1. ARNAUD, C. H. (2013). "FLIPPING CHEMISTRY CLASSROOMS." Chemical and Engineering News **91**(12): 41-43.
   GABRIELA C. WEAVER doesn’t lecture to her general chemistry students—at least not in class. She records short lecture snippets that the students watch online before showing up. During the class period, the students work problems while the Purdue University chemistry professor wanders around the room, observing students, answering their questions, and looking for concepts that are giving them trouble.

2. Bartlett, R. L. (1996). "Discovering diversity in introductory economics." The Journal of Economic Perspectives **10**(2): 141-153.

3. Bates, S. and R. Galloway (2012). The inverted classroom in a large enrollment introductory physics course: a case study. Proc. HEA STEM Conf.
   We present a practice-based case study of curriculum redesign in a large-enrolment introductory physics course taught at the University of Edinburgh. The course has been inverted, or “flipped”, in the sense that content and material is delivered to students for self-study in advance of lectures, via a combination of home-grown electronic course materials, textbook reading and external web resources. Subsequent lectures focus on problems students are still having after self-study of the material, which have been self-reported by them as part of a weekly reading quiz assignment. Lectures are transformed from sessions for transmission or initial presentation of information, to guided discussion sessions, with a particular focus on peer instruction techniques and discussion, facilitated by extensive use of clicker questions. We present details of student engagement with pre-class reading and quiz tasks, comment on student perceptions of this different instructional format, and present data that shows evidence for high quality learning on the course.

4. Becker, W. E. and M. Watts (1995). "TEACHING TOOLS: TEACHING METHODS IN UNDERGRADUATE ECONOMICS." Economic Inquiry **33**(4): 692-700.
   Lectures have long been the dominant pedagogical approach in undergraduate economics courses, but they are certainly no longer the exclusive approach. Much of the recent soul-searching in the discipline, dealing with the desirable characteristics of economics programs and their graduates, has largely ignored the issue of promoting the use of innovative and more active forms of teaching and learning. We review a considerable literature on new teaching approaches, developed by economists over the past twenty-five years, and argue that this should also be a part of the current debate about curriculum and training reforms for the profession.

5. Belton, D. J., R. Allan, et al. (2013). "Inverting the Classroom for Final year Analytical Chemistry."
   Inspired by the work of Bates and Galloway [1], elements of a final year analytical chemistry module were delivered using an inverted classroom approach. A series of five reading assignments were set in order to take some of

the knowledge transmission outside of class time. These were based on a combination of home grown e-notes, books and papers. Each assignment had specific learning objectives and students were directed to make notes about the reading material, using these objectives as a guide. Engagement with and understanding of the reading material was assessed using five online tests, each corresponding to a different reading assignment. These tests also served as an incentive to complete the work, since they were each worth 1% of the module marks. At the end of each test, students were prompted to leave feedback about what they still did not understand. This feedback and the breakdown of marks from the tests were used to direct the teaching in the next lecture i.e. just-in-time teaching [2]. The reading assignments also freed up class time, which was used for the development of higher order thinking skills, such as applying, analysing and evaluating.

Overall, the approach has improved student engagement. For example, there was good uptake of the tests and the students appeared to be very attentive when the lecturer was responding to specific feedback from the tests. A range of different methodologies are being used to evaluate the effectiveness of this approach for improving student engagement and learning. Here we present our latest findings.

6. Bergmann, J. and A. Sams (2012). Flip your classroom: Reach every student in every class every day, International Society for Technology in Education.

7. Berrett, D. (2012). "How'flipping'the classroom can improve the traditional lecture." The chronicle of higher education **12**.

8. Bishop, J. L. and M. Verleger (2013). The flipped classroom: A survey of the research. ASEE National Conference Proceedings, Atlanta, GA.
Recent advances in technology and in ideology have unlocked entirely new directions for education research. Mounting pressure from increasing tuition costs and free, online course offerings is opening discussion and catalyzing change in the physical classroom. The flipped classroom is at the center of this discussion. The flipped classroom is a new pedagogical method, which employs asynchronous video lectures and practice problems as homework, and active, group-based problem solving activities in the classroom. It represents a unique combination of learning theories once thought to be incompatible—active, problem-based learning activities founded upon a constructivist ideology and instructional lectures derived from direct instruction methods founded upon behaviorist principles.

This paper provides a comprehensive survey of prior and ongoing research of the flipped classroom. Studies are characterized on several dimensions. Among others, these include the type of in-class and out-of-class activities, the measures used to evaluate the study, and methodological characteristics for each study. Results of this survey show that most studies conducted to date explore student perceptions and use single-group study designs. Reports of student perceptions of the flipped classroom are somewhat mixed, but are generally positive overall. Students tend to prefer in-person lectures to video lectures, but prefer interactive classroom activities over lectures. Anecdotal evidence suggests that student learning is improved for the flipped compared to traditional classroom. However, there is very little work investigating student learning outcomes objectively. We recommend for future work studies investigating of objective learning outcomes using controlled experimental or quasi-experimental designs. We also recommend that researchers carefully consider the theoretical framework used to guide the design of in-class activities.

9. Brame, C. J. and C. A. Director "Flipping the Classroom."

10. Bretzmann, J. (2013). Flipping 2.0: Practical strategies for flipping your class, Bretzmann Group, LLC.

11. Brown, P. C., H. L. Roediger III, et al. (2014). Make it stick, Harvard University Press.

12. Butt, A. (2014). "Student views on the use of a flipped classroom approach: evidence from Australia." Business Education & Accreditation **6**(1): 33-44.
A report on an introduction of a “flipped classroom” approach to lectures in a final-year actuarial course is presented. At the heart of the flipped classroom is moving the “delivery” of material outside of formal class time and using formal class time for students to undertake collaborative and interactive activities relevant to that material. Students were surveyed both at the start and end of the semester to obtain their views on lectures in general and the flipped classroom structure. After experiencing the entire course with this teaching style, student views became, on average, far more positive towards the flipped classroom approach.

13. Butzler, K. B. (2014). "Flipping at an Open-Enrollment College." ACS CHED CCCE Spring.
The flipped classroom is a blended, constructivist learning environment that reverses where students gain and apply knowledge. Instructors from K-12 to college level are excited about the prospect of flipping their classes, but are unsure how and with which students to implement this learning environment. However, there has been little discussion regarding flipping the classroom with students who are less academically prepared specifically those students at open-enrollment colleges. Many students at the open-enrollment college did not perceive the flipped classroom favorably. This differed from the perceptions reported by instructors in Advanced Placement high school chemistry classes or chemistry at competitive colleges and universities. Students reported that the technology used to deliver content and the overall flipped structure hindered their learning and suggested that the flipped classroom was the reason for lower than expected grades. This study compared class rank (academic preparedness) and mathematics level to overall course grade in a lecture, flipped class, and stealth flip class learning environment. The focus of this paper

is to provide the reader with insights about flipping a general chemistry class at an open-enrollment college where the mathematics level and academic preparedness are much different from students at competitive universities. The author will provide student comments on the flipped classroom as well as revisions to the flipped class structure that provided students with more structure and autonomy support.

14. Christiansen, M. A. (2014). "Inverted Teaching: Applying a New Pedagogy to a University Organic Chemistry Class." Journal of Chemical Education **91**(11): 1845-1850.
Inverted teaching, not to be confused with hybrid learning, is a relatively new pedagogy in which lecture is shifted outside of class and traditional homework is done in class. Though some inverted teaching (IT) designs have been published in different fields, peer-reviewed reports in university chemistry remain quite rare. To that end, herein is disclosed a sophomore organic chemistry course design in which two groups of students were each taught by one of two methods: Group 1 through traditional lecture (TL) and Group 2 through IT. Design rationale and objectives are discussed. Academic performances are compared, along with anonymous student feedback contrasting the two techniques (TL vs IT). Student attendance and viewership, instructor prep time, and total lecture time are also presented for both styles.

15. Come, W. T. (2012). "–Flipping the Classroom." Mining Key Pedagogical Approaches:79.

16. Crews, T. and J. B. Butterfield (2014). "Data for Flipped Classroom Design: Using Student Feedback to Identify the Best Components from Online and Face-to-Face Classes." Higher Education Studies **4**(3): p38.
Colleges and universities have seen considerable enrollment growth in online courses during the past decade. However, online modalities are not optimal for all subject areas or students. There is growing interest in hybrid, blended, and flipped instruction as a way to incorporate the best of different delivery methods. This study investigates and identifies student preferences for both face-to-face and online learning. Participants were undergraduate students from a mix of freshman, junior, and senior level courses. An open response instrument was used to allow broad insights into students' responses without biasing or limiting the feedback. Results suggest that the most positive impact with face-to-face learning is interaction through class discussions, group projects and other types of active learning. Females responded more positively than male students to interactivity in face-to-face classes. The data further indicates the most positive impact with online learning experiences is the class structure that supports flexibility, organization, and clear expectations. Nontraditional students reported more positively than traditional students about the benefits of flexible classes with clear course structures. This report should be of interest to educators who wish to take a research-based, student-centric, data-driven approach to the design of flipped or hybrid classrooms.

17. Crouch, C. H. and E. Mazur (2001). "Peer instruction: Ten years of experience and results." American Journal of Physics **69**: 970.

18. DiRienzo, C. and G. Lilly (2014). "Online Versus Face-to-Face: Does Delivery Method Matter for Undergraduate Business School Learning?" Business Education & Accreditation **6**(1): 1-11.
Considering the significant growth in online and distance learning, the question arises as to how this different delivery method can affect student learning. Specifically, this study compares the student learning outcomes on both a “basic” and “complex” assignment given in the same course, but using two different delivery methods of traditional face-to-face and online, across five undergraduate business courses taught at Elon University during the summer 2007 session. This study includes data from over 120 students and, after controlling for other factors known to affect student performance, the results indicate that delivery method has no significant difference in student learning.

19. Fautch, J. M. (2015). "The flipped classroom for teaching organic chemistry in small classes: is it effective?" Chemistry Education Research and Practice **16**(1): 179-186.
The flipped classroom is a pedagogical approach that moves course content from the classroom to homework, and uses class time for engaging activities and instructor-guided problem solving. The course content in a sophomore level Organic Chemistry I course was assigned as homework using video lectures, followed by a short online quiz. In class, students' misconceptions were addressed, the concepts from the video lectures were applied to problems, and students were challenged to think beyond given examples. Students showed increased comprehension of the material and appeared to improve their performance on summative assessments (exams). Students reported feeling more comfortable with the subject of organic chemistry, and became noticeably passionate about the subject. In addition to being an effective tool for teaching Organic Chemistry I at a small college, flipping the organic chemistry classroom may help students take more ownership of their learning.

20. Flynn, A. B. (2015). "Structure and evaluation of flipped chemistry courses: organic & spectroscopy, large and small, first to third year, English and French." Chemistry Education Research and Practice **16**(2): 198-211.
Organic chemistry is a traditionally difficult subject with high failure & withdrawal rates and many areas of conceptual difficulty for students. To promote student learning and success, four undergraduate organic chemistry and spectroscopy courses at the first to third year level (17-420 students) were "flipped" in 2013-2014. In the flipped course, content traditionally delivered in lectures is moved online; class time is dedicated to focused learning activities. The three large courses were taught in English, the small one in French. To structure the courses, each course's intended learning outcomes (ILOs) were analyzed to decide which course components would be delivered online and which would be addressed in class. Short (2-15 min), specific videos were created to replace lectures. Online and in-class learning activities were created in alignment with

the ILOs; assessment was also aligned with the ILOs. A learning evaluation was undertaken to determine the impact of the new course structure, using Guskey's evaluation model. Analysis of students' grades, withdrawal rates, and failure rates were made between courses that had a flipped model and courses taught in previous years in a lecture format. The results showed a statistically significant improvement in students' grades and decreased withdrawal and failure rates, although a causal link to the new flipped class format cannot be concluded. Student surveys and course evaluations revealed high student satisfaction; this author also had a very positive experience teaching in the new model. The courses' overall design and evaluation method could readily be adapted to other chemistry, science and other courses, including the use of learning outcomes, the weekly course structure, online learning management system design, and instructional strategies for large and small classes.

21. Freeman, S., S. L. Eddy, et al. (2014). "Active learning increases student performance in science, engineering, and mathematics." Proceedings of the National Academy of Sciences **111**(23): 8410-8415.
    To test the hypothesis that lecturing maximizes learning and course performance, we metaanalyzed 225 studies that reported data on examination scores or failure rates when comparing student performance in undergraduate science, technology, engineering, and mathematics (STEM) courses under traditional lecturing versus active learning. The effect sizes indicate that on average, student performance on examinations and concept inventories increased by 0.47 SDs under active learning (n = 158 studies), and that the odds ratio for failing was 1.95 under traditional lecturing (n = 67 studies). These results indicate that average examination scores improved by about 6% in active learning sections, and that students in classes with traditional lecturing were 1.5 times more likely to fail than were students in classes with active learning. Heterogeneity analyses indicated that both results hold across the STEM disciplines, that active learning increases scores on concept inventories more than on course examinations, and that active learning appears effective across all class sizes—although the greatest effects are in small (n ≤ 50) classes. Trim and fill analyses and fail safe n calculations suggest that the results are not due to publication bias. The results also appear robust to variation in the methodological rigor of the included studies, based on the quality of controls over student quality and instructor identity. This is the largest and most comprehensive metaanalysis of undergraduate STEMeducation published to date. The results raise questions about the continued use of traditional lecturing as a control in research studies, and support active learning as the preferred, empirically validated teaching practice in regular classrooms.

22. Fulton, K. (2012). "Upside down and inside out: Flip Your Classroom to Improve Student Learning." Learning & Leading with Technology **39**(8): 12-17.

23. Gaughan, J. E. (2014). "The flipped classroom in world history." History Teacher **47**(2): 221-244.

THe flipped classroom is one in which lectures are presented as homework outside of class in online videos so that class time is reserved for engaging directly with the materials. The first time I employed this pedagogical tool was at Colorado State University-Pueblo (CSU-Pueblo), a regional public university1 with a high percentage of first-generation college students and a high percentage of students who find college-level work unexpectedly challenging. First-year survey courses in the History Department are capped at 40 students. During the Spring semester of 2013, when I first implemented the flipped classroom, enrollments were unusually low. In the two sections of World History to 1100, one had 14 students and the other had 22. In the History Department at CSU-Pueblo, we have the enviable position of teaching World History in three semesters rather than two. The divisions are to 1100 C.E., 1100 to1800, and 1800 to present. I am responsible for the first of these, HIST 101: World Civilization to 1100 C.E.2 We do not share a standard text or curriculum for the World History Sequence. I employ Strayer's World History with Sources and begin with evolution (thanks to a few skulls from a colleague in anthropology) and the Paleolithic age. This is a standard face-to-face course enhanced by Blackboard, where I provide links to online videos and additional primary sources that are not available in the textbook or that
I want the students to read at greater length. Blackboard is also used for posting assignments, links to maps, links for optional further reading, and for the students to submit written assignments. Now that I am employing the flipped classroom, links to videos I have created are also available through Blackboard.

24. Glynn Jr, J. and M. Bozeman (2013). "THE EFFECTS OF A FLIPPED CLASSROOM ON ACHIEVEMENT AND STUDENT ATTITUDES IN SECONDARY CHEMISTRY."
In this investigation flipping was used to see if improvement occurred in achievement and with students' attitudes toward chemistry. Flipping means lecture content usually delivered in the classroom was instead presented through asynchronous videos via the internet in advance of class. This was done in a suburban high school chemistry course. Results from unit tests were analyzed to see the change in summative achievement; while student surveys and interviews were analyzed to see the change in students' attitudes toward chemistry. Results revealed no significant change in achievement with only marginal improvement in positive attitudes toward chemistry. Student comments and interviews showed that students did not have a positive response to using flipping to introduce new content but had a positive attitude towards using flipping in other roles.

25. Haile, J. (2015). "Using a blog to flip the classroom." ACS CHED CCCE Spring.
Just in Time Teaching is a technique where students read the material before class and respond to a few questions via an online interface. The instructor will then develop the class for that material around the students' responses. In a first year seminar course, The Chemistry of Food, students were assigned to maintain blogs for the entire 16-day term. In order to create an online learning community, the instructor's blog in lieu of a quiz was utilized as a forum to

assign the readings and pose questions about the readings. The comments on the instructor blog, as well as individual student posts, were utilized to develop the classroom discussion; moreover, many of the readings were not discussed in class but entirely online. Many students who would not normally participate in class were more than willing to participate online; thus, providing the class discussion with more variety and greater input from the students.

26. Hake, R. R. (1998). "Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses." American Journal of Physics **66**(1): 64-74.

27. Hake, R. R. (1998). Interactive-engagement vs Traditional Methods in Mechanics Instruction. APS Forum on Education Newsletter.
A survey of pre/post test data using the Halloun-HestenesMechanics Diagnostic test or more recent Force Concept Inventory is reportedfor 62 introductory physics courses enrolling a total number of studentsN=6542. A consistent analysis over diverse student populations in highschools, colleges, and universities is obtained if a rough measure of theaverage effectiveness of a course in promoting conceptual understanding istaken to be the average-normalized gain <g>. The latter is defined as theratio of the actual average gain (%<post>%<pre>) to the maximum possibleaverage gain (100-%<pre). Fourteen "traditional"(T) courses (N=2084) whichmade little or no use of interactive-engagement (IE) methods achieved anaverage gain <g>T-ave=0.23 +/- 0.04 (std. dev.). In sharp contrast, 48courses (N=4458) which made substantial use of IE methods achieved an averagegain <g>IE-ave=0.48 +/- 0.14 (std. dev.), almost two standard deviations of<g>IE-ave above that of the traditional courses. Results for 30 (N=3259) ofthe above 62 courses on the problem-solving Mechanics Baseline test ofHestenes-Wells imply that IE strategies enhance problem-solving ability. Theconceptual and problem-solving test results strongly suggest that theclassroom use of IE methods can increase mechanics-course effectiveness wellbeyond that obtained in traditional practice. (Contains 6 figures and 87references.)

28. Hartman, J., Dahm, D. J., Nelson, E. A. (2014). "Time-Saving Resources -- Aligned with Cognitive Science To Help Instructors Flip." ACS CHED CCCE Spring.
If students are given lecture notes that they can read with comprehension during homework, can faculty gain time during lecture for activities that build conceptual understanding? Could this lead to measurable gains in student achievement?
In our experience, under the right conditions, the answer has been: Yes and yes. For several years, the authors have been working to develop materials that would make it easier for faculty to “flip” instruction in first-year chemistry -- without having to videotape lectures. We will discuss our experience and then suggest factors to consider whether you choose among existing resources to assist in flipping or create your own.

29. He, Y., S. Swenson, et al. (2012). "Online Video Tutorials Increase Learning of Difficult Concepts in an Undergraduate Analytical Chemistry Course." Journal of Chemical Education **89**(9): 1128-1132.
Educational technology has enhanced, even revolutionized, pedagogy in many areas of higher education. This study examines the incorporation of video tutorials as a supplement to learning in an undergraduate analytical chemistry course. The concepts and problems in which students faced difficulty were first identified by assessing students? homework assignments and exam responses. Then, a tutorial video clip aimed at that specific knowledge point was designed by the instructor using the Camtasia software package and was uploaded to the course Web site portal (Blackboard). To assess the effectiveness of the tutorials, students? oral and written feedback, pre- and post-video-tutoring exam performance, and data from previous classes taught by the same instructor were examined. Results indicate that online video tutorials are a valuable, flexible, and cost-effective tool to improve student mastery of chemistry problem solving.

30. Heath, C. and D. Heath (2007). Made to stick: Why some ideas survive and others die, Random House Digital, Inc.

31. Herreid, C. F. and N. A. Schiller (2013). "Case studies and the flipped classroom." Journal of College Science Teaching **42**(5): 62-66.

32. Hill, P. (2014). "Online educational delivery models: A descriptive view."
Honeycutt, B. and J. Garrett (2014). "Expanding the definition of a flipped learning environment." Instructional Design: Faculty focus.

33. Houston, M. and L. Lin (2012). Humanizing the Classroom by Flipping the Homework versus Lecture Equation. Society for Information Technology & Teacher Education International Conference 2012. P. Resta. Austin, Texas, USA, AACE**:** 1177-1182.
Technology is often accused of separating people, and in classrooms it can distance students even further from teachers if used improperly. However, innovative educators are using technology to revolutionize teaching by inverting or flipping the homework versus lecture equation. In an inverted or flipped classroom, students review pre-recorded lecture content online before class, freeing class time for active learning. Salman Khan, an entrepreneur and vocal proponent of flipping the lecture versus homework equation believed that flipping the homework with lecture literates and humanizes the classroom. Current research and practices about the inverted teaching, requirements for its successful implementation, and its possible payoffs are discussed in this paper.

34. Hughes, H. (2012). Introduction to flipping the college classroom. World Conference on Educational Multimedia, Hypermedia and Telecommunications.
“Flipping the classroom” is a pedagogical concept and method that replaces the standard lecture-in-class format with opportunities for students to review, discuss, and investigate course content with the instructor in class. There are

many ways that a classroom can be flipped, but the underlying premise is that students review lecture materials outside of class and then come to class prepared to participate in instructor-guided learning activities. This paper provides an introduction to classroom flipping and the instructional design strategies for flipping the college classroom developed at one university.

35. Jamaludin, R. and S. Z. M. Osman (2014). "The use of a flipped classroom to enhance engagement and promote active learning." Journal of Education and Practice **5**(2): 124-131.
This study was based on Reeve's (2013) four-aspect conceptualization regarding student engagement to promote active learning using a flipped classroom. The flipped classroom is defined as using technology to provide lectures outside of the classroom, while assignments with concepts are provided inside the classroom through learning activities (Clark, 2013). Behavioral engagement is defined as teachers' direction of students toward activities that require them to apply initiative (Fredricks, Blumenfeld, & Paris, 2004). Emotional engagement is promoted by intentionally selecting materials that stimulate students' interaction with and feedback to the material (Taylor & Statler, 2013). Cognitive engagement is defined as the teacher's skill in questioning and the students' elaboration of an idea as an answer (Smart & Marshall, 2012). Agentic engagement is student selflearning, with a contribution from the lecturer to provide instructional support (Reeve & Tseng, 2011). A descriptive quantitative methodology was used in which 24 undergraduate TESOL students took the course QMT 212 Instructional Design. The results show that emotional engagement (x =5.79)(sd=1.02) has the highest score, followed by behavioral engagement (x =5.62)(sd=0.69), cognitive engagement (x =5.61) (sd=1.02) and agentic engagement (x =5.1)(sd=1). This study also shows that, for active learning to occur, emotional engagement is one of the important factors as compared to other types of engagement.

36. Janson, A., S.-J. Ernst, et al. (2014). "Creating awareness and reflection in a large-scale IS lecture—the application of a peer assessment in a flipped classroom scenario." Vortrag, 4th Workshopon Awareness and Reflection in Technology-Enhanced Learning (ARTEL 2014) to be held in the context of EC-TEL.
Large-scale lectures are a typical way of teaching university students. However, these lectures often lack interaction elements and do not foster awareness and reflection in the learning process. This results in insufficient learning outcomes such as learning satisfaction and success. Therefore, a new approach to engage interaction in such large-scale lectures is the flipped classroom concept which seeks to overcome these challenges by stimulating selfregulated learning phases and improving interaction as well as awareness and reflection in the presence phases of a lecture. However, it is still unclear how to actually increase reflection and awareness through interaction in such learning scenarios. For this purpose, we propose an application of a technologyenhanced peer assessment that is carried out in large-scale information systems lectures. Preliminary evaluation results suggest the potentials of this approach. Thus, we are able to

provide first theoretical and practical implications for the application of a technology-enhanced peer assessment in large-scale lectures.

37. Jensen, J. L., T. A. Kummer, et al. (2015). "Improvements from a Flipped Classroom May Simply Be the Fruits of Active Learning." CBE-Life Sciences Education **14**(1): ar5.
The “flipped classroom” is a learning model in which content attainment is shifted forward to outside of class, then followed by instructor-facilitated concept application activities in class. Current studies on the flipped model are limited. Our goal was to provide quantitative and controlled data about the effectiveness of this model. Using a quasi-experimental design, we compared an active nonflipped classroom with an active flipped classroom, both using the 5-E learning cycle, in an effort to vary only the role of the instructor and control for as many of the other potentially influential variables as possible. Results showed that both low-level and deep conceptual learning were equivalent between the conditions. Attitudinal data revealed equal student satisfaction with the course. Interestingly, both treatments ranked their contact time with the instructor as more influential to their learning than what they did at home. We conclude that the flipped classroom does not result in higher learning gains or better attitudes compared with the nonflipped classroom when both utilize an active-learning, constructivist approach and propose that learning gains in either condition are most likely a result of the active-learning style of instruction rather than the order in which the instructor participated in the learning process.

38. King, A. (1993). "From sage on the stage to guide on the side." College teaching **41**(1): 30-35.

39. Kordyban, R. and S. Kinash (2013). "No more flying on autopilot: The flipped classroom." Education Technology Solutions **56**: 54.

40. Lage, M. J. and G. Platt (2000). "The internet and the inverted classroom." The Journal of Economic Education **31**(1): 11-11.

41. Lage, M. J., G. J. Platt, et al. (2000). "Inverting the classroom: A gateway to creating an inclusive learning environment." The Journal of Economic Education **31**(1): 30-43.
Recent evidence has shown that a mismatch between an instructor's teaching style and a student's learning style can result in the student learning less and being less interested in the subject matter (Borg and Shapiro 1996; Ziegert forthcoming). This finding implies that either educational administrator should strive to ensure a good match between the instructor's teaching style and the students' learning styles (a difficult task) or that concerned instructors should use a portfolio of teaching styles so as to appeal to a variety of student learning types. Unfortunately, a majority of introductory economics courses are taught using only one teaching style-the traditional lecture format (Becker and Watts 1995). The ability of instructors to vary teaching styles in introductory economics courses is seemingly limited by time constraints. If an instructor wanted to lecture for those students who learn best via lecturing, conduct experiments for the experiential learners, give group assignments for the collaborative and cooperative learners, and oversee self-directed study for the independent

learners, then he would need to increase student contact time fourfold. However, both the proliferation of students' access to multimedia and the advances in ease of multimedia development for faculty have created an environment where these layers of learning can be integrated without inordinately increasing contact time or sacrificing course coverage. We outline a strategy for teaching that appeals to a broad range of learning styles without violating the constraints typically faced by instructors at most institutions. In addition, we present student and faculty perceptions of such a course.

42. Lasry, N., M. Dugdale, et al. (2014). "Just in time to flip your classroom." The Physics Teacher **52**(1): 34-37.
With advocates like Sal Khan and Bill Gates1, flipped classrooms are attracting an increasing amount of media and research attention2. We had heard Khan‟s TED talk and were aware of the concept of inverted pedagogies in general. Yet, it really hit home when we accidentally flipped our classroom. Our objective was to better prepare our students for class. We set out to effectively move some of our course content outside of class and decided to tweak the Just-in-Time-Teaching approach (JiTT)3. To our surprise, this tweak - which we like to call the flip-JiTT - ended up completely flipping our classroom. What follows is narrative of our experience and a procedure that any teacher can use to extend JiTT to a flipped classroom.

43. Lasry, N., E. Mazur, et al. (2008). "Peer instruction: From Harvard to the two-year college." American Journal of Physics **76**: 1066.
We compare the effectiveness of a first implementation of peer instruction PI in a two-year college with the first PI implementation at a top-tier four-year research institution. We show how effective PI is for students with less background knowledge and what the impact of PI methodology is on student attrition in the course. Results concerning the effectiveness of PI in the college setting replicate earlier findings: PI-taught students demonstrate better conceptual learning and similar problem-solving abilities than traditionally taught students. However, not previously reported are the following two findings: First, although students with more background knowledge benefit most from either type of instruction, PI students with less background knowledge gain as much as students with more background knowledge in traditional instruction. Second, PI methodology is found to decrease student attrition in introductory physics courses at both four-year and two-year institutions.

44. Lockwood, K., J. McCall, et al. (2013). Implementing the inverted classroom (abstract only). Proceeding of the 44th ACM technical symposium on Computer science education. Denver, Colorado, USA, ACM**:** 763-763.
The Inverted Classroom is an exciting pedagogical technique where more passive information assimilation activities (e.g. lectures) are assigned as homework and class time is reserved for active applied problem solving and group activities. With current technology, instructors wishing to implement inverted classroom have a variety of options to create engaging and accessible learning modules. In this workshop, we will provide an overview of inverted classroom philosophy and some initial data from successful pilots of the inverted classroom. Participants will work in small groups to develop small inverted classroom activities using software and technology provided by the presenters. We will wrap up with presentations from the groups and a discussion about assessment.

45. Lucille, A. B. and R. F. James (2014). Flipping Crazy: The Large Lecture Flipped Classroom Model at the University of Southern Maine. Addressing the Millennial Student in Undergraduate Chemistry, American Chemical Society. **1180:** 59-70.
While the flipped classroom model has really taken off in high school and smaller undergraduate classrooms, it has been slow to develop into a model that can be utilized in a large lecture classroom. Starting in the fall of 2012 we decided to ?flip? the general chemistry classroom at the University of Southern Maine (USM). By creating YouTube videos and assigning online pre-class quizzes, we were able to move much of the content delivery outside the classroom. A classroom response system allowed us to quickly gauge the level of student understanding of the assigned material, and to focus on problem

areas. Online homework, a Google+ community, and a new course web space provided additional student support. During the first year, we found we were able to have students work in groups, complete more practice problems, build problem-solving skills, and have more in-depth class discussions. While these changes made appreciable improvements on student engagement and learning, we realized many students were still unsuccessful in the class due to underdeveloped math and study skills. In the second year of the flipped classroom, we added a recitation session with undergraduate teaching assistants, focusing this extra hour on math, study, and problem solving skills. These course changes had a major impact on student success and retention in the general chemistry course at the University of Southern Maine. Our D, F, W rates significantly dropped while the number of students passing the course significantly increased. Student responses to an end of semester survey found that many of the students found the course structure extremely beneficial to their learning and helped to alleviate many of the pressures (anxiety, and under-developed math and study skills) of the course.

46. Maher, M. L., H. Lipford, et al. "Flipped Classroom Strategies Using Online Videos." The basic principles of a flipped classroom teaching method are to deliver instruction online and to move active learning into the classroom. There are many strategies for delivering the instruction online, such as, preparing online lectures by the course instructors, wrapping the course around a MOOC, and
collecting online videos from various sources. There are also many strategies for including active learning in the classroom. In this paper we describe our strategies for a flipped classroom using online videos: selecting videos from various sources, integrating the critique and selection of videos as part of the learning experience, and organizing in class learning around scaffolding skills development and identifying misconceptions. The course content includes design and layout for web pages as well as applications development for interactivity. This paper contributes a set of strategies to consider for online instruction and active learning of skills and concepts for programming courses. Through course evaluations and student surveys we present the distribution of students' positive and negative responses to our strategies.

47. Marcey, D. J. and M. E. Brint (2012). Transforming an undergraduate introductory biology course through cinematic lectures and inverted classes: A preliminary assessment of the clic model of the flipped classroom. Biology Education Research Symposium at the meeting of the National Association of Biology Teachers. Retrieved on February.
Two sections of an undergraduate introductory Biology lecture course were run in parallel as a pilot pedagogical experiment. One section (N = 32) was taught in a long-established, traditional manner, with lectures delivered during class, readings assigned in a textbook, and access to lecture graphics/slides provided via the online syllabus. The other, "flipped" section (N = 16) lacked both required reading assignments and in-class lectures. Instead, students were assigned online cinematic lectures (cinelectures) for viewing outside of class. In class,

students were broken into small groups and engaged in active learning assignments. This model of flipping is termed CLIC (Cinematic Lectures and Inverted Classes). Accounting for all sources of content, the subject material covered was the same for both sections and assessments of learning were identical quizzes and examinations. Statistically significant differences in learning were observed during the first half of the semester, with the flipped-class students performing better on all tests and quizzes. These differences disappeared in the second half of the semester, coincident with a large increase in the number of views of cinelectures recorded on the course YouTube channel. Survey of the traditional class revealed that approximately 3/4 of the students had learned of the cinelectures at this time and had added viewing of these to their study, providing an internal, if initially unintended, control sample to the experiment. These results, along with other analyses, provide preliminary but strong evidence that supports the conversion of traditional Biology lecture classes to a CLICed model.

48. Mason, G., T. R. Shuman, et al. (2013). Inverting (flipping) classrooms-< -< Advantages and challenges, ASEE, Atlanta, GA.
The educational benefits of learner-centered instruction, including active, collaborative, and problem-based learning, are widely recognized. However, educators are often reluctant to implement learner-centered activities because they perceive doing so will reduce class content coverage. An inverted classroom is a method that can free classroom time for learner-centered activities. In an inverted classroom (IC), course content is disseminated outside the classroom through mediums such as video lectures and web-based tutorials, in addition to traditional methods such as assigned reading, assigned homework problems, interactive exercises, and power-point presentations. Students are responsible for learning basic course material outside of class time. Unlike an online class, an IC includes face-to-face time with the instructor in classroom or laboratory setting where the material learned outside of class is discussed and applied. The IC allows an educator to present course material in several different formats, and so engages the different learning styles and preferences of students. The IC format encourages students to become self-learners and help prepare them for how they will need to learn as practicing engineers. Our experience shows that the IC format can free class time for learnercentered activities without sacrificing course content.
This paper describes the implementation of an IC in a senior-level Control Systems course. Two offerings of these courses with 20-25 students each have been entirely taught as inverted. This paper describes best practices in offering these courses, including suggestions for instructors on preparing video lectures and structuring the course to provide a safe environment for students to learn in this unique format. Three years of assessment data are presented in this paper, including student exam performance, and instructor and student observations and perceptions of the inverted classroom format collected through surveys and interviews. Key results from assessments are: 1) although there was some initial

resistance from the students to the new format, students adjusted to the format after a few weeks – the format should be implemented for an entire term in order to obtain full benefits of this approach; 2) students showed an increased awareness of the importance of self-learning and the benefit of taking responsibility for their own learning; 3) the format frees time for students to individually or collaboratively solve more problems than in a lecture setting and opens the opportunity to implement problem-based learning without sacrificing content coverage; 4) student performance on exams and homework was not diminished through the uses of an IC; 5) aside from the initial time investment by the instructor to create on-line content, the work load on the instructors and the students was not much different than in the traditional classroom; 6) the video-lectures don't need to be production quality, rather content-focused and succinct; 7) an IC should be offered with an adequate course structure, including a guide to the on-line content.

49. Mazur, E. (1997). Peer instruction: getting students to think in class. AIP ConferenceProceedings.

50. McLaughlin, J. E., M. T. Roth, et al. (2014). "The flipped classroom: a course redesign to foster learning and engagement in a health professions school." Acad Med **89**: 00-00.
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, lecturebased 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.

51. Mehta, N. B., A. L. Hull, et al. (2002). "Just imagine: new paradigms for medical education." Revolution.

For all its traditional successes, the current model of medical education in the United States and Canada is being challenged on issues of quality, throughput, and cost, a process that has exposed numerous shortcomings in its efforts to meet the needs of the nations' health care systems. A radical change in direction is required because the current path will not lead to a solution. The 2010 publication Educating Physicians: A Call for Reform of Medical School and Residency identifies several goals for improving the medical education system, and proposals have been made to reform medical education to meet these goals. Enacting these recommendations practically and efficiently, while training more health care providers at a lower cost, is challenging. To advance solutions, the authors review innovations that are disrupting higher education and describe a vision for using these to create a new model for competency-based, learner-centered medical education that can better meet the needs of the health care system while adhering to the spirit of the above proposals. These innovations include collaboration amongst medical schools to develop massive open online courses for didactic content; faculty working in small groups to leverage this online content in a "flipped-classroom" model; and digital badges for credentialing entrustable professional activities over the continuum of learning.

52. Miller, K., J. Schell, et al. (2015). "Response switching and self-efficacy in Peer Instruction classrooms." Physical Review Special Topics-Physics Education Research **11**(1): 010104.
Peer Instruction, a well-known student-centered teaching method, engages students during class through structured, frequent questioning and is often facilitated by classroom response systems. The central feature of any Peer Instruction class is a conceptual question designed to help resolve student misconceptions about subject matter. We provide students two opportunities to answer each question—once after a round of individual reflection and then again after a discussion round with a peer. The second round provides students the choice to "switch" their original response to a different answer. The percentage of right answers typically increases after peer discussion: most students who answer incorrectly in the individual round switch to the correct answer after the peer discussion. However, for any given question there are also students who switch their initially right answer to a wrong answer and students who switch their initially wrong answer to a different wrong answer. In this study, we analyze response switching over one semester of an introductory electricity and magnetism course taught using Peer Instruction at Harvard University. Two key features emerge from our analysis: First, response switching correlates with academic selfefficacy. Students with low self-efficacy switch their responses more than students with high self-efficacy. Second, switching also correlates with the difficulty of the question; students switch to incorrect responses more often when the question is difficult. These findings indicate that instructors may need to provide greater support for difficult questions, such as supplying cues during lectures, increasing times for discussions, or ensuring effective pairing (such as having a

student with one right answer in the pair). Additionally, the connection between response switching and self-efficacy motivates interventions to increase student self-efficacy at the beginning of the semester by helping students develop early mastery or to reduce stressful experiences (i.e., high-stakes testing) early in the semester, in the hope that this will improve student learning in Peer Instruction classrooms.

53. Moore, A. J., M. R. Gillett, et al. (2014). "Fostering student engagement with the flip." MatheMatics teacher **107**(6): 420-425.

54. Muzyka, J. (2014). "Just-in-Time Teaching in Organic Chemistry." ACS CHED CCCE Spring.
In the Just-in-Time Teaching approach, a faculty member assigns readings to students before every class. After the students have done the daily reading, they access a short reading quiz on a course management system (e.g., Moodle). The faculty member uses student responses to the quiz in the preparation of the day's class material and is able to tailor his or her explanations to target specific student questions or confusion. This paper describes the use of this approach to engage students in chemistry classes at Centre College.

55. Olson, S. and D. G. Riordan (2012). "Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics. Report to the President." Executive Office of the President.
Economic projections point to a need for approximately 1 million more STEM professionals than the U.S. will produce at the current rate over the next decade if the country is to retain its historical preeminence in science and technology. To meet this goal, the United States will need to increase the number of students who receive undergraduate STEM degrees by about 34% annually over current rates.
Currently the United States graduates about 300,000 bachelor and associate degrees in STEM fields annually. Fewer than 40% of students who enter college intending to major in a STEM field complete a STEM degree. Increasing the retention of STEM majors from 40% to 50% would, alone, generate threequarters of the targeted 1 million additional STEM degrees over the next decade. Many of those who abandon STEM majors perform well in their
introductory courses and would make valuable additions to the STEM workforce. Retaining more students in STEM majors is the lowest-cost, fastest policy option to providing the STEM professionals that the nation needs for economic and societal well-being, and will not require expanding the number or size of introductory courses, which are constrained by space and resources at many colleges and universities.

56. Overmyer, J. (2012). Flipped classrooms 101, Principal**:** 46-47.

57. Palladino, G. F. (1979). "General chemistry: An alternative to PSI for advanced students." Journal of Chemical Education **56**(5): 323.

The Thayer Concept of teaching emphasizes small class size, ability grouping, and competition among students; summary of its benefits, requirements, and application.

58. Prince, M. (2004). "Does active learning work? A review of the research." Journal of engineering education **93**(3): 223-231.
This study examines the evidence for the effectiveness of active learning. It defines the common forms of active learning most relevant for engineering faculty and critically examines the core element of each method. It is found that there is broad but uneven support for the core elements of active, collaborative, cooperative and problem-based learning.

59. Prober, C. G. and C. Heath (2012). "Lecture halls without lectures—a proposal for medical education." N Engl J Med **366**(18): 1657-1658.

60. Prober, C. G. and S. Khan (2013). "Medical education reimagined: a call to action." Acad Med **88**: 1407-1410.
The authors propose a new model for medical education based on the "flipped classroom" design. In this model, students would access brief (~10 minute) online videos to learn new concepts on their own time. The content could be viewed by the students as many times as necessary to master the knowledge in preparation for classroom time facilitated by expert faculty leading dynamic, interactive sessions where students can apply their newly mastered knowledge. The authors argue that the modern digitally empowered learner, the unremitting expansion of biomedical knowledge, and the increasing specialization within the practice of medicine drive the need to reimagine medical education. The changes that they propose emphasize the need to define a core curriculum that can meet learners where they are in a digitally oriented world, enhance the relevance and retention of knowledge through rich interactive exercises, and facilitate in-depth learning fueled by individual students' aptitude and passion. The creation and adoption of this model would be meaningfully enhanced by cooperative efforts across medical schools.

61. Rhem, J., S. Simkins, et al. (2010). Just-in-time teaching: Across the disciplines, across the academy, Stylus Publishing, LLC.

62. Roehl, A., S. L. Reddy, et al. (2013). "The flipped classroom: An opportunity to engage millennial students through active learning strategies." Journal of Family & Consumer Sciences **105**(2): 44-49.

63. Rossi, R. D. (2014). "Improving Student Engagement in Organic Chemistry using the Inverted Classroom Model." ACS CHED CCCE Spring.
Improving student engagement in STEM (Science, Technology, Engineering, and Mathematics) courses generally, and organic chemistry specifically, has long been a challenging goal for educators. In fact the academically demanding nature of organic chemistry has, many times, the unintended consequence of

disengaging students, particularly those that don’t immediately see the relevance of the subject matter to their field of study.

64. Recently educator’s at all academic levels are exploring the “inverted classroom” or “flipped classroom” pedagogical model for improving student engagement in subjects spanning the fields from liberal arts to business studies to science and technology. This learner-centered pedagogy, where students are responsible for understanding fundamental course concepts outside the classroom, allows class time to be more productively used for higher level engaging activities such as collaborative and problem-based learning through the instructor led application of the material delivered outside of class.

65. This paper describes the techniques used to accomplish and the technology employed to deliver an inverted two semester organic chemistry classroom at Gloucester County College. It will also explain and show how each semester topics were divided and presented to the students, and discuss the use of classroom
face-to-face time during the semester. Preliminary student performance data vs. the traditional lecture classroom format along with student comments about the inverted classroom approach are also presented.

66. Ruddick, K. W. (2012). "Improving chemical education from high school to college using a more hands-on approach."
In this work, various alternative teaching methods and activities for chemical education are developed, presented, and evaluated. In the first study, an original hands-on activity using LEGO® blocks to model ionic chemical formulas is presented together with quantitative and qualitative data regarding its educational effectiveness. Students explore cation to anion ratios using LEGO® blocks to represent trivalent, divalent and monovalent cations and anions. High school chemistry students who participated in the LEGO® lab showed significantly higher post-test scores than other students. The second study grows out of the creation of a computational lab module that is shown to significantly increase student learning in the subject of molecular orbital theory in first semester college General Chemistry. The third and final study presented is a course redesign project for college CHEM 1100, Preparation for General Chemistry. In this project the classroom is "flipped". Students watch video lectures at home, and spend class time working with peers and the instructor on problem solving activities. The results presented here are one of the first quantitative studies showing the effectiveness of "flipping the classroom". Students who were taught using the Reverse-Instruction (RI) method had significantly higher success in both the Preparation for General Chemistry course and traditionally taught General Chemistry I the following semester.

67. Schell, J. and E. Mazur (2015). "Flipping the Chemistry Classroom with Peer Instruction." <u>Chemistry Education: Best Practices, Opportunities and Trends</u>: 319-344.
Universities are hotbeds of innovation. Since the advent of our first institutions of higher learning, millions of inventions borne on campuses have radically

transformed our lives. The flipped classroom is one such educational disruption that is being adopted in classrooms of all types across the globe. In this chapter, we introduce the concept of a flipped classroom and situate it within the context of chemical education. We identify three big ideas of flipped classrooms: (i) prior knowledge is required to scaffold deeper learning; (ii) people learn best when they are engaged; and (iii) flipped classrooms enable a sustained learning path which cycles from preclass work, to in-class learning, to after-class activities. Finally, we introduce Peer Instruction, which is one research-based way for flipping the chemistry classroom in use at Harvard University.

68. Schullery, N. M., R. F. Reck, et al. (2011). "Toward solving the high enrollment, low engagement dilemma: A case study in introductory business." International Journal of Business, Humanities and Technology **1**(2): 1-9.
The challenges of high enrollment, apparent low engagement, questionable evaluation, and a scarcity of faculty to teach an introductory business course were addressed by reformatting the course delivery to a hybrid style "inverted classroom," which devotes classroom time to active learning and assigns reading and videotaped lectures for completion outside class. In 75 minute class meetings each week, faculty and part-time business-oriented instructors work with 24 students per section to clarify and reinforce concepts through discussion of related current events and a group problem-solving exercise. We sought to determine if the new format achieved our learning objectives and engaged students. Factor and content analyses of student surveys (N = 868) show that the students' level of overall satisfaction with the course and their perceived learning of concepts correlates with their in-class engagement. Results indicate the reformatted delivery has successfully addressed the challenges presented by this high enrollment course.

69. Schultz, D., S. Duffield, et al. (2014). "Effects of the Flipped Classroom Model on Student Performance for Advanced Placement High School Chemistry Students." Journal of Chemical Education **91**(9): 1334-1339.
This mixed-methods study investigated the effects of the flipped classroom on academic performance of high school advanced placement chemistry students. Student perceptions about the approach were also studied. The control group consisted of students from the 2011?2012 academic year, in which traditional teaching methods were used. The treatment group consisted of students from the 2012?2013 academic year, in which the flipped classroom approach was used. Identical assessments were administered and analyzed through both descriptive statistics and independent t tests. A statistically significant difference was found on all assessments with the flipped class students performing higher on average. In addition, most students had a favorable perception about the flipped classroom noting the ability to pause, rewind, and review lectures, as well as increased individualized learning and increased teacher availability. This contribution is part of a special issue on teaching introductory chemistry in the context of the advanced placement (AP) chemistry course redesign.

70. Seery, M. K. (2014). "Student Engagement with Flipped Chemistry Lectures." ACS CHED CCCE Spring.
This project introduces the idea of "flipped lecturing" to a group of my second year students. The aim of flipped lecturing is to provide much of the "content delivery" of lecture in advance, so that the lecture hour can be devoted to more in-depth discussion, problem solving, etc. As well as development of the material, a formal evaluation is being conducted.
Fifty-one students from year 2 Chemical Thermodynamics module took part in this study. Students were provided with online lectures in advance of their lectures. Along with each online lecture, students were given a handout to work through as they watch the video. Each week, a quiz was completed before each lecture, which allowed students to check their understanding and provided a grade for their continuous assessment mark.
The evaluation is examining both the students' usage of materials and their engagement in lectures. This involves analysis of access statistics along with an in-class cognitive engagement instrument. The latter is measured by "interrupting" students as they work through a problem and asking four short questions which are drawn from another study, which aim to examine how students were engaging with the materials in that moment.
Results from this, along with access data, quiz scores, and student comments, aim to build up a profile of how the flipped lecture works for middle stage undergraduate students.

71. Sharples, M., A. Adams, et al. (2014). "Innovating Pedagogy 2014."
This series of reports explores new forms of teaching, learning and assessment for an interactive world, to guide teachers and policy makers in productive innovation. This third report proposes ten innovations that are already in currency but have not yet had a profound influence on education. To produce it, a group of academics at the Institute of Educational Technology in The Open University proposed a long list of new educational terms, theories, and practices. We then pared these down to ten that have the potential to provoke major shifts in educational practice, particularly in post-school education. Lastly, we drew on published and unpublished writings to compile the ten sketches of new pedagogies that might transform education. These are summarised below, starting with two updates to last year's report, followed by eight new entries, in an approximate order of immediacy and timescale to widespread implementation.

72. Shell, A. E. (2002). "The Thayer method of instruction at the United States Military Academy: a modest history and a modern personal account." Problems, Resources, and Issues in Mathematics Undergraduate Studies **12**(1): 27-38.
In 2002, The United States Military Academy at West Point celebrates its bicentennial. For most of those two hundred years the academy has taught its courses by what is known as the Thayer method of instruction. In short, the philosophy is that cadets are responsible for their own learning. They study the material prior to attending class. The learning is then reinforced in class through a combination of group learning and active learning exercises done primarily at

the blackboards. I will give a short overview of how instruction at West Point has evolved in two hundred years, along with a discussion of our current teaching methods and how they can be integrated into any science classroom.

73. Slezak, S. (2014). "FLIPPING A CLASS: THE LEARN BY DOING METHOD." ACS CHED CCCE Spring.
Two major advantages of the flipped classroom format are it allows for greater flexibility in the use of class time and enhances the quality and quantity of one-on-one teaching encounters between faculty and students. There are as many varieties of the flipped format as there are educators using it, so experience varies from classroom to classroom. What is important is the format should emphasize active learning on the part of the students, empowering them to take responsibility for the learning process. The teacher’s role becomes one of facilitator or coach.

74. Slomanson, W. R. (2014). "Blended Learning: A Flipped Classroom Experiment." Journal of Legal Education **64**(1): 93.

75. Talbert, R. (2012). "Inverted classroom." Colleagues **9**(1): 7.

76. Teo, T. W., K. C. D. Tan, et al. (2014). "How flip teaching supports undergraduate chemistry laboratory learning." Chemistry Education Research and Practice **15**(4): 550-567.
In this paper, we define flip teaching as a curricular platform that uses various strategies, tools, and pedagogies to engage learners in self-directed learning outside the classroom before face-to-face meetings with teachers in the classroom. With this understanding, we adopted flip teaching in the design and enactment of one Year 1 and one Year 2 undergraduate chemistry laboratory session at a higher education institution. The undergraduates viewed videos demonstrating the practical procedures and answered pre-laboratory questions posted on the institution's mobile device application before the laboratory lessons. Analyses of the lesson videos, interviews with the undergraduates and instructors, and undergraduate artefacts showed that the undergraduates had developed a better understanding of the theory undergirding the procedures before they performed the practical, and were able to decipher the complex practical procedures. They also experienced less anxiety about the complex practical steps and setup, and subsequently, improved work efficiency. The findings of this study have implications for chemistry educators looking for ways to improve on the design and enactment of the laboratory curriculum to enhance the undergraduates' self-directed learning.

77. Trogden, B. G. (2014). "Reclaiming face time: how an organic chemistry flipped classroom provided access to increased guided engagement." ACS CHED CCCE Spring.
Affording adequate time for students in organic chemistry to engage with material is a constant struggle for those teaching the course. By using the

flipped classroom model, students have more time in class to process information in the presence of the professor, while course content is not sacrificed. This paper will discuss what it means to ‘flip a classroom,’ how the classroom time can be restructured, and how it improves student success rates. In addition to presenting some alternative ways for flipping, this paper will also address the best means for implementation and how the flipped classroom ties into current research for cognitive theory.

78. Tucker, B. (2012). "The flipped classroom." Education Next **12**(1): 82-83.

79. Young, J. R. (2009). "When computers leave classrooms, so does boredom." Chronicle of Higher Education **55**(42): n42.