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

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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

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Total Letter Grades by Semester
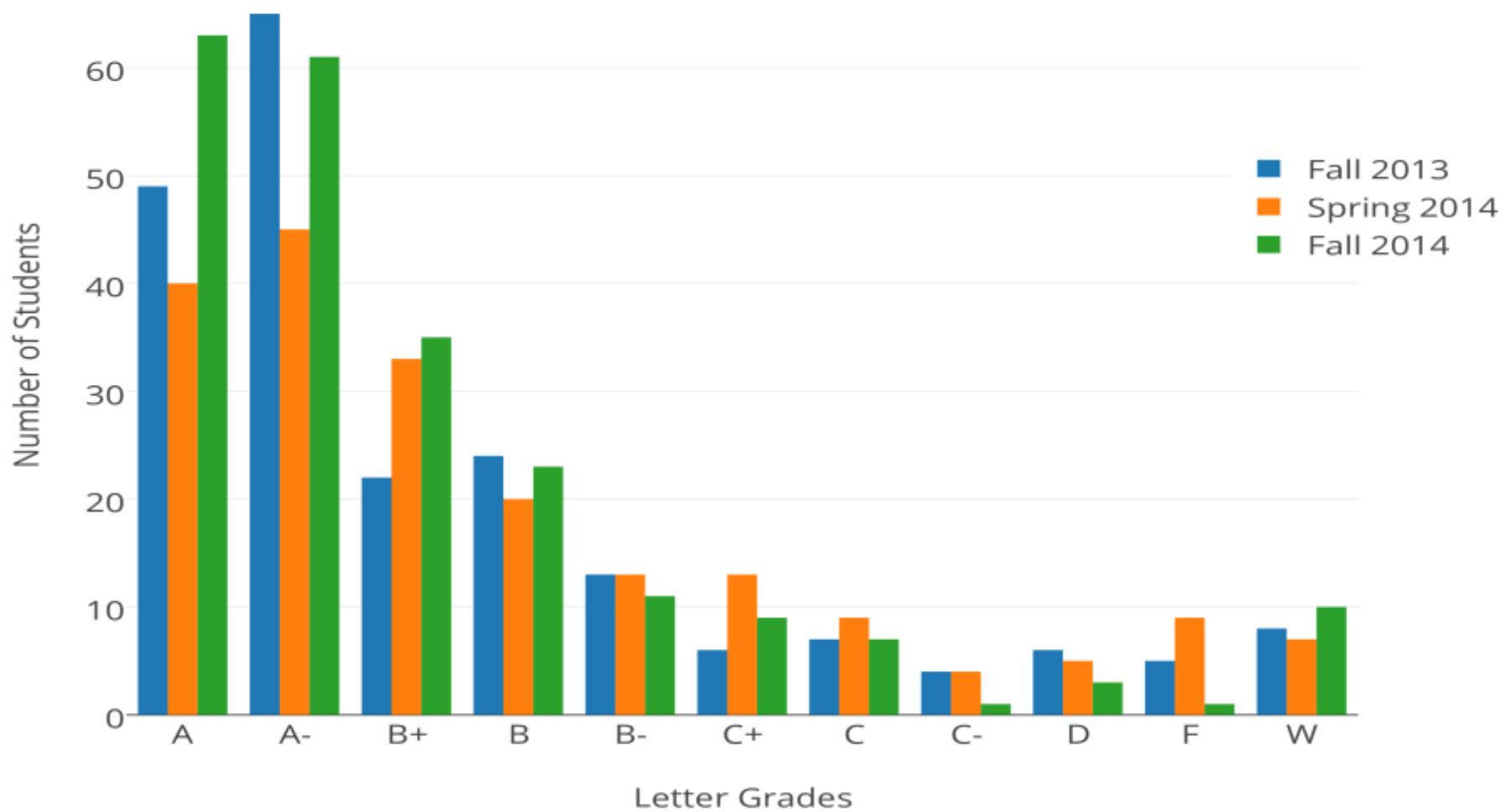
Fall 2014 Grades by Lecture Section
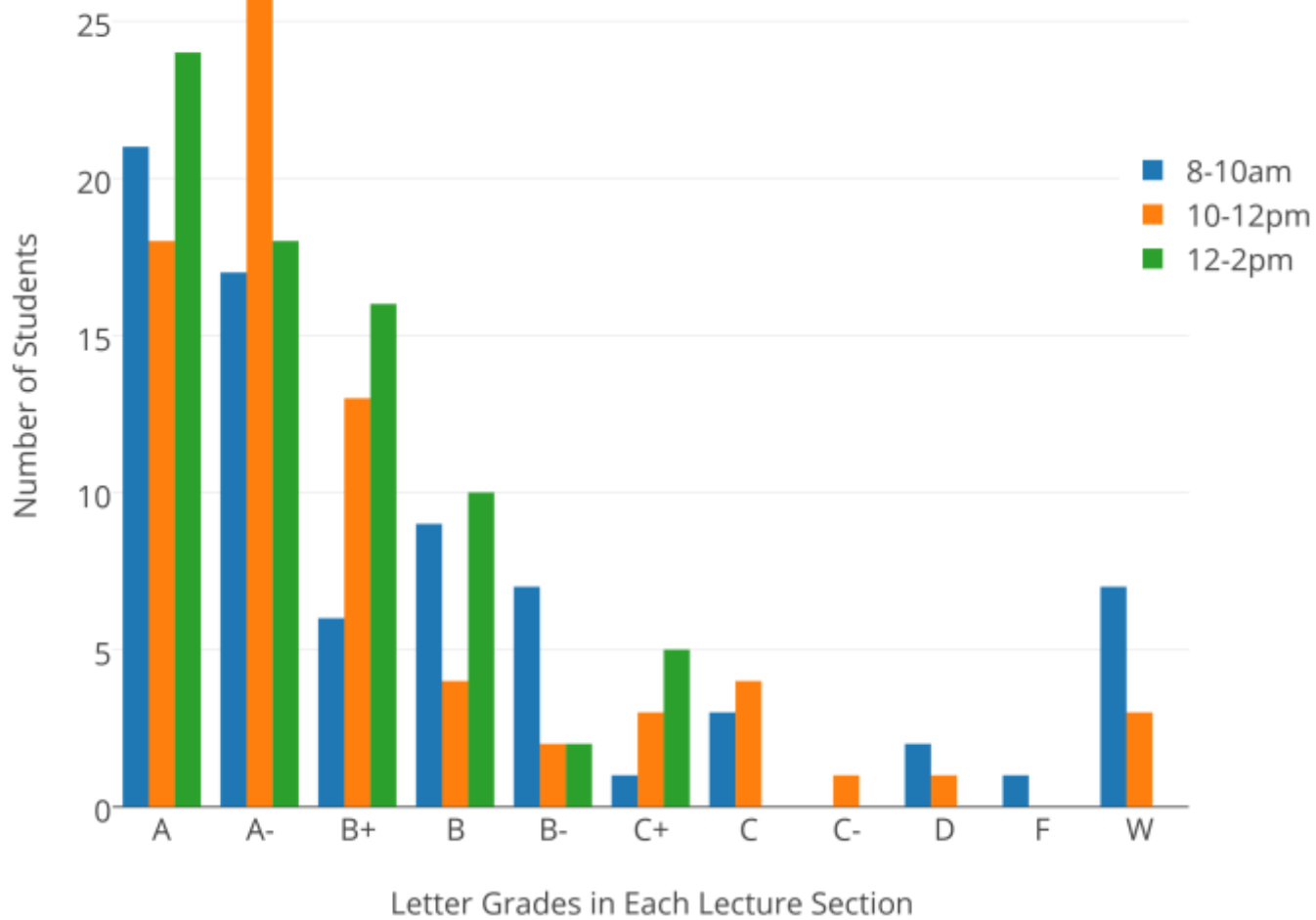
Course Results: Student Engagement

- 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 on-line 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!!

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