Journey to a Flipped Computation Course using MATLAB

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Outline of Talk

• Goals: why flip?
• Basic contents of course
• Evolution from traditional lecture to completely flipped format
• Results: Student outcomes
• Lessons learned
• Future improvements
Goals: why flip?

1. Improve the student learning outcomes
   • Assessment measures:
     – Grades: GPA
     – Number of D/F/W grades

2. Improve engagement of students in course
   • Assessment measure:
     – Attendance
Enable an Active Learning Environment
Course Background

• Introduction to Engineering Computation
• Basic programming, or coding, concepts
• From time to time, the language has changed, but for the last 9 years, we have used MATLAB
• Taken by ~450 students per year, mostly freshmen
Use of MATLAB in course

• Using MATLAB enables us to teach basic concepts such as selection statements, loops, modular code, string processing, data structures, etc.

• Applications such as plots, Graphical User Interfaces, curve fitting

• Also, vectorizing is very important; once simple constructs are covered, problems are posed and then solved using the “programming method” (loops, etc) and also using vectorized code
Traditional Format

• For many years, the weekly format was:
  • Lecture / Lab / Lecture / Lab / Discussion

• Lecture: Held in a case-style room; combination of Power Point slides, some writing on board, pause for Quick Questions

• Lab: Held in a computer lab; students work on problem sets in MATLAB

• Discussion: Wrap-up of the week; Quiz
Gradual Transformation

• Transformation from traditional lecture format to flipped class, to enable active learning and peer-to-peer instruction

• Systematic achievement over several years (evidence-based)
Transformation Process

- Began with partial active learning; students read the relevant chapter or section, then filled out synopsis form before class which included important concepts learned, questions pending, and some simple problems to solve
- Continued with experimental sections; used others as control groups
- Experimented with screen capture software and platforms
- Created some pre-class videos
It works! No need to determine whether active learning works or not

• Research has proven that active learning works
• I stopped worrying about proving whether it works or not and started spending more time figuring out how to get it done
Summer 2014: Completely Flipped

- Created lecture videos for the rest of the lectures (building on work from previous semester)
- Moved to edge.edx for the platform
- Emailed students before the class started, telling them to do the reading, go online and view the lectures before coming to class; they did!!
- Format: all active learning in class
- Small class, only 23 students; in a conference room with round tables
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Worked in the summer

• So, it worked well in the summer with 23 students
• But, will it work in the regular semester with 10 times that number of students?
Fall 2014: Scale to 230 Students

• Needed to scale from 23 students in the summer to 230 in the fall, in three sections
• Held in former computer lab, now stripped of most computers; tables that seat 12
• Seating not as ideal as round tables
• Improvements:
  – Introduction of assessment questions after pre-class lecture videos
  – White-board paint on walls allowed student creation of problems/solutions on walls
New Format

- **Weekly schedule is now:**
  - Pre Class / Class / Lab / Pre Class / Class / Lab / Discussion
- **Pre-class:** Students read relevant section(s) from text, view lecture videos and answer simple assessment questions on edX edge
- **In class:** Active Learning
- **Lab:** Held in a computer lab; students work on problem sets in MATLAB
- **Discussion:** Wrap-up of the week; Quiz
Section Schedule

• Class sections are Monday/Wednesday mornings, 1.5 hours each
• Lab sections are Monday/Wednesday afternoons, 1.5 hours each
• Discussion sections are Friday, 1 hour
In Class Format

• Most days start with an Individual Problem Set
• Very simple questions, meant to be a warm-up and so I can see quickly if anyone is not adequately prepared
• Then, students discuss their solutions to these problems and move on to Group Practice Problems
Group Practice Problems

- Students work in small groups (typically 2-4) of their choosing
- Problems are solved on paper and/or on the walls (white board paint), not using MATLAB
- Problem sets are given in parts
- For each part,
  - Solve my problems
  - Create your own problems (and write them on the wall)
  - Get solutions checked by instructor or teaching assistant before moving on to the next problem set
Individualized Instruction and Peer-to-Peer Learning

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Lab Format

- Classes are held in the morning; labs later that same day
- In labs, students work on problem sets (“worksheets”) using MATLAB
- Students download the Worksheet from edge, cut and paste their solutions from MATLAB so they end up with one document consisting of the problem statements and solutions
- Some problems are also submitted to Cody Coursework and to an embedded MATLAB on edge.edx
Course Results: Learning Outcomes

• Better achievement of learning as evidenced by grades:
  – Fall 14: GPA 3.64
  – Spring 14: GPA 2.93
  – Fall 13: GPA 3.27

• Fewer D/F/W grades:
  – Fall 14: 14 D/F/W
  – Spring 14: 21 D/F/W
  – Fall 13: 19 D/F/W

• Fewer Failing grades:
  – Fall 14: 1
  – Spring 14: 9
  – Fall 13: 5

• Note: most of the Fall 2014 D/F/W grades were in the 8am section; by contrast, the lowest grade in the noon section was C+ (No C/C-/D/F/W grades at all); same number of students in each of the 3 sections
Total Letter Grades by Semester

- Fall 2013
- Spring 2014
- Fall 2014

Letter Grades:
- A
- A-
- B+
- B
- B-
- C+
- C
- C-
- D
- F
- W

Number of Students
Fall 2014 Grades by Lecture Section

Letter Grades in Each Lecture Section

Number of Students

A  A-  B+  B  B-  C+  C  C-  D  F  W

8-10am  10-12pm  12-2pm
Course Results: Student Engagement

- Engagement is up as evidenced by attendance:
  - Fall 14: Ave 9.52
  - Spring 14: Ave 8.98
  - Fall 13: Ave 9.36

- Attendance was up overall despite earlier start
  - First class at 8am in Fall 2014, vs. 9am in Spring 2014 and Fall 2013

- Average attendance grade in 8am section was 9.0, vs. 9.7 and 9.8 in later sections
Comments at edX Global Forum
Student Panel

- “Deeper understanding of material”
- “More individual attention”
- “Get more perspectives (not just from instructor but from peers as well)”
- When asked “doesn’t this take more of your time?” one student answered “No, it just shifts the time spent. In the old model, I went to class, left with questions, then had to try to do homework on my own and go to my professor’s office hours to get my questions answered. Now, I view the lecture first, get my questions answered in class, and leave feeling that I know the material. In the old format, I crammed for exams. Now, I don’t have to do that because I know that I know the material!”
Snowy Spring Semester in Boston Bonus

• With a flipped class, there are no lectures during class time
• Lectures are all online
• Snow days: not a problem!
  – The in-class active learning problem sets simply become homework
  – Not ideal, but better than missing classes!
Future Improvements

• Currently working on the following:
  – Adding transcriptions to accompany the online lecture videos
  – Creating test scripts to auto-grade student work online (this is not easy!)

• Want to make the materials more widely available
Lessons Learned

- It’s difficult for faculty to let go of the traditional lecture
- It takes a lot of effort, over a long period of time
- It may be confusing to the students to partially flip, but for most that’s what has to happen because it’s difficult to do it all at once
- It is more challenging and physically more demanding to run an active classroom
- The tools exist to enable the online assessments, but creating test scripts is not easy

BUT It’s all totally worth it! Just do it!!