Flipping the classroom in Rutgers Mathematics Courses

Rutgers Active Learning Conference 2019

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What is a flipped math course?

Students work through video lectures on their own time, before each class meeting. Thus they 

“go to class at home.”

Class time is devoted primarily to active learning, whereby students 

“do their homework in class.”
Advantages of flipping:

1. Flipping maximizes the amount of class time that can be devoted to active learning.

2. Faculty can add greater value during class time by facilitating active learning.
Advantages of flipping:

3. Students can rewatch each video as many times as needed, whether before class, while doing homework after class, or studying for an exam.
Advantages of flipping:

4. There is no such thing as (the instructor) falling behind the schedule of topics, or failing to cover a certain topic.

5. Students who fall behind due to absences, etc. have every opportunity to catch up. This is true even in non-flipped sections of the same courses, once the flip-inspired resources exist!
A question for flip-skeptics:

What price are you willing to pay to observe the traditional rule that as instructor, you must say/write all course content during lecture?

Does saying/writing everything during lecture take absolute priority over other goals, such as active learning, answering student questions, etc.?
Implementing the flip:

• How to ensure that students do the required preparation for class?

• How to ensure that students really engage in the active learning component?

• How to provide quick, effective feedback before, during, and after class?
Implementing the flip:

• To use existing videos or make your own, and if the latter, how to structure them?
Pedagogy of the videos in Math 103/104

• The videos are structured to mimic a classroom presentation organized around active learning.

• They are deliberately kept short, 8 minutes on average.
Pedagogy of the videos in Math 103/104

• Each video ends with a problem that the student is asked to solve before going on to the next video.

• The next video begins with a solution to that problem, and then moves on to new examples or new ideas.
**Pedagogy of the videos in Math 103/104**

- The conceptual level of the videos is intended to be accessible to students working on their own. They are not expected to have full mastery of the subject when they come to class, but rather to be prepared to acquire that mastery through the work they do in class.

- The total run time of the videos for a full week, is about 80 minutes.
Model #1: Flipped hybrid

• There is one 80-minute class meeting per week.

• Before class, students work through about 80 minutes of videos.
Model #1: Flipped hybrid

• Each video set has an associated assignment A (problem solutions due online before class) and assignment B (solutions to problems from in-class work, due online within 24-36 hours).
Model #1: Flipped hybrid

• Class time moves quickly from addressing confusions from assignment A (graded and returned online before class), to an active learning session of group work on the next conceptual level of problems.
Model #1: Flipped hybrid

• Class ends with a quiz. Some colleagues begin with a quiz, and some do both!

• Assignment B is graded and returned online, well before the next meeting.
Model #1: Flipped hybrid

Implemented in two courses for a general audience,

Math 103: Topics in Mathematics for the Liberal Arts (since spring 2015)

and

Math 104: Introduction to Probability (since spring 2016)
Model #1: Flipped hybrid

• 14 meetings during the semester, plus a final exam

• Of the 14 meetings, 1 is a course introduction and 2 are exams.

• No time for exam review in class, except in the last meeting.

• Students appreciate the logistics of having just one meeting per week.
Model #1: Flipped hybrid

Important point: Nobody says that every section of these courses needs to be flipped!
We still run both traditional (with active learning) and flipped versions.
Model #2: Flipped standard, weekly cycle

• 2 meetings per week, 80 minutes each.

• Students work through a full set of videos (80 minutes run time) before the first of two meetings for the week.

• The first meeting clarifies the contents of the videos by working in “back and forth mode” at the same conceptual level.
Model #2: Flipped standard, weekly cycle

• The second meeting runs entirely in active learning format, with a quiz at the end, much the same as the one meeting of the flipped hybrid format.

• Only 1 assignment due per week, based on class work from the second day, due online within 24-36 hours.
Model #2: Flipped standard, weekly cycle

- 28 meetings during the semester, plus a final, i.e. much more face to face time.

- 3 midterm exams, with a devoted review session prior to each one.

- Both of the above were the chief motivations for this model. But classroom constraints had some influence (AL-unfriendly Tuesdays, AL-friendly Thursdays).
Model #3: Flipped standard, half-weekly cycle

• Two weekly class meetings, both work exactly the same way.

• For each meeting there is a pre-class assignment, set up in Canvas as a quiz containing half a video set. Each video is embedded as one question, and students are prompted to enter an answer as text. After the last video, students are asked what questions they have about that set.
Model #3: Flipped standard, half-weekly cycle

• The instructor reads the student entries before class, gives brief feedback via Canvas.

• The first part of class is devoted to giving more substantial feedback on pre-class submissions, and working in “back and forth mode” on problems at a slightly higher level.
Model #3: Flipped standard, half-weekly cycle

• The second part of class is devoted to active learning in groups, on the problems that will be homework, due online 24-36 hours after class.

• Homework is graded before students need to start on the next half-set of videos.
Model #3: Flipped standard, half-weekly cycle

• Two full work/feedback cycles per week

• Students always have something to do, but only a moderate amount, whether finishing work from the previous class or preparing for the next one.

• Switching to Canvas has significantly facilitated this model! Speed Grader is a game changer.
In flipped format in summer 2019

- Math 152: Calc 2 for the Math/Phys Sciences
- Math 311: Intro to Real Analysis
To run in flipped format in fall 2019:

Flipped Math 115: Precalculus (for engineers)

Math 123: Preparation for Calculus I

• For students placed into calculus who need stronger foundations
• Uses the adaptive learning system Knewton Alta
Partial flipping

• Students can be assigned just 10 to 20 minutes of videos before each class meeting.

• They get some familiarity with basic ideas of the new lesson, or are reminded of important background.
Partial flipping

• 10 to 20 minutes of class time are freed up for active learning.

• Under serious consideration in our large calculus courses, as part of the P2C2 Reform Project.
Conclusion:

A word of caution and humility

“In contrast, it is not clear whether effect sizes of this magnitude would be observed if active learning approaches were to become universal. The instructors who implemented active learning in these studies did so as volunteers. It is an open question whether student performance would increase as much if all faculty were required to implement active learning approaches. ” (Freeman et al., 2014)