Flipped Classroom Field Guide

The Flipped Classroom Field Guide is a compilation of best-practices and community resources centered around the flipped classroom and blended learning initiatives of the Coursera-partner community. In addition to the resources outlined in the table of contents (including our Three Golden Rules of Flipping which have been shown to significantly improve student outcomes), be sure to click on the reports below to learn more about the instructors and their flipped classrooms that motivated and informed the creation of this guide:

Maya Adam flipped report

University: Stanford
Class: Child health and nutrition
Strategies: Applications, Extensions, Experiential learning
Size: 85 students

Dan Boneh's flipped report

University: Stanford
Class: Cryptography
Strategies: Sequence of questions, Applications
Size: 150 students

Doug Fisher's flipped report

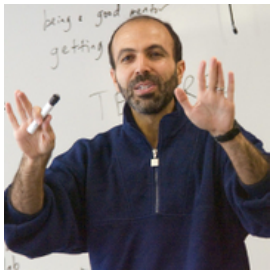
University: Vanderbilt
Class: Machine Learning, Databases
Strategies: Student-generated content, Small group problem solving, Applications
Size: 10 students, 30 students

Scott Klemmer flipped report

Name: Scott Klemmer
University: Stanford
Class: Human-Computer Interaction
Strategies: Small group problem solving, Experiential learning
Size: 250 students

Dan McFarland flipped report

University: Stanford
Class: Organizational Theory
Strategies: Experiential learning, Applications
Size: 44 students

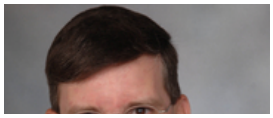


Mohamed Noor flipped report

University: Duke
Class: Genetics and Evolution
Strategies: Just-in-time teaching, Packet of problems, Sequence of questions, Small group problem solving
Size: 450 students

Scott Rixner/Joe Warren flipped report

University: Stanford
Class: Introduction to Python
Strategies: Extensions, Small group problem solving, Peer feedback, Applications



Kristin Sainani flipped report

University: Stanford
Class: Writing in the Sciences
Strategies: Collaborative Learning Activities Peer feedback, Discussion activities
Size: 12 students

Size: 70 students

Adrienne Williams flipped report

University: UCI
Class: Introductory Biology
Strategies: Applications, Extensions, Just-in-time teaching, Small group problem solving
Size: 75 students

Philip Zelikow flipped report

University: UVA
Class: Global History
Strategies: Applications, Discussion activities
Size: 76 students

Steve Everett flipped report

University: Emory
Class: Intro to Electronic Music
Strategies: Applications, Discussions
Size: 15 students

Larry Diamond flipped report

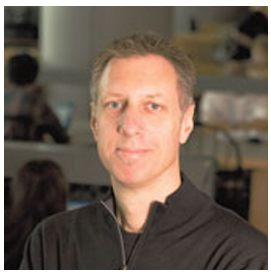
University: Stanford
Class: Democratic Development
Strategies: Discussion activities, Sequence of questions
Size:

John Booske flipped report

University: University of Wisconsin
Class: Analytical Methods for Electromagnetic Engineering
Strategies: Applications, Small group problem solving, Packet of problems
Size: 80+ students

Jen Campbell flipped report

University: Toronto
Class: Introduction to Programming
Strategies: Applications, Small group problem solving, Packet of problems, Discussions
Size: 500 students



Jeff Himpele, Princeton

Coming soon!

Greg Moses flipped report

University: University of Wisconsin
Class: Introduction to Programming
Strategies: Applications, Small group problem solving, Packet of problems
Size: 40 students

Laura Shaddock, Princeton

Coming soon!

Jeremy Adelman, Princeton

Coming soon!

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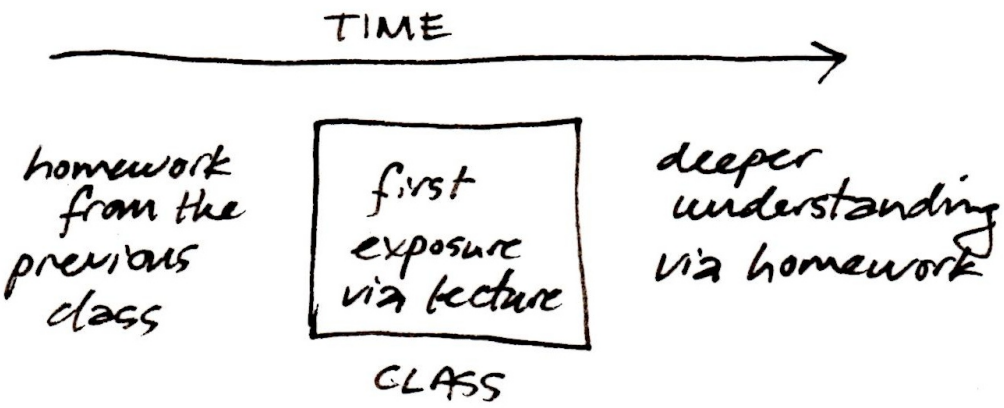
INTRODUCTION

What are flipped classrooms?

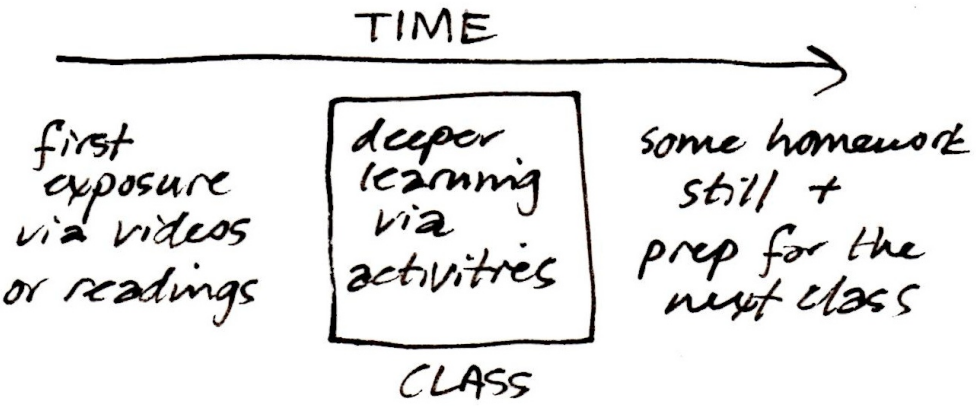
The flipped classroom is a teaching strategy that allows instructors to more actively engage with students in the classroom. In the flipped classroom, instructors typically assign recorded video lectures as homework, and use class time for active learning exercises and direct engagement with students. As Mung Chiang from Princeton said, "class time is for two-way interactions." Flipped classrooms help make these two-way interactions possible.

Derek Bruff from Vanderbilt contributed his own flipped overview to the Coursera Partners' Portal forums along with the following diagrams highlighting the differences between the traditional and flipped classroom model:

Traditional Classroom:



Flipped Classroom:



Flipped classrooms are a form of of blended learning, a term that refers to any form of education that combines face-to-face instruction with computer-mediated activities.

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The Golden Rules of Flipping

In flipped classrooms, students watch online lectures outside class and participate in engaged learning activities inside

class. This approach allows instructors to more deeply engage their students with evidence-based learning practices that can significantly improve student outcomes [1]. **Despite the many ways to implement this model, we've found that the most successful flipped classrooms have found creative ways to increase time on task and student engagement in the following ways:**

1. The in-class activities involve a **significant amount of quizzing, problem solving and other active learning activities**, forcing students to **retrieve**, **apply**, and/or **extend** the material learned outside of class. These activities are often **slightly easier** than those tackled outside of class, and are **directly relevant** to the out-of-class work.
2. Students are **heavily incentivized** through grading, in-class activities, and instructor expectations **to complete out-of-class work and attend in-person meetings.**
3. The in-class learning environments are ***highly*** **structured** (often planned down to the minute).

Results and examples

As a result of this model, pass rates in a circuits and electronics course at San Jose State jumped from 59% to 91%; students also scored an average of of 5.7% higher on the first exam and 9.6% higher on second exam [2]. Outside class, students completed online assignments and watched lectures. As seen below, the highly-structured in-class time centered around relentlessly quizzing students with various problem sets:

- 10 minutes: Content warm-up
- 15 minutes: Just-in-Time teaching
- 15 minutes: 3-4 students complete group quizzes
- 5 minutes: Quiz review
- 15 minutes: Individual quizzes
- 5 minutes: Quiz review
- 5 minutes: Wrap-up

Similarly, an engineering course at the University of Wisconsin observed the percentage of students scoring 95-100% on proctored exams increase from 3% in 2008 to 45% in 2012 [3]. Outside class, students watched online lecture videos and completed an online quiz; students were also given a short quiz on this material at the beginning of class. During class, students worked in pairs on randomly generated quiz questions:

- 5 minutes: Review quiz
- 5 minutes: Announcements
- 70 minutes: Students solve quiz questions in pairs

In a Stanford writing course, students spent out-of-class time watching online lecture videos and completing writing assignments [4]. In class, students participated in writing and peer-grading exercises (e.g. students wrote short essays and then graded the essays of their peers). At the conclusion of the course, 77% of students reported that the flipped model helped them learn more than the traditional lecture:

- 5 minutes: Content warm-up
- 3 minutes: Students presented with a writing prompt
- 20 minutes: Students complete writing prompt
- 15 minutes: Students assess each other's papers
- 2 minutes: Wrap-up

In addition to quizzing, other effective active learning activities include applications, extensions, asking a sequence of questions, student-generated content, experiential learning, discussion activities, giving a packet of problems, Classroom Assessment Techniques (CATs) and collaborative learning activities, all of which are described in detail in our Active

Learning Activities section.

1: Deslauriers, L., Schelew, E., & Wieman, C. (2011) Improved Learning in a Large-Enrollment Physics Class, Science, Vol. 332 no. 6031 pp. 862-864
2: Covitz, Akiba. "Reinventing Education in the Blended Classroom." *Coursera Partners' Conference, Philadelphia, April 2013.* (Video, slides)
2: Booske, John. Flipped Classroom Report from Coursera's Flipped Classroom Field Guide
3: Sainani, Kristin. Flipped Classroom Report from Coursera's Flipped Classroom Field Guide

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Why flip your classroom?

In flipped classrooms, instructors are able to more deeply engage with students in class by assigning lectures and other passive learning activities as homework and using in-class time for more active learning activities. This strategy yields a number of benefits to both students and instructors, including:

Improved educational outcomes: Studies have shown that flipped classrooms and blended learning environments can significantly improve educational outcomes when compared to traditional classrooms. The efficacy of blended learning environments and active learning strategies is well-documented in the literature: a 2010 meta-analysis from the Department of Education based on 45 studies showed that online learning is as effective as face-to-face learning, and that blended learning is considerably more effective than either. Additionally, Deslauriers, Schelew and Wieman (2011) compared two large sections of an introductory undergraduate physics course: one section was taught as a traditional lecture by an experienced, highly-rated instructor; the other was taught by an inexperienced instructor using active learning strategies. In the active-learning group, student engagement nearly doubled, attendance increased by 20%, and average scores on assessments increased from 41% to 74%. Similar results by Wieman (2011), Mazur (2009), and others, were obtained across multiple disciplines and diverse institutions. After Jeremy Adelman of Princeton flipped his class "A History of the World since 1300," he reported that he had "...never seen such good final papers and take-home exams in 20 years of Princeton teaching."

Efficiency: Lecturing and assignment grading are time-intensive activities. The long-run time savings from automating some of the repetitive lecture and grading activities allow faculty members to spend more time on active learning activities, teaching problem solving, and giving students personal attention and individual help. Similarly, autograded assignments allow instructors to quickly and efficiently evaluate each student's understanding of learned concepts.

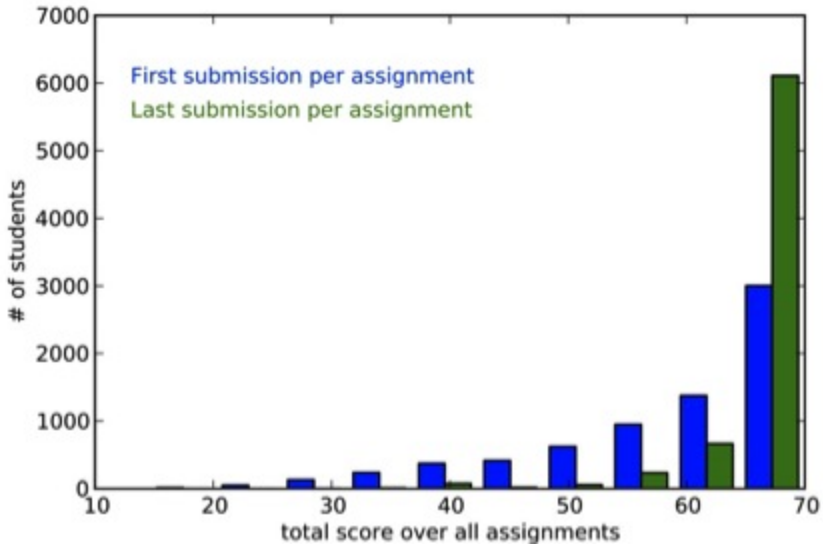
Interactive lectures: On the Coursera platform, instructors are able to intersperse in-video quizzes throughout their lectures, making the student lecture experience more interactive, dynamic, and personalized than traditional lectures. Instructors are also able to implement elements that would be difficult to incorporate into traditional lectures, such as animations, simulations, interviews with distinguished individuals in the field, etc. These features have value not only in maintaining student focus and engagement, but also in improving student performance: research shows that even simple retrieval exercises (e.g. in-video quizzes) are more effective than traditional study strategies and can significantly improve student outcomes (Karpicke & Roediger III, 2008; Karpicke & Blunt, 2011). Students also have the ability to rewind, pause, and speed up lectures in addition to watching them with subtitles, giving students more control in the way they navigate course content.

Data and analytics: Imagine starting your class knowing that 65% of your students answered the same wrong answer on a quiz they took the night before. In blended learning environments, educators are able to collect such data

on student performance, giving opportunities to target their lessons and address gaps in student comprehension while refining their teaching strategies for subsequent offerings of the course. This is particularly useful for those employing Just-in-time teaching.

Student-driven lectures: Despite the great variance of student learning styles and ability that exist in classrooms, traditional lectures are often one-size fits all. Video lectures, on the other hand, put students in the drivers seat, and allow them to engage with the material at their own pace, review confusing concepts, or break the lectures into easily-digestible chunks. More generally, flipped classrooms allow instructors to more easily implement a variety of differentiated instruction techniques.

Mastery learning: In mastery learning, students are encouraged to master each concept before proceeding to the next. This practice has been shown to increase student performance by about one standard deviation over more traditional forms of instruction (Bloom, 1984). To put things into perspective, this means that if 50% of a class passed a course in a traditional educational environment, approximately 84% of the same class would pass in a mastery-learning environment. For example, Martin Odersky from École Polytechnique Fédérale de Lausanne allowed students to take his quizzes as many times as they wanted in his Functional Programming Principles in Scala course. Many students kept taking the quiz until they received 100%, which unsurprisingly led to higher scores for that particular quiz. But students who chose to improve their scores by taking the quiz multiple times did better on future quizzes as well. For students of similar current performance, mastery-based score improvements correlate with future performance:



Multiple submissions encourage grade improvement. The data shown correspond to total cumulative scores across all assignments for all students who submitted every assignment in Ecole Polytechnique Federale de Lausanne's "Functional Programming Principles in Scala" taught by Martin Odersky.

Integrating Coursera's assessment tools (e.g. randomized assignments, immediate feedback, etc) into a flipped classroom allows for the utilization of this powerful pedagogical strategy.

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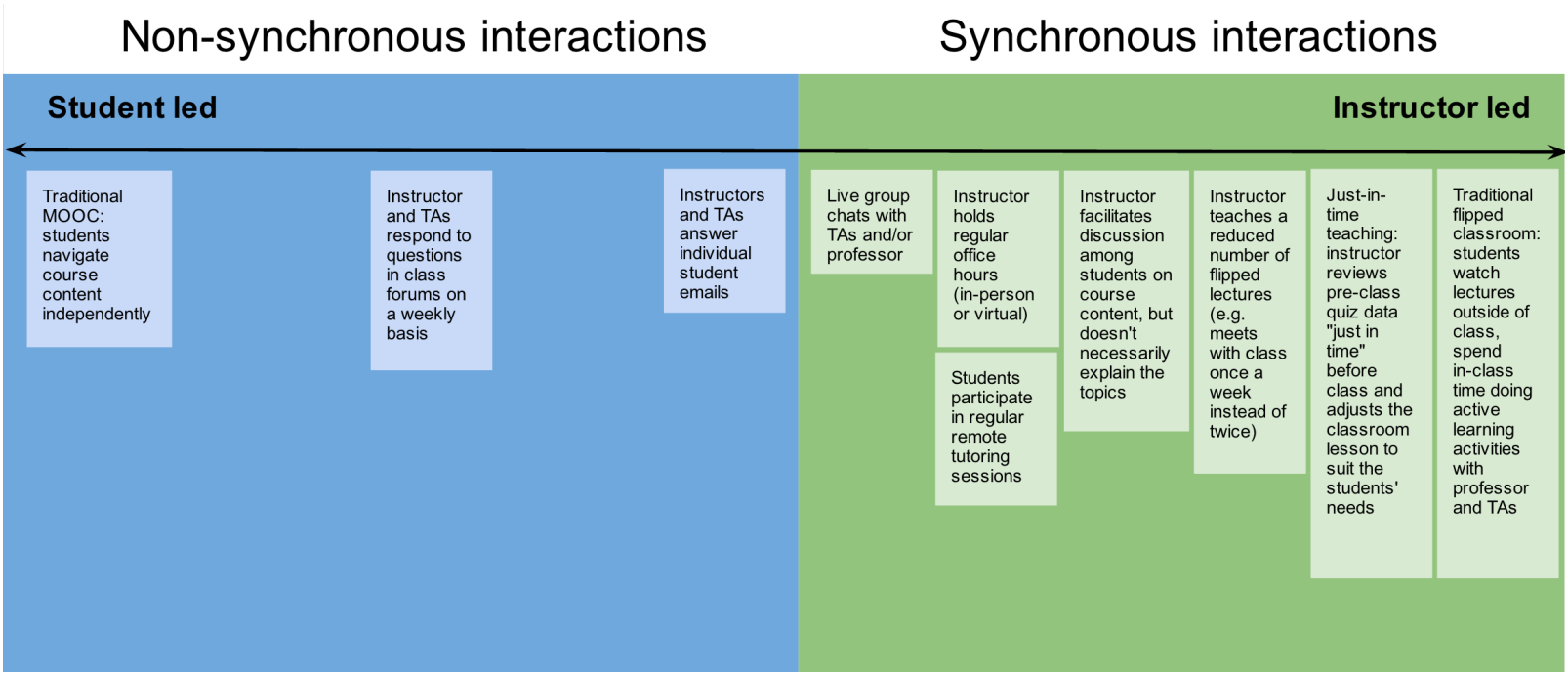
Blended learning models

Flipped classrooms (and blended learning environments more broadly) can vary greatly depending on the attributes of the class, student needs, and the level of involvement required by the instructor. Below, we've outlined some possible

blended learning models. These models are placed on a spectrum based on the level of instructor involvement in the course; we then further group these student-instructor interactions as synchronous and nonsynchronous:



In this section, we'll describe the two broad categories of blended learning environments: instructor- and student-led.

Instructor-led model

In an instructor-led flipped classroom, the instructor is typically involved in every aspect of the course and has ample opportunities to engage with students. Outside of class, students engage with the more passive elements of the course; inside class, students participate in active learning activities coordinated by the instructor. Such activities might include group discussions, role-playing games, case studies, group problem solving, team projects, etc.

One common instructor-led model involves Just-in-Time Teaching (JiTT). In most JiTT learning environments, students respond electronically to autograded assignments due shortly before class. After the specified deadline, the instructor reviews student submissions "just-in-time," and uses these data to adjust the lecture to better suit the students' needs. Mohamed Noor of Duke used this strategy with considerable success. The night before every lecture, Noor would review his students' answers to autograded assessments; he would then spend the first 5-10 minutes of lecture overviewing the concepts that students found confusing.

Student-led model

In a student-led blended learning environment, the instructor's involvement in the day-to-day running of the course is relatively low. Students have more flexibility and freedom in navigating the course content, and instructors have the option of using a variety of lower-touch strategies to interact with their students. In this model, the instructor acts more acts as an organizer or guide in the learning process, providing the resources and support necessary to allow learners to develop and shape their own learning. Examples of low-touch strategies that can be implemented by the instructor or other course facilitators include:

- Answering student questions via email or on the community forums
- Periodically giving feedback on student work
- Providing motivational nudges or reminders throughout the course
- Periodically holding open office hours

- Identifying students who are struggling with a concept and holding a facilitated discussion (perhaps in a small group) on that topic to help them get over the hurdle
- Periodically holding group video or text chats

Doug Fisher from Vanderbilt utilized a student-led flipped classroom model in his Fall 2012 Machine Learning course. Fisher required that his students take Andrew Ng's Machine Learning in its entirety and present a Statement of Accomplishment at the conclusion of the course. Because the course's assessments, lectures, and assignments were automated on the Coursera platform, Fisher only had to meet with his students once a week for 90 minutes. During these meetings, Fisher and his students discussed assigned journal readings, sometimes corresponding closely to topics in Ng's lectures and sometimes very different topics that Fisher thought it important to cover.

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Flipped101 Lectures by Andrew Ng

The following lecture series, created by Courser co-founder Andrew Ng, provide a high-level overview of the flipped classroom:

Lecture 1: "Introduction"
Learn why instructors should consider flipping their classrooms.

Lecture 2: "Getting Started"
Learn the basics of the flipped classroom, first-timer tips, and potential pitfalls.

Lecture 3: "Engaged Learning Activities"
Learn about engaged learning activities that can be used with students during class time.

Lecture 4: "Collaborative Learning Activities"
Learn strategies for engaging your students in collaborative learning activities.

Lecture 5: "Just-in-Time Teaching"
Learn about Just-in-Time Teaching, a strategy which allows instructors to use class time to target the concepts that their students need help with most.

Lecture 6: "Coursera Tools"
Learn how different tools on the Coursera platform can be used in a flipped classroom environment.

Lecture 7: "Conclusion"
Watch a review of the major elements of the Flipped Classroom Lecture Series.

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GETTING STARTED

Quick start

Ready to flip your class now? While every flipped classroom will vary depending on a number of factors (e.g. class size, content, professor, school resources, etc.), many follow a process similar to the following:

1. **Give students an opportunity to gain first exposure to lectures before class**
    a. *Quick tip:* Try recording your lectures and breaking them into smaller conceptual chunks.
2. **Provide proper incentives for students to prepare for class**
    a. *Quick tip:* Pairing lecture video with autograded assessments helps ensure that students are prepared for the subsequent in-class activities.
3. **Facilitate engaged-learning activities in the classroom**
    a. *Quick tip:* Possible activities include small-group problem solving, extensions, applications, and peer feedback.
4. **Create opportunities for student feedback**
    a. *Quick tip:* Try Just-in-Time teaching by using student feedback and assessment performance to calibrate your in-class activities.

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Potential Pitfalls

Flipping your class for the first time can be a difficult process. To help you put the best foot forward, we've compiled a list of potential pitfalls collected from our partners:

Pitfall: Professors don't "sell" the flipped classroom
Notes: Given the pervasiveness of the standard lecture, some students may resist the implementation of a flipped classroom. Be mindful of how you frame their new learning environment. For example, some professors avoid using words such as "experimenting" or "flipping," as these terms are loaded with preconceived notions which might not be true or applicable to your class. However, it's also important to be as transparent as possible about the motivations behind the change as well as the benefits of flipped classrooms and blended learning environments more broadly. Similarly, make sure that your students understand the logistics of the new system, from the grading of participation and assessments to how to use the technology. As Adrienne Williams of UCI reports, its important to "sell the class": "Many students are concerned that the flipped format will force them to "learn on their own" and increase their study load. Take time to explain the research supporting it. Here is a sample of our "Introduction to the class" video students watched before the first day of class in order to understand the format, and a copy of the first day's in-class presentation slides that explain why we are flipping."

Pitfall: Classroom space is not conducive to flipping
Notes: The physical space of a classroom is one of the most important (and often, underestimated) factors of a successful flip. Scott Klemmer reported that the classroom for his Human-Computer Interaction class was "terrible" for flipping, and that this was the biggest obstacle he encountered during the flip. Because Stanford only has seven classrooms that hold more than 239 students and they're all "too cavernous," Klemmer plans to cap enrollments for his next offering at 239 people, which will enable him to use more flip-friendly spaces on campus. Klemmer stated that his "number one recommendation for Stanford is to physically to redesign the classrooms" to make them more conducive to flipping.

Pitfall: Students don't show up for lecture
Notes: Flipping your class can have mixed effects on attendance: Duke observed improved attendance for each of their

flipped classes because students felt that class time was more engaging; other partners have experienced a dip in attendance after flipping a class, possibly due to students feeling there's no need to come to class when the lectures are readily accessible online. These anecdotes highlight the importance of properly pitching the flipped classroom when implementing it for the first time, and also incentivizing students to come to lecture. Mohamad Noor from Duke noticed a significant drop in attendance for his course: of the 450 students enrolled, an average of only 250 or so showed up for his in-class activities. The next time he runs his course, Noor will administer in-class quizzes to address the drop in attendance. To accommodate his students' schedules, he's considering allowing them to drop their seven lowest quizzes. He hopes this will nudge them to attend the in-class lectures, while still providing enough flexibility for those with legitimate excuses for missing class.

Pitfall: In-class activities are not relevant to out-of-class lectures
Notes: Many professors have reported difficulty in designing in-class activities that cohere with the out-of-class lectures. Scott Klemmer stated that one of the greatest challenges that arises when putting your lectures outside of class is trying to design in-class activities that overlap with those lectures. Similarly, Doug Fisher (Vanderbilt) reported that the most difficult part of flipping his classroom was finding moments of overlap and connectedness between the journal articles his students discussed in class and the pre-recorded lecture videos on Coursera: "students had more of a sense of schism or disconnect..the degree of coupling is something that instructors should really focus on when planning their flipped classrooms."

Pitfall: Instructors assign students too much work
Notes: Many educators are accustomed to giving assignments outside of class that complement their in-class lectures. When flipping, it's important to be sensitive to how changes to the classroom structure affect your students' workload. In particular, by not adjusting the amount of homework students are expected to complete outside class in addition to the added video lectures, professors risk doubling the amount of out-of-class work. To avoid overworking your students, try reducing their homework by focusing your learning goals and trimming unnecessary content. This tip was summed up well by Adrienne Williams of UCI: "Remove unnecessary content. We were able to easily convert our lectures to video because we had already written our learning goals, and had previously trimmed extraneous content from our lectures to make space for clicker questions and group activities. If you are converting a dense, traditional lecture to a flipped class, take this opportunity to remove content that only tests student recall and does not further your learning goals. This essay by G. Bergrom at Univ. Wisconsin is an excellent example of how to modify a course." Instructors could also try reducing class time to compensate for the increased amount of out-of-class work.

Pitfall: Not all students have equal access to online materials
Notes: It's important to remember that not all students have access to basic technologies such as computers or high-speed internet. With this in mind, it's important that every student is aware of public, easily-accessible computer resources (e.g. school libraries, public libraries, internet cafes, etc) that will allow them to access the course materials. Publicly sharing such information helps ensure that those who need extra help will have it available to them, even if they're too embarrassed to ask. Also, make sure students understand the technology before asking them to use it. Stanford's Dan McFarland ensured that his students were up to speed by having representatives from the IT office in class when students tried to access his course content for the first time.

Pitfall: Instructors don't realize the amount of preparation necessary for in-class activities
Notes: Some professors have reported being surprised at the amount of work that flipping a classroom requires. After flipping his Machine Learning Course, Doug Fisher from Vanderbilt says that one of the main things he learned was that the instructor "has to do a lot more work in advance when flipping the classroom." Don't fall into the trap of assuming that technology will reduce amount of the time you invest in your course; many professors report investing *more* time in their flipped courses (at least initially- reusable lectures can increase efficiency in the long run) due to the extra time involved in filming their lectures and creating in-class activities. Remember, it's not the technology, but the

pedagogy that drives the success of blended learning environments. Flipping your classroom for the first time will take work, innovation, and perseverance to realize the long-term gains.

Pitfall: Students aren't completing work assigned for outside of class
Notes: Some professors have reported difficulty in getting their students to complete the pre-class activities (e.g. watching video lectures). This can be problematic in a flipped classroom environment, in which the pre-class activities are often a necessary prerequisite for the in-class activities. As such, students who don't prepare are unable to realize the full benefit of the flipped classroom. Using assignments to test student comprehension of the lecture videos is one way to ensure that students do the work outside of class and are therefore able to be more productive in the subsequent lectures. Another strategy is to encourage students to watch lectures together in groups. This will help students keep one another on track while providing additional opportunities for discussion around the presented topics. Scott Rixnor and Joe Warren of Rice addressed this problem by dividing their students into two groups: those who had done the homework and those who hadn't. Those who hadn't spent class time working on the homework; those who had were presented with challenging problems that extended the homework in interesting ways. Rixner reports: "By splitting up class...I was able to give individualized attention to students lagging behind; for the students running ahead, I could give individualized attention...and push them further and have interesting debates and discussions about the material in the class" (more info here).

Pitfall: Instructors have difficulty accommodating the varying ability levels of their students during in-class activities.
Notes: Accommodating for the variation in student ability in a flipped classroom can be difficult. Scott Klemmer from Stanford experienced this when trying to coordinate programming labs for his Human-Computer Interaction course: "the challenge is that different students program at different rates. In any project that I assign, there will always be one student who is done in 40 seconds, and another who won't be able to open the file by the end of the class." Klemmer said that designing in-class activities that can accommodate both of these populations is very tricky.

Pitfall: Instructors are unable to successfully flip large lectures
Notes: Flipping a lecture hall of 300 is a daunting task; doing so with limited or no teaching assistants may seem impossible. Some instructors have found it necessary to break up their classes into smaller groups. Philip Zelikow of UVA decided to break his 120-person class into two back-to-back sessions because he finds it "prohibitively hard" to run discussion if there are more than 50 or 60 students in a class. Similarly, Maya Adam reported that she prefers not to teach a class of more than 50 ("I like students to feel that I know who they are"), so she divided the students into two smaller groups.

For those who wish to flip large lectures with limited resources, try training a group of student TAs to facilitate your blended learning activities. For example, a professor wishing to flip their large lecture could take the following steps:

- Approach top-performing students from the current or most recent iteration of the brick-and-mortar course about serving as student TAs
- Meet with student TAs to review the course syllabus and in-class activities that they'll be facilitating
- Break up the students into small groups
- Use student TAs to facilitate group problem solving activities in these groups

While this model will work for some, there are still a number of obstacles when flipping large classrooms. One of these is dealing with the physical constraints of the classroom: sometimes, no matter how many TAs or how well-planned the activities, a classroom simply will not be conducive to small group problem solving activities. In these situations, try relying on partner work, individual work, or engaged learning activities that can be completed with one or two students.

Pitfall: Professors don't put in place mechanisms to collect metrics for feedback
Notes: There's no flipped formula that will work for every classroom, so its important to use metrics to evaluate the efficacy of your newly-flipped class. Give your students ample opportunities to give feedback on the activities,

assessments, and their overall course experience. For example, you could compare different active learning techniques across sections by comparing assessment scores. This feedback paired with performance metrics can be used to recalibrate and refine your flipped classroom experience. Duke professor Mohamad Noor used qualitative feedback to adjust his lessons by including the question "what did you find interesting or confusing?" at the end of each of his autograded assessments.

Pitfall: Professors don't engage fellow instructors about their flipped experiences
Notes: Often times your fellow educators will be your best resource for designing and implementing an effective flipped classroom; use them as much as possible by sharing your ideas and soliciting their input! Some of our instructors have had great success in setting up regular lunch chats with their colleagues, during which they discuss their flipped classroom experiences and brainstorm innovative ways to more deeply engage students with the material. Also, be sure to visit the Partners' Portal forums to discuss flipped classrooms and blended learning with others in the Coursera community.

Pitfall: Professors still act as the "sage on the stage" rather than the "guide on the side"
Notes: Perhaps one of the most common and deeply-ingrained conventions of the traditional lecture is that in-class time revolves around the professor. In flipped learning environments, class time revolves around the students, a switch Jeremy Adelman of Princeton experienced; Adelman described his new role in his flipped classroom as that of a "coach." Getting used to this shift can be difficult, especially for professors who have grown accustomed to being the "sage on the stage" after many years of lecturing. There are ways to proactively address these old habits: Andrew Ng from Stanford would consciously turn his back to students and do his own work during in-class activities, encouraging them to not rely on him for the answers and communicating that that *they* were facilitating the activity, and therefore, their own learning.

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ACTIVE LEARNING ACTIVITIES

Filming your lectures is just the beginning of flipping your class. The next step, often the most important and challenging, is deciding what to do with the newly-available in-class time. In this section, we'll review some effective learning activities for a flipped classroom and tips for their implementation.

Applications

Application activities give students the opportunity to use what they've learned to solve problems and grapple with learned concepts in novel ways. The variations of application activities are endless. Some examples from different courses include:

- **Sociology and current events**: Ask students to apply learned sociological concepts to analyze and deconstruct current events.
- **Business class and differentiation strategy:** After teaching students about the different variables that must be true in order for a differentiation strategy to succeed (e.g. customer not price sensitive, market is competitive, some customers have narrow needs, company has unique resources which are hard to duplicate, etc.), take one or more real-life companies and evaluate whether a differentiation strategy might succeed in the business.
- **Foreign language class:** After teaching simple past tense, encourage students to tell one of their classmates a simple story from their childhood.

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Extensions

Extension activities require students to derive properties or theoretical extensions of what they've learned. Some professors characterize extensions as the concepts or skills that they would've taught had there been more time. These activities deepen students' understanding of the material by encouraging them to apply learned concepts to a novel domain. Some examples of extension activities include:

- **Fitting a straight line to a data set:** If you have a plot with m data points, how long does the software take to run as m increases? This is an extension of the material where students are deriving a property of a piece of software that they just learned how to write.
- **Teaching the concept of comparative advantage in an economics class:** Imagine there are two countries that each produce varying amounts corn and what. The concept of comparative advantage lets you calculate how much corn and wheat each should produce in order to maximize the overall welfare of the citizens of both of these countries. An extension activity could involve asking students to calculate how citizens from *three* countries would trade off their production of corn and wheat to maximize everyone's welfare.

Scott Rixner and Joe Warren used extension activities in their Introduction to Python course. Once in class, students were divided into two groups: those who had done the homework and those who hadn't. Those who hadn't spent class time working on the homework; those who had were presented with challenging problems that extended the homework in interesting ways. Rixner reports: "By splitting up class...I was able to give individualized attention to students lagging behind; for the students running ahead, I could give individualized attention...and push them further and have interesting debates and discussions about the material in the class."

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Sequence of Questions

In a sequence of questions activity, complex problems are broken into smaller parts and then solved systematically with the students. This process of breaking complex problems into smaller bits has been shown to improve learning outcomes (Marzano, Pickering, & Pollock, 2001). Some best practices for this technique include:

- **Pick the right problem:** Pick a problem that you'd like students to get to be able to solve, but is too hard to offer all at once. This problem should have a significant and challenging end result that would be very difficult to solve if not tackled incrementally.
- **Break it down:** Break down the problem into as many pieces as possible
- **Solve incrementally**: Have students solve incrementally, repeatedly layering on complexity
- **Let students grapple with the question:** Research has shown that by increasing the amount of "wait time" after asking a question, teachers foster increased student discourse and more student-to-student interaction (Fowler, 1975).
- **Pace yourself:** Be aware of the number and difficulty of the questions you're asking your students. Students should have sufficient time to grapple with each question before moving onto the next.
- **Go beyond recall:** The most effective questions go beyond asking students to simply recall information. Research has shown that higher-level questions that ask students to analyze information result in more learning than just asking students to recall information. (Redfield & Rousseau, 1981).

Examples of the sequence of questions technique include:

- **King Lear:** Discuss the topic of literal vision and metaphorical blindness. Analyze the metaphor in the context of one of the characters (e.g. Gloucester), then another (e.g. Lear), and then tie them together into a unifying theme.
- **Mathematical proofs:** Help students guide themselves through incremental pieces of proof.
- **Comparative advantage:** Discuss the concept of comparative advantage in the context of two countries and two goods. Propose a situation with two countries and three goods, three countries and two goods, and then show why three countries and three goods results in the math breaking down.

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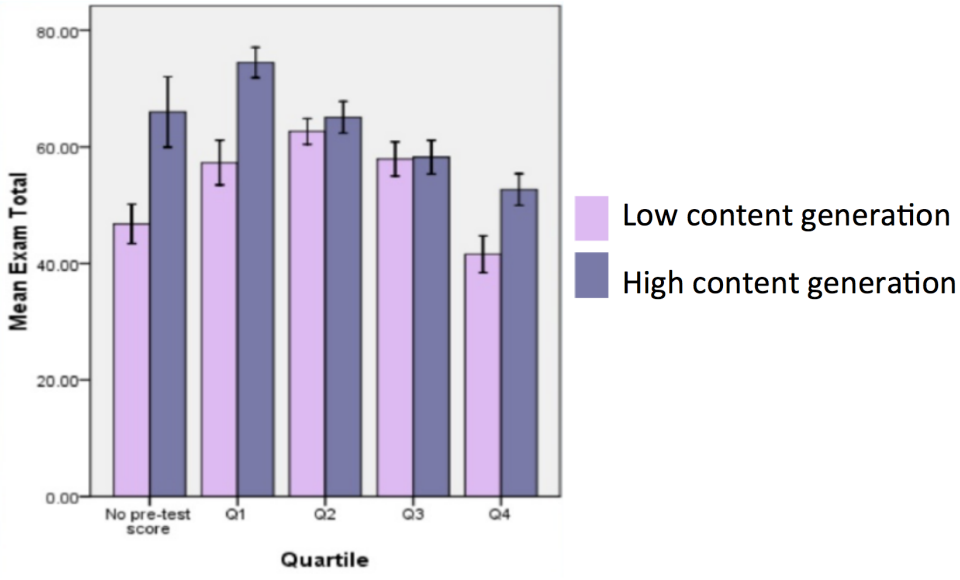
Student-generated content

In many traditional classrooms, students are viewed as content consumers whose role is to absorb and reproduce information for various assessments. In blended learning environments, students are able to create and share "student-generated content" with their peers. There are a variety of ways to solicit, curate, and use student-generated content that vary by course and the available technologies. Some common ways to have students interact with student-generated content that can be applied across any number of courses include:

- Students curate course learning materials in a public, online space. This could include defining terms, creating assessments, compiling relevant resources, etc.
- Students create blogs, videos, podcast, poems, quizzes, etc relevant to the lesson.
- Students share their work with the rest of the class, making their products central to the trajectory of the class.
- Students comment on (and possibly evaluate) one another's work.

There are many advantages to integrating student-generated content into your flipped classroom. For one, students feel as if they have more ownership over their learning and the trajectory of the course. In addition, the use of student-generated content in a course has been correlated with improved student outcomes. For example, in a study conducted at the University of Edinburgh, researchers demonstrated a significant correlation between participation in student-generated content activities and course performance in an introductory Physics course. The following graph illustrates that students who generated more content performed significantly better than their peers on in-class exams:



Student-generated content coursera tools

A number of Coursera tools can be used to facilitate the creation and sharing of student generated content. These include:

- Editable wikis
- Class forums
- Peer assessments

General guidelines

Keep in mind the following best practices as you attempt activities involving student-generated content:

1. **Experiment with different formats**: With the aid of technology, students can produce and interact with student generated content in a number of ways. Encourage students to be creative in how they share and interact with this content. **Feedback**: The process of giving feedback on student generated content is a valuable learning opportunity for students. Carve out ample opportunities for these sorts of exchanges, both between students and between student and professor.
2. **Help students help you!:** By giving students a stake in the content creation process, professors are gaining an incredible resource. Use student content and feedback to approach problems in novel ways, enliven boring or dry activities, and encourage students to more deeply engage with the course content.
3. **Set clear standards**: It's important to set clear standards for student-generated content, especially when the content will be used by other students in the course. Properly incentivize high-quality work through grades and clear, direct feedback on student work.

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Experiential learning

In experiential learning activities, students learn through immersive, hands-on learning experiences. These may differ from application activities in that students are learning new concepts from experiences, rather than reinforcing previously learned activities through novel applications.

The pedagogical benefits of these learning experiences have been well-documented in the literature and demonstrate the efficacy of simulation environments and modeling in enhancing learning (Gordin & Pea, 1995).

Experiential learning activities can take a number of forms, including role-playing, experimentation demonstrations, trips, labs, computer simulations, competitions, debates, and trips. When evaluating your planned experiential learning activity, try asking yourself the following questions:

- Are students actively involved in the experience, as opposed to being passive observers of the experience?
- Do students have the opportunity to collaborate and cooperate with their peers?
- Do students have the opportunity to cultivate awareness about their learning? Are they given time to reflect on the experience after it's completed?
- Do students possesses the knowledge base and analytical skills to conceptualize the experience, and realize desired educational outcomes?
- Do students have the ability and opportunity to use the new ideas gained from the experience (perhaps in

subsequent in-class activities such as applications or extensions)?

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Modified lectures

Modified lectures can be used to introduce new topics or individuals into the classroom. Example modified lectures could include guest lectures, advanced lectures, or lectures on current events. When possible, try to engage learners in these guest lectures as much as possible and avoid the passive-lecture paradigm, possibly by incorporating complementary engaged learning activities.

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Discussion activities

Organized discussion activities are frequently used in flipped learning environments to facilitate peer-to-peer exchanges and a deeper engagement with the course content. Many effective discussion activities:

- Begin with thoughtful questions, anecdotes, illustrative quotes, current events, or controversial statements about the lecture videos and/or readings viewed outside of class
- Are well-structured and organized beforehand
- Set clear expectations for participation and civility

Benefits

Discussion activities have the potential to yield great benefits to your flipped class. These include:

- Making course concepts more meaningful and relevant to students
- Helping students to explore diverse perspectives
- Testing student assumptions
- Improving student communication skills
- Developing a better understanding of your students' perspectives

Example activities

There are a number of ways to structure your in-class discussion activities. Check out some ideas for ideas on engaging students in classroom discussions from Brookfield and Preskill's *Discussion as a way of Teaching* (1999) below:

The Circle of Voices Activity
Steps:

1. Pose a question, read a passage, make a statement, etc., that relates to the course content.
2. Ask students to form groups of 4-5.
3. Allow students a few minutes of quiet time to organize their thoughts.
4. Give each student three minutes of uninterrupted time to respond to what was proposed in step one
5. After everyone in the circle has had their three minutes, the discussion is opened up with the following ground rule: students are only allowed to talk only about other people's ideas, not expand on their own ideas (unless asked a direct question).

Circular Response Activity

There are six ground rules in this activity:

1. No one may be interrupted while speaking.
2. No one may speak out of turn in the circle.
3. Each person is allowed only three minutes to speak.
4. Each person must begin by paraphrasing the comments of the previous discussant.
5. Each person, in all comments, must strive to show how his or her remarks relate to the comments of the previous discussant.
6. After each discussant, the floor is open for general reactions (can be timed or not).

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Packet of Problems

A very simple engaged learning activity (especially for those teaching large lectures) is to give students a packet of problems to solve in class. In Mohamed Noor's Introduction to Genetics and Evolution lecture, the first 5-10 minutes were spent overviewing the concepts that students identified as confusing. After this review exercise, students would break into groups and solve a packet of questions distributed by Noor and his TAs. During this time, Noor and his TA's would walk around the room and offer help or challenge students as needed (e.g. "How did you come up with this answer?" "Why do you think that?" etc.). Twenty minutes before the end of the class, Mohammed would review the solutions to the problems in the packet. The last 5-10 minutes of the course were spent discussing what students indicated as "interesting" on the pre-class quiz (e.g. "We talked about topics like 23 and me, what services they offer, the ethical responses to the service, etc.")

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Classroom Assessment Techniques (CATs)

Classroom Assessment Techniques (CATs) are ongoing formative assessments that facilitate learning and provide both student and professors with feedback about their learning and teaching, respectively. For example, used a quick CAT Mohamed Noor (Duke) by asking his students "What did you find interesting or confusing?" after every quiz. He would then review their progress the night before class, use their answers to guide the slides he'd make for the class period. At the beginning of class, Mohamed would address what students found confusing; at the end, he would elicit conversations around what they found interesting.

Effective CATs are typically learner-centered, beneficial to both the instructor and student, formative, context-specific and ongoing.

Commonly used CATs:

Some commonly used CATs that have been used successfully in higher learning environments include:

The minute paper: The minute paper is a short informal writing assignment that typically occurs at the end of a lecture. Minute papers are straightforward, require relatively little time, and can be assessed easily, which is likely why they are one of the most commonly used CAT methods used in large lectures. Steps for using the minute paper technique are outlined below:

a. **Present the topic:** Ask a specific question that involves a key concept from lecture or use a general question such as "What is the most important thing we discussed today?"
b. **Student reflection:** Either have students work individually or divide the class into informal groups and give them up to few minutes to consider their answer to the question.
c. **Writing:** Have each group appoint a reporter and have them write a few sentences to answer the question. Collect the writing assignments for later review. Give one minute only for writing.
d. **Assessment of content:** Review the minute papers following class to determine if student perceptions of lecture material corresponded to your teaching and learning goals. If there is a common misconception or a gap in comprehension it can be addressed at the start of the next lecture period.

Concept maps: concept maps are a common CAT that involve asking students to produce drawings and diagrams that illustrate the connections between learned concepts. Research has shown that presenting information graphically as well as symbolically reinforces vocabulary learning and supports reading skills (Brookbank Grover, Kullberg, & Strawser, 1999; Moore & Readence 1984). With the aid of concept maps, students can accomplish the following:

- Synthesize and integrate information and ideas
- Think holistically by seeing the whole as well as the parts, and the relationships among them
- Think creatively about a subject
- Improve memory and comprehension of learned content
- Develop higher-level thinking skills, strategies, and habits

Additional CAT activities can be found here. For more information about CATs, check out this overview of *Classroom Assessment Techniques: A Handbook for College Teachers*, by Thomas A. Angelo and K. Patricia Cross.

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COLLABORATIVE LEARNING

Most engaged learning activities can be used in collaborative learning environments. The engaged-learning activities below are unique in that they rely on collaboration amongst peers, and lend themselves well to collaborative/group learning opportunities.

Regardless of the flipped model you plan to implement, the introduction of collaborative learning activities are encouraged; studies have shown that students who meet in learning groups at least once a week show significant improvements in learning (Marzano, Pickering, & Pollock, 2001).

Considerations when grouping students

The foundation of most collaborative learning activities in flipped classrooms is the formation of effective student groups. There are a number of factors to consider when grouping your students, some of which include:

- **Positive interdependence**: group members share mutual goals, joint rewards, grading incentives, etc.
- **Resource interdependence**: each group member has different skills or resources that must be used to complete the assignment
- **Role interdependence**: each group member is assigned a specific role; each group member understands how this role fits into the groups overall process

- **Group dynamics:** students are encouraged to be positive and encouraging.
- **Interpersonal skills:** students are encouraged to use effective interpersonal and small-group communication skills, helping them effectively communicate with one another, share ideas, disagree, etc.

Some best practices for putting your students into effective groups include:

1. **Structure groups based on your needs**: Determine what type of group would best help your students reach the desired educational outcomes. For example, you might weigh the pros and cons of having ad hoc groups during every class, or consistent groups that endure across multiple classes.
2. **When possible, keep groups small**: Typically, the larger the group, the more difficult it is to encourage each of the group members to actively participate in the group activites.
3. **Mix it up**: Ensure that students have the opportunity to work through problems on their own and not just with their peers.
4. **Clearly identify expectations of group work**: How will the success of the group and the individual members be assessed? Ensure that these and other expectations are clearly presented to students before they begin their group work.
5. **When possible, form randomized, heterogenous groups**: Collaborative learning activities are an excellent opportunity for your students to learn to work with people of different ability levels and backgrounds. When possible, try to make these groups as heterogeneous as possible; research has shown that low-ability students perform worse when grouped in homogeneous ability groups (Kulik & Kulik, 1991, 1997; Lou et al, 1996).

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Small-group problem solving

Small-group problem solving activities are some of the most popular uses of in-class time. After breaking up the class into small groups, the instructor can present any number of problem-solving activities (many of which could be modified versions of the aforementioned engaged learning activities) for the groups to tackle. While students are working, the professor and his/her TAs can visit each of the groups, guide the conversation, help the groups that are struggling, and further challenge those that are not. Many studies have demonstrated the efficacy of small-group problem solving, such as those that suggest improved learning in STEM classes, particularly amongst science minorities such as women and ethnic minorities.

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Mazur's peer instruction model

"Peers make the best instructors because they remember what it is not to understand."

Mazur's peer instruction model is a systematic process for encouraging collaborative learning amongst peers. This model is easy to implement, cost-effective, and applicable to nearly any subject or class. The model in it's most basic form typically includes the following steps:

1. Instructor poses question
2. Students reflect on the question
3. Students commit to an answer
4. Instructor reviews student responses
5. Students discuss thinking with peers

6. Students commit again to an individual answer
7. Instructor again reviews responses and moves on to the next concept unless more explanation is needed

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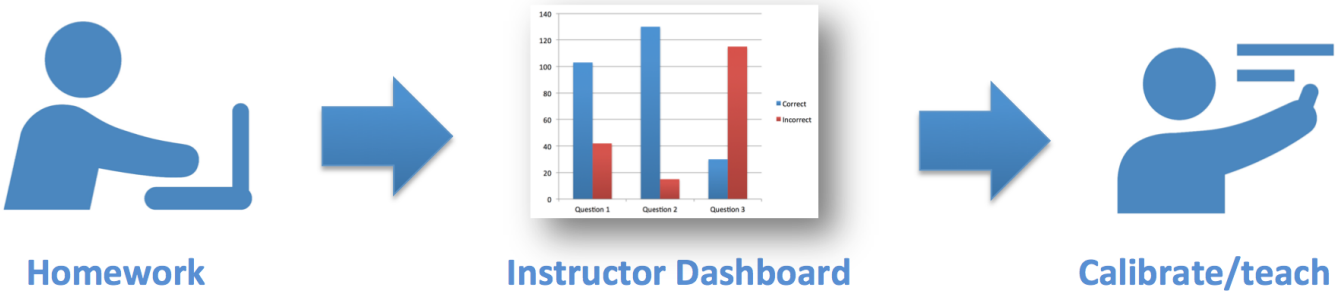
Peer feedback

In peer feedback activities, students participate in the process of evaluating their peers. This turns every stage of the assessment process into a learning opportunity, from completing the assignment to evaluating the work of others. A study conducted by Atay and Kurt (2007) revealed that peer feedback activities can increase student self-confidence, build social affective strategies, and allow for deeper engagement with the course material.

This strategy can be applied to nearly any course or subject matter. One common peer feedback process is comprised of three stages:

1. **Assignment/rubric design:** Creating the assignment and corresponding rubric
2. **Content creation:** Allowing students to complete the assignment
3. **Peer assessments:** Facilitating a peer assessment activity between peers or groups of peers in the class



Rubric Design:

Despite many instructor's emphasis on the creation of the assignment, well-written rubrics have been shown to be particularly important in improving learning outcomes: research has shown that criterion-referenced feedback can significantly improve student understanding (Crooks, 1988; Wilburn & Felps, 1983). Check out some effective rubrics created by other instructors on the Peer Assessment Gallery in the Partners' Portal, and a detailed overview of creating effective rubrics and assignments in our support docs. Consider the following suggestions when creating your rubric:

- Break down your grading process into individual components, and communicate the weighted importance of each component. Break each component into its individual components.
  - Example components are: depth of analysis, grasp of course materials, strength of thesis/argument, evidence, conclusion, organization, style, clarity, etc.
  - The grading component "Did the author build a convincing argument?" is more effective when what comprises a convincing argument is explicitly outlined, for example "Does the argument contain a clearly articulated thesis?", "Does the author use data to support the argument?", etc.
- Provide examples
  - For each of the rubric elements, what is an example to illustrate an answer that would receive that score?

- Provide opportunities for both quantitative and qualitative feedback
- Be as explicit and descriptive as possible.

Assignment Design:

Consider the following suggestions when creating your peer assessment assignment:

- Communicate learning objectives
  - What will students learn by doing this assignment?
  - How does this fit with the broader learning objectives of the class?
- Communicate with extreme clarity
  - Are your instructions clear enough that students from all over the world with different backgrounds and different English language capabilities will understand the assignment and expectations for its completion?
- Provide examples
  - What is an example of a great answer or assignment?

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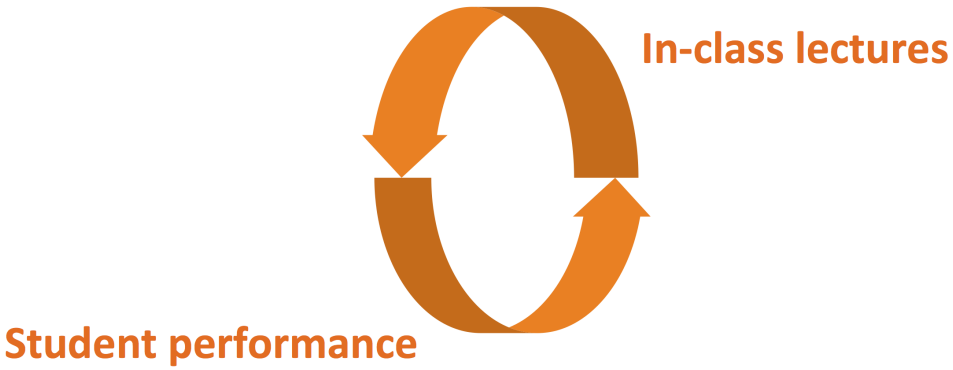
JUST-IN-TIME TEACHING (JiTT)

Just-in-Time Teaching is a pedagogical strategy in which instructors use student-performance data to understand which concepts students are struggling with and pinpoint particular students who are more at-risk, in order to give these students more personalized attention.

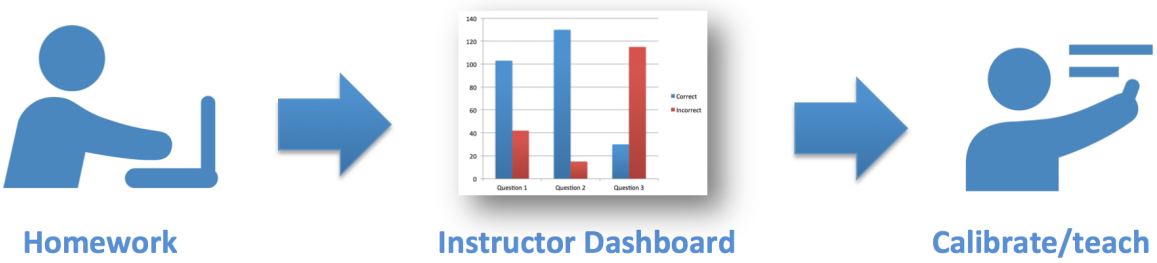
In most JiTT learning environments, students respond electronically to autograded assignments which are due shortly before class. After the specified deadline, the instructor reads student submissions "just-in-time," and uses these data adjust the classroom lesson to address the students' needs. Thus, the heart of JiTT is a "feedback loop" formed by the students' performance on out-of-class activities and the subsequent lectures tailored to their performance:



How to implement JiTT

Effective JiTT relies on well-designed assessments administered before lectures. These assessments will likely be short, autograded, and designed to give professors relevant feedback on the direction of lectures that follow. Ideally, the

pre-class assessments are administered as close as possible (e.g. the night before) to the subsequent lecture, ensuring that the information covered is as relevant and timely as possible:



The different strategies for using these analytics are constantly evolving. For example, some have found great success in grouping students in different sessions based on their assessment performance: if a group of students are struggling with a particular concept, one could hold a session just for those students, or an advanced session for students who displayed a greater mastery of the material.

JiTT Best Practices

Interested in trying JiTT? Read over the following best practices generated from the experiences of other JiTT instructors:

Maximize student participation: Make an effort to maximize student participation in the pre-class assessments. The more students who participate, the better understanding you'll have of your class' relative strengths and weaknesses.

Ask the right questions: Be meticulous when structuring your pre-class assessments. Ensure that each of the desired concepts is covered, and that each question will yield relevant and actionable data. One way to test each question is to make a list of the possible explanations of why students might choose each incorrect response; the fewer explanations you're able to generate, the more confident you'll be in addressing the source of their confusion in lecture.

Be realistic: After looking over the pre-class assessments, select a reasonable number of concepts to cover in the following lecture. Remember that the pre-class data will likely reveal more gaps in student comprehension that you can cover in a single lecture. Instead of superficially addressing all of these gaps, select a few that you can thoroughly cover within the lecture before moving onto the next concept, a strategy that helps engender the benefits of mastery learning.

Autograding: Whenever possible, rely on auto-graded assessments to inform the direction of your lectures.

Give timely feedback: Whenever possible, try to address student comprehension gaps as soon as they are identified: research has shown that delay in providing students with feedback on misunderstood concepts diminishes its value for learning (Banger-Drowns, Kulik, Kulik, & Morgan, 1991).

Allow sufficient time to calibrate lectures: While it's important to minimize the amount of time between assessment and the subsequent lecture, it's also important to allow sufficient time to calibrate the lectures based on student performance. Each professor will differ in this regard depending on the content and specific features of the class: some professors find they need a day or more to review student data; others wait until just before the start of class.

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TOOLS

Data and Analytics

The Coursera platform collects a tremendous amount of data about the way students learn and navigate a course. These data are valuable in tracking student progress and identifying gaps in their comprehension, a critical element of Just-in-Time teaching strategies.

There are four ways of accessing analytics for your course on the Coursera platform:

- Activity Tracking lets you see activity on the level of individual lectures and quizzes.
- Course Overview Statistics give a concise overview of the level of activity and student performance in your class.
- Export Statistics allows you to investigate how the data shown in the Course Dashboard has varied over time.
- Raw Data can be requested from Coursera for a more detailed overview of student performance and activity.

You can access more information about data and analytics on the Coursera platform on our support docs.

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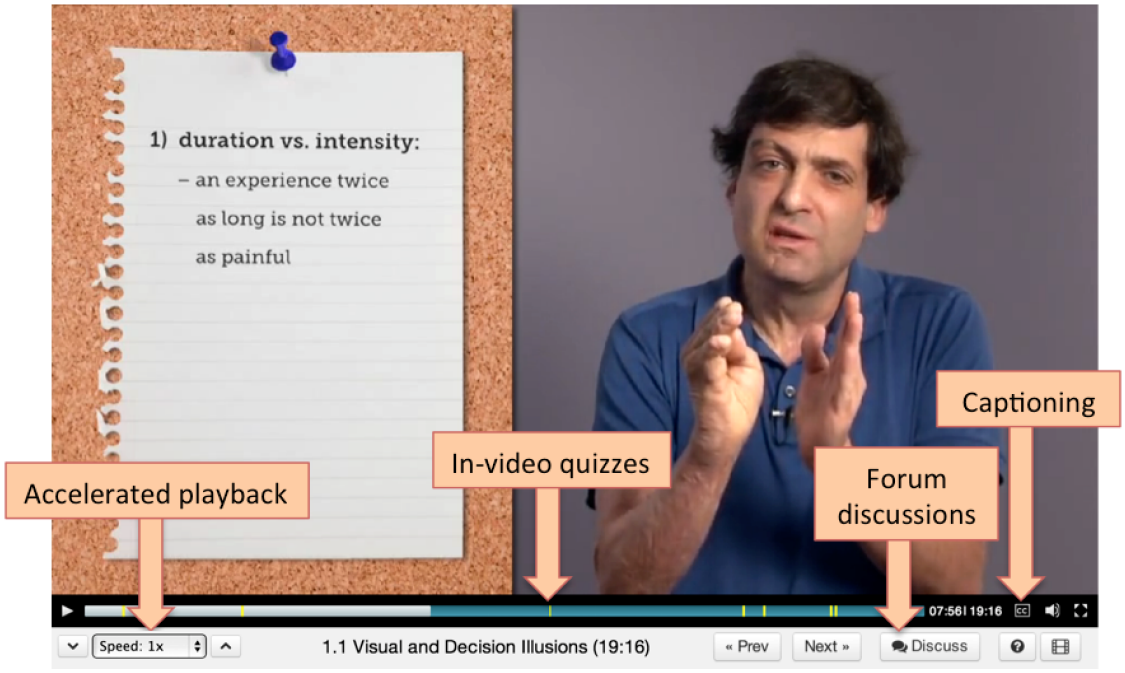
Video lectures

Online lectures are a critical element of flipped classroom environments. Instead of giving the same lecture year after year, instructors are able to craft modular, high-quality, well-structured video lectures that can be used multiple times across different classes. Jeremy Adelman of Princeton reported that his benefited from "being able to replay lectures and work off comprehensive notes instead of the hasty scrawl derived from watching live lectures" in his class "A History of the World since 1300."

The Coursera lecture interface gives students an unprecedented level of personalization as they navigate through different elements of the course. Key features include:

- Option for accelerated/decelerated playback
- Dynamic in-video quizzes
- Direct links to forum discussions to discuss concepts with their peers
- Support for captioning



Consequently, interactive video lectures yield a number of benefits, including:

- Increased opportunities for self-directed and self-paced learning
- Greater time and location flexibility
- Unlimited access to the learning material
- Increased interactivity and learning/training opportunities

Adrienne Williams of UCI put together some useful best practices on creating effective flipped-classroom lectures: “Keep it short. If you require more than 12 minutes of brisk speaking in order to cover the content, consider reducing content in order to free up time for connections and applications. Plan your class activities in conjunction with developing the pre-class video. The class activities should reinforce the video material, not repeat it or present new information to memorize. Students like to see at least some "face time" during the video. Incorporate video of you talking if you are comfortable doing so.”

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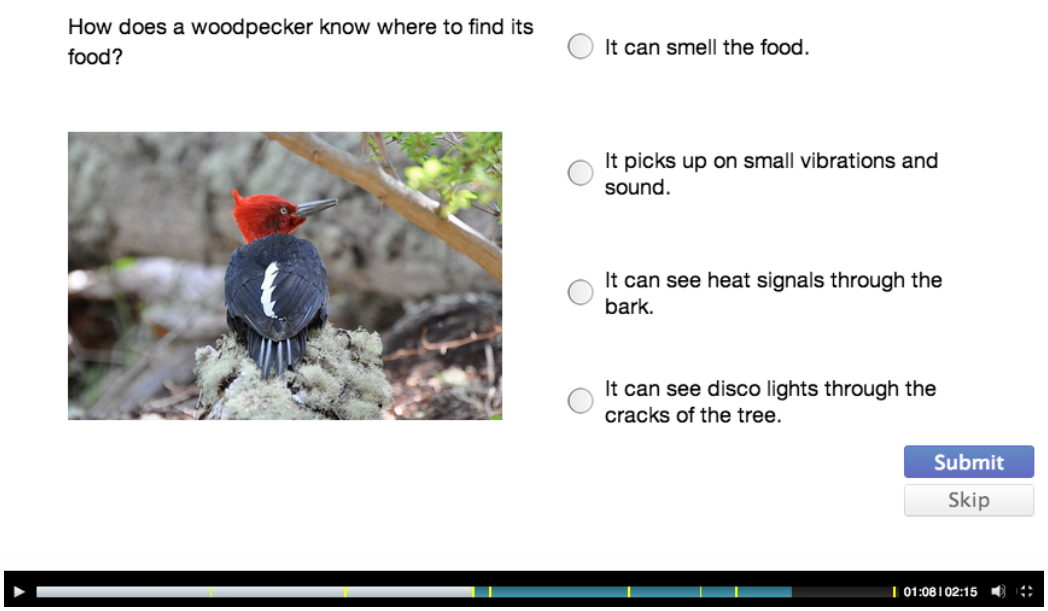
In-video quizzes

In-video quizzes are a type of informal assessment that appears within lecture videos, typically after a key concept has been explained. In-video quizzes allow for lecture videos that are more interactive, dynamic, and personalized. In addition, these quizzes facilitate retrieval-based learning and enable students to test their understanding on the spot. Research shows that such interactivity plays a critical role of the efficacy of videos in e-learning environments (Zhang et al., 2006).In addition, research shows that even simple retrieval questions have significant pedagogical value. For example, in two papers in Science, (Karpicke & Roediger III, 2008; Karpicke & Blunt, 2011) show that activities that require students to retrieve or reconstruct knowledge produces significant gains in learning - much more so than many other learning strategies.

Click here to watch a video overviewing about Coursera’s in-video quiz functionality:



For more information about in-video quizzes, please check out this support doc.

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Forums

The community forums allow students to collaborate, share ideas, and give feedback in an immersive, dynamic, shared digital space. There are numerous applications of the forums in flipped classrooms, including:

- **Just-in-Time Teaching:** Forums are an excellent way to gauge student comprehension of a particular topic. Professors can use forum discussions to adjust subsequent lessons to better target areas of confusion.
- **Follow-up discussions:** Typical classrooms are heavily restricted by resources and time; when the class is over, it's often difficult to facilitate out-of-class discussion around the topic. Forums help ensure that any students who want to present ideas or discuss topics outside of class have the ability to do so.
- **Collaboration:** Forums allow students to collaborate in an organized, public, digital setting. This online collaboration is useful for a number of flipped activities including small-group problem solving, peer-to-peer feedback, and student generated content.

You can access more information about community forums on our support docs.

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Peer assessments

Coursera's peer assessments are a useful tool in flipped learning environments. Our peer assessment interface allows you to create organized, linear peer assessment activities, and has many advantages over in-class peer grading activities. These include:

- **Training:** Instructors are able to train their students in peer assessments before giving them other students assignments to grade. During a typical training, students are presented with 3-5 instructor-graded submissions. Students must pass training by giving evaluations that fall within an acceptable range of the instructor grade in

80% (adjustable) of cases.

- **Forum integration:** Instructors are able to automatically post assignment submissions to the community forums, allowing students to provide comments and feedback on all peer assessment submissions. This feature may be particularly valuable for student generated content activities and open-ended assignments in which the diversity of student responses can encourage rich discussion, and where students can benefit from exposure to a wide range of peer submissions and evaluations.
- **Assignment/rubric integration**: Students are presented with an organized rubric while evaluating their peers' work. These rubrics can feature explanations of the question, model answers, and point values awarded for a variety of criteria.
- **Organization:** Instructors can easily adjust various features of their students' peer assessment process including the number of peers they must assess, whether or not to display the rubric while students are completing the assignment, deadlines, etc.
- **Ground truthing:** It can often be difficult to gauge the consistency or reliability of peer assessment activities done in the classroom. Coursera's peer assessment tool allows for something called "ground truthing" which is a process that checks the reliability of peer-graded scores by comparing the student's score with the instructor's score.

For more information on peer assessments, check out our support docs.

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Editable wiki-pages

Editable wiki-pages enable students to collaborate, share ideas, and curate content. This resource is particularly useful when trying to integrate student generated content into your course.

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Autograded assignments

Autograded assignments allow professors to more efficiently and effectively collect and respond to student performance. The Coursera platform allows for a number of different autograded assignment types including multiple choice, math expressions, short answers, and computer programs.

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SUMMARY:

Flipped classroom overview

What are flipped classrooms?

In flipped classrooms, technology enables instructors to more actively engage with their students. This is typically accomplished by using in-class time for active learning exercises and out-of-class time for watching recorded lectures.

Why flip your classroom?

In-class benefits

Flipped classrooms allow for an unprecedented level of interactivity and insight into student learning and performance. By moving passive learning experiences outside of class, professors are able to use in-class time to engage students in activities such as small group problem solving, peer grading, and experiential learning activities; such active learning exercises have been shown to significantly improve educational outcomes (Deslauriers, Schelew and Wieman, 2011; Topping, 1998; Mazur, 2009). Additionally, autograded assessment data helps instructors target their lessons and address student comprehension gaps while refining their teaching strategies for subsequent course offerings.

Out-of-class benefits

By moving lectures online, instructors are able to make modular, high-quality lecture videos that can be reused repeatedly across classes. Video lectures also allow for considerably more interactivity than their brick-and-mortar counterparts: dynamic in-video quizzes give students an opportunity to test their understanding while improving learning outcomes (Agarwal et al., 2012; Karpicke and Grimalidi, 2012; Roediger et al., 2006). Coursera's autograded assessments allow instructors to efficiently evaluate student comprehension while facilitating the use of mastery learning techniques (Bloom, 1984; Kulik et al., 1990). Perhaps more importantly, these autograded assessments give instructors valuable data related to student learning and performance.

Flipped classroom models

Flipped classrooms can vary greatly depending on the attributes of the class, student needs, and the level of involvement required by the instructor. In this document, we'll describe two broad categories of flipped classrooms: student- and instructor-led.

Student-led Model

In a student-led flipped classroom, the instructor's involvement in the day-to-day running of the course is relatively low. Students have more flexibility and freedom in navigating the course content, and instructors have the option of using a variety of lower-touch strategies to interact with their students, including: answering student questions via email or on the community forums; offering feedback on student work; providing motivational nudges or reminders throughout the course; periodically holding open office hours; or identifying students who are struggling with a concept and holding a facilitated discussion (perhaps in a small group) on that topic to help them get over the hurdle.

Instructor-led Model

In an instructor-led flipped classroom, the instructor is much more involved in the coordination of the course. Outside of class, students engage with the more passive elements of the course; inside class, students participate in active learning activities coordinated by the instructor. Such activities might include group discussions, role-playing games, case studies, group problem solving, team projects, etc. Instructors can also employ Just-in-Time Teaching strategies by using student assessment data to determine the concepts or questions that students are struggling with and that should be addressed in class.

Flipped cheat sheet

Just looking for the gist? This flipped cheat sheet overviews each of the major elements of this resource.

Why flip your classroom?

- Improved educational outcomes
- The efficiency/efficacy of recorded lectures

- The ability to make lectures more interactive
- More opportunities to collect and utilize data and analytics
- The ability to offer more personalized learning
- The ability to facilitate mastery learning

Common step-by-step process for flipping your classroom:

1. Record lectures
2. Assign lectures as homework
3. Facilitate engaged-learning activities in the classroom
4. Create opportunities for student feedback

Tips and tricks for first-time flippers:

- Be mindful of how you pitch the flipped classroom to students
- Use technology to increase, not decrease, interactions with students
- Use student feedback and analytics to refine your flipped teaching strategies
- Share ideas and solicit input from your fellow instructors about your flipped class

A list of some engaged learning activities for in-class time:

- **Applications-** Application activities give students the opportunity to use what they've learned to solve problems and grapple with learned concepts in novel ways.
- **Extensions-** Extension activities require students to derive properties or theoretical extensions of what they've learned.
- **Sequence of Questions**- By using a sequence of questions, complex problems are broken into smaller parts and then solved systematically with the students
- **Student-generated content**- Incorporate student-generated content into a course to increase engagement and allow students to become more active participants in the learning process.
- **Experiential learning**- In experiential learning activities, students learn through immersive, hands-on learning experiences.
- **Modified lectures**- While less-recommended than other in-class activities, modified lectures may include guest lectures, advanced lectures, or lectures on current events.
- **Discussion activities**- Organized discussion activities can be used to facilitate peer-to-peer exchanges and a deeper engagement with the course content.
- **Classroom Assessment Techniques**- Classroom Assessment Techniques (CATs) are ongoing formative assessments that facilitate learning and provide both student and professors with valuable feedback.
- **Service Learning**- Service learning activities allow students to engage with course content through community-based service projects.

A list of some collaborative Learning Activities for in-class time:

- **Considerations when grouping students**: Effectively grouping students can be difficult. Be cognizant of factors such as role interdependence, group dynamics, and the interpersonal skills of different group members.
- **Facilitated learning: F**acilitated learning is low-touch instructional approach in which students are heavily involved in every aspect of their own learning. Some considerations of the facilitator when implementing a facilitated learning model include the focus of the session, timing of the session, and characteristics about the learning environment.
- **Small Group Problem Solving:** Instructors break up the class into small groups and present any number of problem-solving activities (many of which could be modified version of the aforementioned engaged learning activities) for the groups to tackle.
- **Mazur's peer instruction model:** A systematic process for encouraging collaborative learning amongst peers.

- **Peer feedback**: In peer feedback activities, students participate in the process of evaluating their peers. Most peer feedback activities are comprised of three parts: 1) assignment/rubric design, 2) content creation and 3) the administration of peer-to-peer feedback.

A brief summary of Just-in-time teaching (JiTT):
Just-in-Time Teaching provides instructors with valuable student-performance data that inform the content and method of their in-class instruction. This typically involves students responding electronically to autograded assignments due shortly before class and the instructor using these data to better address student needs in lecture. Some best practices for JiTT include maximizing student participation on pre-class assessments, using autograded assessments, giving timely feedback, and systematically tackling comprehension gaps.

A brief summary of differentiated instruction:
"Differentiated instruction" refers to the practice of varying the ways in which students engage with course materials, depending on their students' unique attributes. Coupling technology with increased opportunities to engage with students during class in flipped classrooms allows professors to more easily differentiate their instruction. Instructors can differentiate a number of features of their instruction including the classroom content, their presentation of new concepts, their students' expected product (e.g. evaluations, reports, projects, assignments, and assessments), and their students' learning environment.

A list of some Coursera tools that support flipped classrooms and blended learning environments:
- **Data and analytics:** The data collected on the Coursera platform allows professors to track students progress and identify gaps of their comprehension.
- **Video lectures:** Recorded video lectures allow instructors to craft modular, high-quality, well-structured video lectures that can be used multiple times across different classes.
- **In-video quizzes:** In-video quizzes are an informal assessment and enrichment activity that appears within lecture videos, typically after a key concept has been explained. In-video quizzes allow for lecture videos that are more interactive, dynamic, and student-driven.
- **Forums:** The community forums allow students to collaborate, share ideas, and give feedback in an immersive, dynamic, shared digital space.
- **Peer assessments:** The peer assessment tool allows instructors to create well-structured peer assessment activities.
- **Autograded assignments:** Autograded assignments (including multiple choice, math expressions, short answers, and computer programs) allow professors to more nimbly and effectively collect and respond to student performance.
- **Editable wikis:** Editable wiki-pages allow students to collaborate, share ideas, and curate content.

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READING

Check out the academic and news articles below to learn more about flipped classrooms and blended learning.

Literature

The list below features some academic articles relevant to flipped classrooms and blended learning:

A.A. Gokhale, (1995). Collaborative Learning Enhances Critical Thinking. Journal of Technology Education:

This study demonstrates that students who learn collaboratively develop better critical thinking skills than students who learn individually.

Bloom, B., (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. Educational Researcher, Vol. 13, No. 6, pp. 4-16

This paper examines the effects of "mastery learning," a pedagogical strategy in which students are encouraged to master each concept before proceeding to the next. This practice has been shown to increase student performance by about one standard deviation over more traditional forms of instruction.

Bowen, W.G., Chingos, M.M., Lack, K.L., & Nygren, T.I. (2012). Interactive Learning Online at Public Universities: Evidence from Randomized Trials. ITHAKA:

"We find that learning outcomes are essentially the same—that students in the hybrid format "pay no price" for this mode of instruction in terms of pass rates, final exam scores, and performance on a standardized assessment of statistical literacy. These zero-difference coefficients are precisely estimated. We also conduct speculative cost simulations and find that adopting hybrid models of instruction in large introductory courses have the potential to significantly reduce instructor compensation costs in the long run."

Crouch CH and Mazur E (2001). Peer instruction: Ten years of experience and results. American Journal of Physics, 69: 970-977.

This study explores the efficacy of peer instruction.

Deslauriers, L., Schelew, E., & Wieman, C. (2011) Improved Learning in a Large-Enrollment Physics Class, Science, Vol. 332 no. 6031 pp. 862-864

In this study, Deslauriers, Schelew and Wieman compared two large sections of an introductory undergraduate physics course: one section was taught as a traditional lecture by an experienced, highly-rated instructor; the other was taught by an inexperienced instructor using active learning strategies. In the active-learning group, student engagement nearly doubled, attendance increased by 20%, and average scores on assessments increased from 41% to 74%. Read an excellent summary of the study from The Economist here.

Hake 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: 64-74.

This study demonstrates the efficacy of interactive engagement methods. Students exhibited improved educational outcomes almost two standard deviations higher than those observed in the traditional courses.

Lovett, M., Meyer, O., & Thille, C. (2008). The Open Learning Initiative: Measuring the effectiveness of the OLI statistics course in accelerating student learning. Journal of Interactive Media in Education:

"In this study, results showed that OLI-Statistics students learned a full semester's worth of material in half as much time and performed as well or better than students learning from traditional instruction over a full semester."

Marzano, Pickering, & Pollock (2001). Classroom Instruction that Works: Research-based Strategies for Increasing Student Achievement. ASCD.

This book includes a number of evidence based pedagogical finding, including that students who meet in learning groups at least once a week show significant improvements in learning and that the process of breaking complex problems into smaller bits has been shown to improve learning outcomes.

Redfield, D. L., & Rousseau, E. W. (1981). A meta-analysis of experimental research on teacher questioning behavior. Review of Educational Research, 51(2), 237-245.

"Results show that gains in achievement can be expected when higher cognitive questions assume a predominant
role during classroom instruction."

Roediger, H., Karpicke, J. (2006) Test-Enhanced Learning: Taking Memory Tests Improves Long-Term Retention. Psychological Science:

This study demonstrates that the process of testing students on learned material is considerably more effective in improving retention than traditional studying methods.

Kearsley, G., Shneiderman, B., (1998) Engagement Theory: A framework for technology-based teaching and learning. Educational Technology, v38 n5

"The fundamental idea underlying engagement theory is that students must be meaningfully engaged in learning activities through interaction with others and worthwhile tasks. While in principle, such engagement could occur without the use of technology, we believe that technology can facilitate engagement in ways which are difficult to achieve otherwise. So engagement theory is intended to be a conceptual framework for technology-based learning and teaching."

Scheines, R., Leinhardt, G., Smith, J., & Cho, K. (2005). Replacing lecture with web-based course materials. Journal of Educational Computing Research, 32, 1, 1-26:

"This article overviews the efficacy of various features of the online experience and student learning strategies. The researchers found that students who entirely replaced going to lecture with doing online modules did as well and usually better than those who went to lecture. In addition, the study demonstrated the effectiveness of incorporating frequent interactive comprehension checks into the online material (something that is difficult to do in lecture). The results also show that smaller, more interactive educational environments are effective than large, passive lectures."

University of Wisconsin-Madison. Flipping Courses: Transitioning From Traditional Courses to a Blended-Learning Approach, 2013

A fantastic high-level overview of flipping the classroom from the University of Wisconsin-Madison.

U.S. Department of Education. Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies. Washington, D.C., 2009.

This meta-analysis from the Department of Education is based on 45 studies and shows that online learning is as effective as face-to-face learning, and that blended learning is considerably more effective than either.

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News articles

- *Chronicle of HIgher Education*: How 'Flipping' the Classroom Can Improve the Traditional Lecture
- *Duke.edu*: Flipping Teaching Around
- *New York Times*: Learning In The Dorm Because Class Is On The Web
- *Stanford.edu*: 'Now you try it': Stanford faculty share experiences of online teaching
- *USA Today*: Flipped Classrooms Take Advantage Of Technology

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