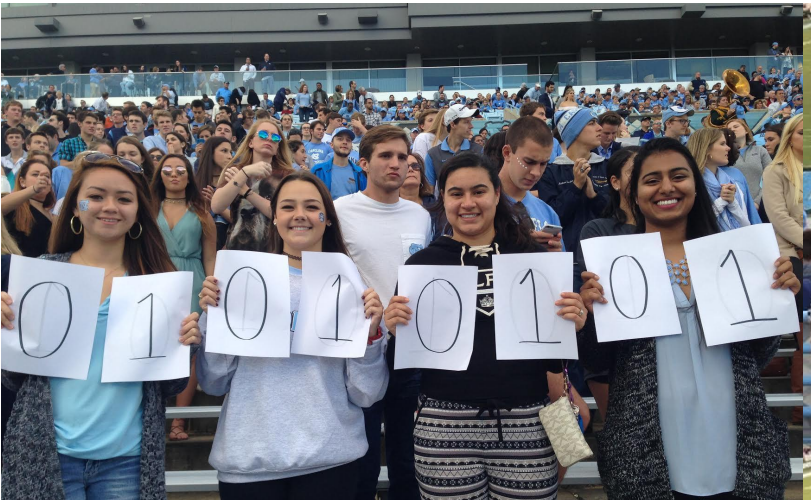
Scaling Learning Experiences when Teaching Large Courses



Today's Goals

1. Discuss:
   How do you make the most effective use of student's time?

2. Explore:
   What can a large lecture course achieve that a smaller course cannot?

My Background

- I teach large courses.
  - COMP110 - Introduction to Programming
  - COMP211 - Systems Fundamentals
  - COMP423 (Future) - Foundations Soft. Eng
  - COMP426 - Modern Web Development

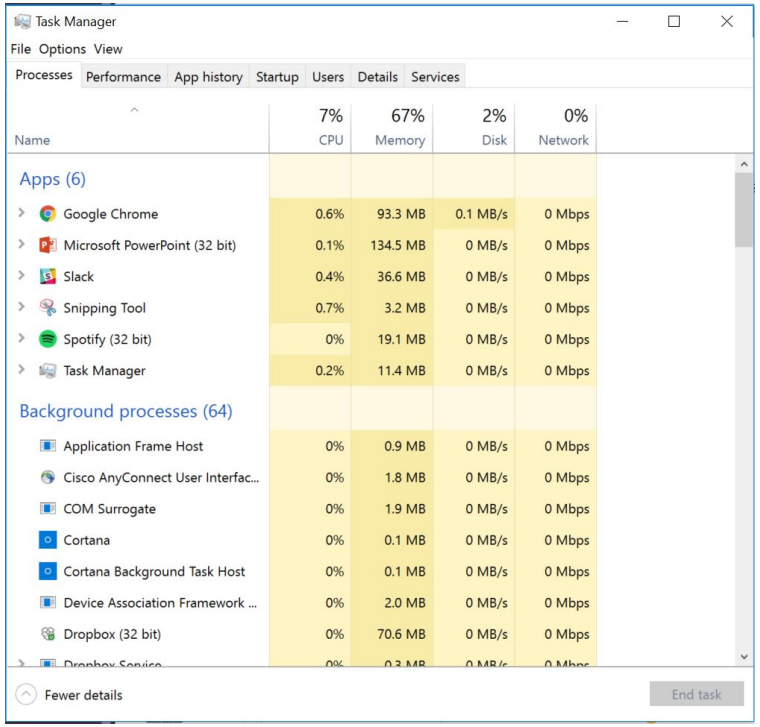
- > 10,000 students in 8 years

Time is your student's and your course's scarce resource.

- How does the design of your course allocate student's time?

- Knowledge Acquisition
  - Reading
  - Watching
  - Listening

- Knowledge Application
  - Working problems
  - Programming
  - Completing assessments



- How is time spent synchronously vs. asynchronously?
  - How is time spent in the classroom vs. outside of it?

Think, Pair, Share

1. In a large CS course, **what is more impactful for learning outcomes**: time spent on **knowledge acquisition** or on **knowledge application**?

2. Class meetings are an expensive synchronization checkpoint and the scarcest slices of student's time you have. **How do you allocate time in-class to knowledge acquisition vs knowledge application?**

- Think on these points for a minute.
- Share with your neighbor(s) for a minute.
- Then we'll discuss.

What is active learning?

“Active learning engages students in the process of learning through **activities and/or discussion in class**, as opposed to passively listening to an expert.

It also emphasizes **higher-order thinking** and often involves **group work**.”

The Case for Active Learning vs. Lecturing

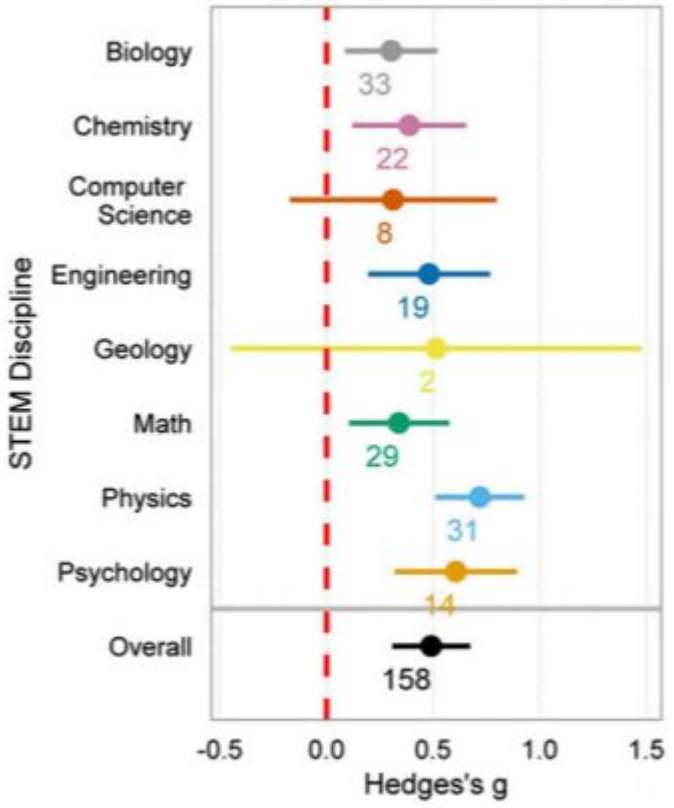
- Key findings in most comprehensive meta-analysis to date
- “Active learning increases student performance in science, engineering, and mathematics” – 2014 Proceedings of the National Academy of Sciences – Scott Freeman, Sarah L. Eddy, et. al.
- 225 studies with data from 29,300 students
- Criteria for admission were studies that compared traditional lecture vs. “active” classified as 10% to 100% of class time on active learning activities including
  - Cooperative group activities in class
  - In-class worksheets
  - Clickers / Digital Response Systems
  - Problem-based Learning
  - Digital Studios

The meta-analysis focused on two questions:

- Does active learning **raise** examination scores?
- Does active learning **lower** failure rates?

Does active learning **raise** examination scores?

- Yes, on average, by just under ½ standard deviation.
- In “letter grade” terms by about a third of a letter, i.e. B to B+, B+ to A-, and so on.
- Fail-safe numbers on publication bias: 114 studies with effect size 0 would be necessary to negate findings.

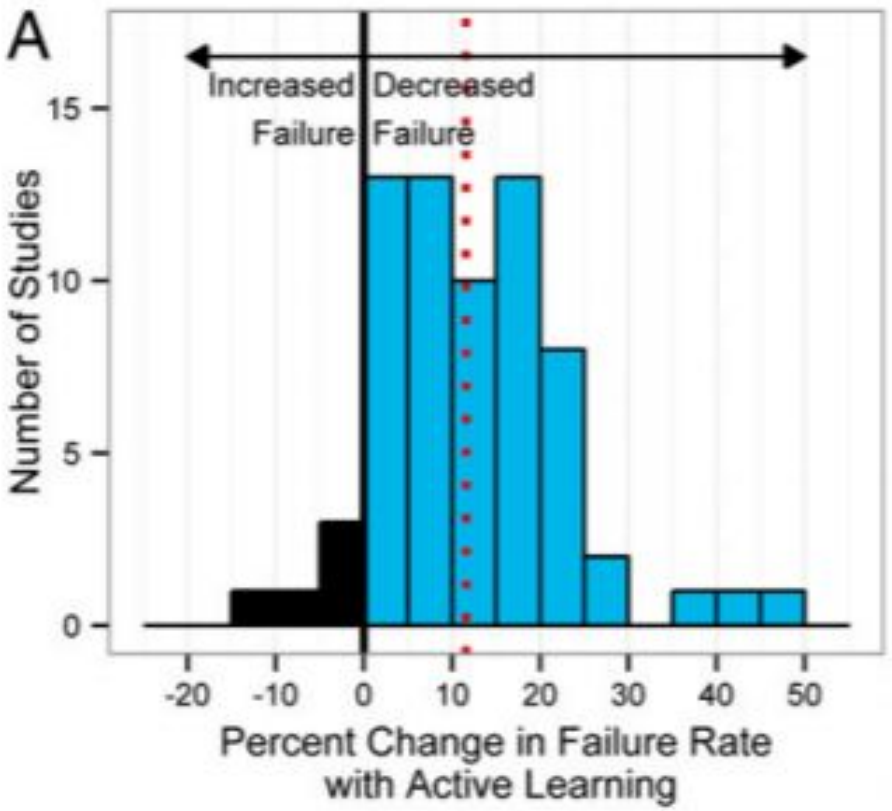


Does active learning **lower** failure rates?

- Yes. “On average, students in traditional lecture courses are 1.5 times more likely to fail than students in courses with active learning.”

- “If the experiments here had been conducted as randomized controlled trials of medical interventions, they may have been **stopped for benefit** – meaning that enrolling patients in the **control condition might be discontinued** because the treatment being tested was **clearly more beneficial**.”

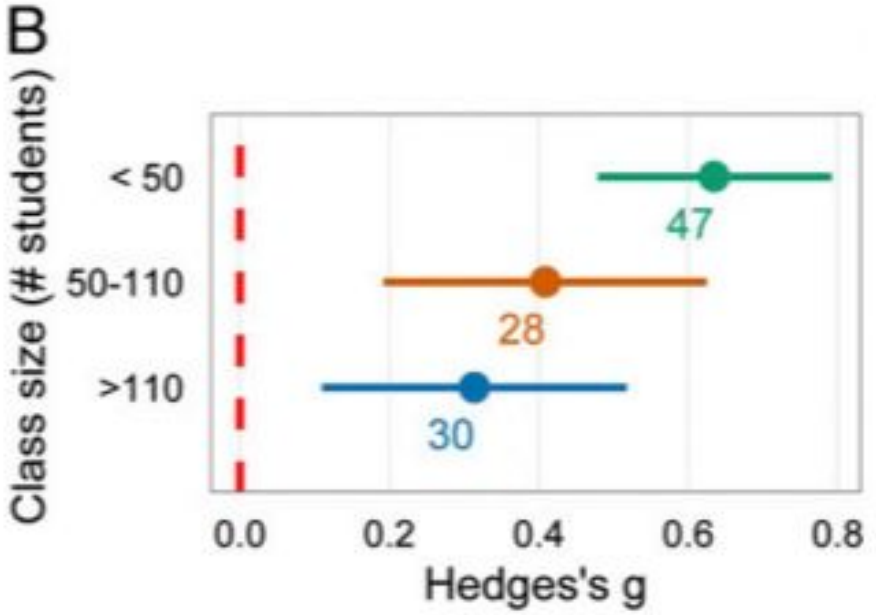
- Fail-safe numbers on publication bias: 438 studies with effect size 0 would be necessary to negate findings.



Are these effects only relevant to large courses?

- No!
- The strongest effects were observed in courses with < 50 students.
- The findings were durable across all sizes.

Improvement on Exam Scores by course Size

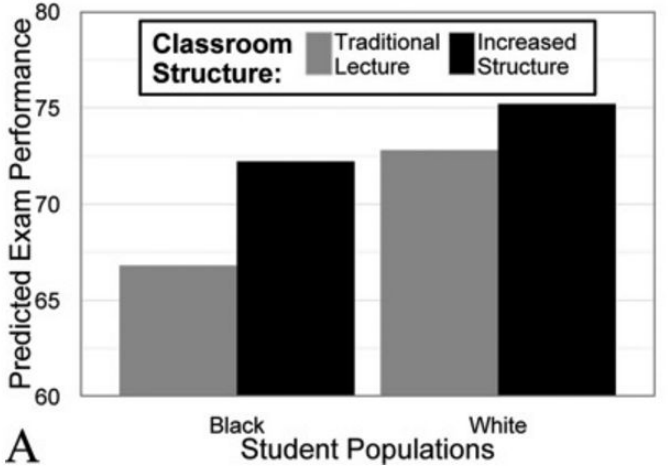


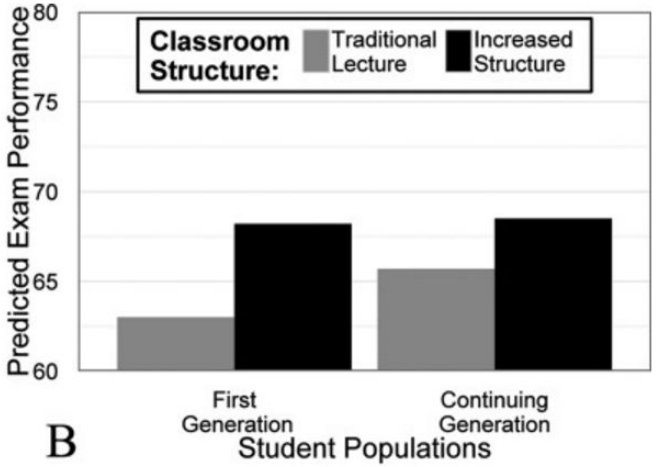
Who benefits from active learning and high structure?

- Results from UNC's Kelly Hogan (BIOL) in her 2014 paper "Getting Under the Hood: How and for Whom Does Increasing Course Structure Work?"

- "We found that a "moderate-structure" intervention increased course performance for all student populations, but worked disproportionately well for black students-halving the black-white achievement gap-and first-generation students-closing the achievement gap with continuing-generation students."

- Everyone benefits. Underrepresented groups benefited most.

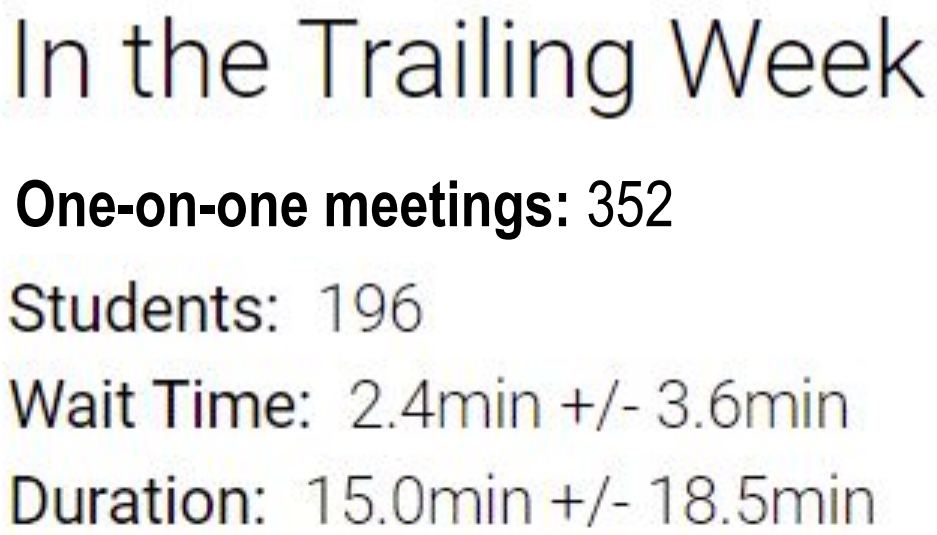




Flipped Classrooms and Frequent Assessment

- Deliver canned lessons outside of class through
  - Videos
  - Readings
  - "Check for understanding" questions
- Use policy and small incentives to ensure students prepare
  - "You can use one page of notes to take the next low stakes quiz"
- Lecture focuses on common misconceptions, practice, and engagement.
- Evidence-based research supports the efficacy of flipped classrooms.

What can a large lecture course *achieve* that a smaller course cannot?



High-availability and Fault-tolerance

- Managing a large course is an exercise in distributed systems design

- More students means larger staffs
  - More availability outside of the classroom for help!

- Laws of large numbers means *lots* of issues
  - If 2% of students have a computer hardware failure…
    1 student in a 50 student class, 16 in COMP110
  - Deaths in family, injuries, depression. You see it all.
  - The only way to address this is to **build-in fault tolerance policies**.
    - Automatically drop or replace a few low grades
    - Late policies not to penalize, but to prevent students from falling behind

The Importance of UTAs

- Provide high quality 1:1 help
  - Staffing around the clock!
- Distribute the e-mail load, grading load, review sessions
- Have recently been in the student's seats
- A great source of feedback and ideas for improving the course

Data Points – COMP110 Fall 2016

- Performance
  - Poll Everywhere
  - Assignment (12,582 final submissions)
  - Exams (57,200 data points)
- Effort
  - Office Hours Visits
    - 664 students visited at least once
    - 8,018 interactions
  - Poll Everywhere (91,950 responses)
  - Assignment Attempts (38,918 submissions)
  - Review Sessions (566 check-ins*)
- Suggestive
  - Mid-semester Feedback (855 responses)
  - Suggestion Box Form (100 suggestions)
  - Teaching Evaluations (484 evals)
- Out-of-Band
  - LA Applications (N=105)

Data helps you steer the course and spend more time effectively.