quality. 2003 Washington, DC National Academies Press eds

- Cited Here

7. Irby DM, Cooke M, O'Brien BC. Calls for reform of medical education by the Carnegie Foundation for the Advancement of Teaching: 1910 and 2010. Acad Med. 2010;85:220–227

- Cited Here

8. Speedie MK, Baldwin [...] abits of mind" in the scholarly pharmacy clin [...] uc. 2012;76:S3

- Cited Here

9. Flexner A Medical Ed [...] e Foundation for the Advancement of Teachi [...]

- Cited Here

10. Prober CG, Heath C [...]. N Engl J Med. 2012;366:1657–1659

- Cited Here

11. Hartley J, Cameron [...] 7;20:30–37

- Cited Here

12. MacManaway LA. T [...] Higher Educ Q. 1970;24:321–329

- Cited Here

13. Stuart J, Rutherford RJ. Medical student concentration during lectures. Lancet. 1978;2:514–516

- Cited Here

14. Thomas J. The variation of memory with time for information appearing during a lecture. Stud Adult Educ. 1972;4:57–62

- Cited Here

15. Hartley J, Davies IK. Note-taking: A critical review. Innov Educ Train Int. 1978;15:207–224

- Cited Here

16. Bligh DA What's the Use of Lectures?. 2000 San Francisco, Calif Jossey-Bass

- Cited Here

17. Bergmann J, Sams A Flip Your Classroom: Reach Every Student in Every Class Every Day. 2012 Washington, DC International Society for Technology in Education

- Cited Here

18. Prince M. Does active learning work? A review of the research. J Engr Educ. 2004;93:223–231

- Cited Here

19. Freeman S, O'Connor E, Parks JW, et al. Prescribed active learning increases performance in introductory biology. CBE Life Sci Educ. 2007;6:132–139

- Cited Here

Your Privacy

To give you the best possible experience we use cookies and similar technologies. We use data collected through these technologies for various purposes, including to enhance website functionality, remember your preferences, show the most relevant content, and show the most useful ads. You can select your preferences by clicking the link. For more information about cookies, please review our **Privacy & Cookie Notice**

Manage Cookie Preferences

Reject All Cookies

Accept All Cookies

20. Bonwell CC, Eison JA Active Learning: Creating Excitement in the Classroom. 1991 Washington, DC George Washington University

- Cited Here

21. Bransford JD, Brown AL, Cocking RR How People Learn: Brain, Mind, Experience, and School. 2000 Washington, DC Natio...

- Cited Here

22. McKeachie WJ, Pint... e Classroom: A Review of the Literature...

- Cited Here

23. Thompson C How K... uly 15, 2011 http://www.wired.com/...

- Cited Here

24. Lage MJ, Platt GJ, T... sive learning environment. J Econ Ec...

- Cited Here

25. Wood KL, Jensen D... o incrementally and systematically teach des...

- Cited Here

26. Blouin RA, Joyner PU, Pollack GM. Preparing for a Renaissance in pharmacy education: The need, opportunity, and capacity for change. Am J Pharm Educ. 2008;72:42

- Cited Here

27. Blouin RA, Riffee WH, Robinson ET, et al. Roles of innovation in education delivery. Am J Pharm Educ. 2009;73:154

- Cited Here

28. Gleason BL, Peeters MJ, Resman-Targoff BH, et al. An active-learning strategies primer for achieving ability-based educational outcomes. Am J Pharm Educ. 2011;75:186

- Cited Here

29. . Active Learning Techniques: Alternatives to Traditional Lectures. https://learn.pharmacy.unc.edu/alt/. Accessed October 7, 2013

- Cited Here

30. . Echo360 Classroom Capture [computer program]. Version 5.1.2012-06-26.1*. 2012 Dulles, Va Echo360 Inc.

- Cited Here

31. Sakai. http://www.sakaiproject.org. Accessed October 7, 2013

- Cited Here

32. Kee TP. The one minute lecture. Educ Chem. 1995;32:100–101

- Cited Here

33. Anderson LW, Krathwohl DR A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. 2001 New York, NY Longman eds

- Cited Here

34. Bloom BS Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain. 1956

- Cited Here

35. Ryan RM, Deci ELE dbook of Self-Determination Researc

- Cited Here

Supplemental

- ACADMED_89_2

View full article text

∧Back to Top

Your Privacy

To give you the best possible experience we use cookies and similar technologies. We use data collected through these technologies for various purposes, including to enhance website functionality, remember your preferences, show the most relevant content, and show the most useful ads. You can select your preferences by clicking the link. For more information about cookies, please review our **Privacy & Cookie Notice**

Manage Cookie Preferences

Reject All Cookies

Accept All Cookies

Never Miss an Issue

Get new journal Tables of Contents sent right to your email inbox [Type your email] [Get New Issue Alerts]

Browse Journal Content

- Most Popular
- For Authors
- About the Journal
- Past Issues
- Current Issue
- Register on the website
- Subscribe
- Get eTOC Alerts

For Journal Authors

- Submit an article
- How to publish with us

Customer Service

- Activate your journal subscription

- [Activate Journal Subscription](#)
- [Browse the help center](#)
- [Help](#)
- Contact us at:
  - Support:
    [Submit a Service Request](#)
  - TEL: (USA):
    TEL: (Int'l):
    800-638-30
    301-223-230

[Manage Cookie P]

- [Privacy Policy](#)
- [Legal Disclaimer](#)
- [Terms of Use](#)
- [Open Access Polic](#)
- [Feedback](#)
- [Sitemap](#)
- [RSS Feeds](#)
- [LWW Journals](#)

- [Your California Privacy Choices](#)

- Copyright © 2024
- [by the Association of American Medical Colleges](#)