

A large crowd of graduates in black caps and gowns at a commencement ceremony. The graduates are diverse in age and ethnicity. Many are wearing sunglasses. The scene is outdoors and brightly lit.

# Personalizing Education at Scale

Designing for Equity, Inclusion, and Learning

Tim McKay, University of Michigan, @TimMcKayUM

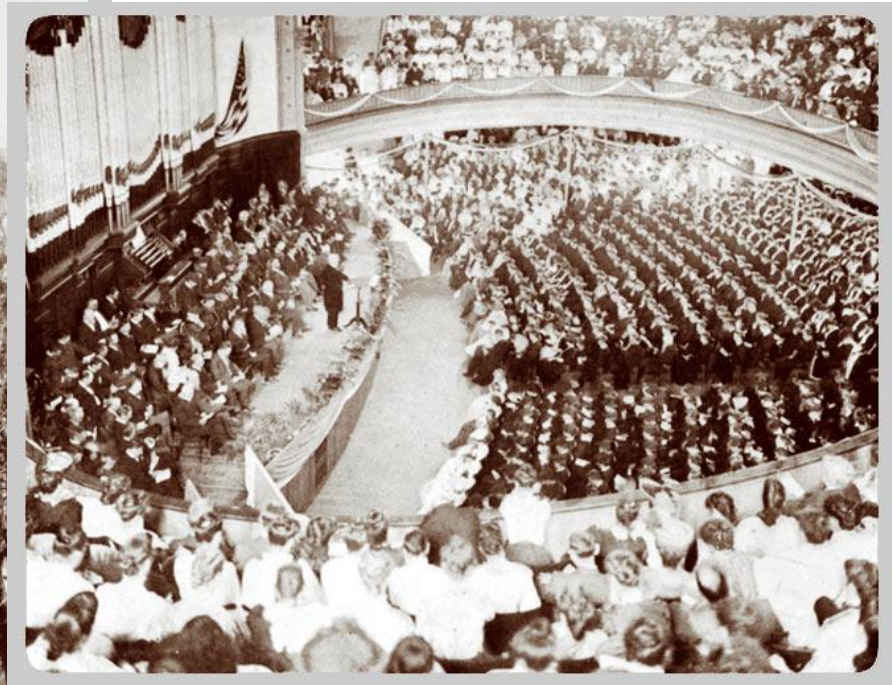
# Some background to provide context

- Detroit auto family, 1<sup>st</sup> gen in college, Temple U. commuter, Chicago PhD, Fermilab postdoc
- To Michigan in '95: physics, astronomy, education, now Associate Dean for UG Ed
- Drawn to complex projects with diverse goals and rich data
- Education research & practice, rigorous analysis & digital tools



- A focus on education at scale
  - In large foundational courses: using design and technology for generational transformation
  - For Michigan: exploring and expanding the impacts of liberal education on life and society

# Public higher education: creating citizens for our societies



Founded in 1817, Michigan began with 8 students. University Hall was constructed in 1871, when total enrollment at the University was 1200 students. This building featured an auditorium seating 3000. *No small plans were made.*

# Birth of the industrial university

- By 1900, enrollment had tripled, to 3482: the industrial era had begun
- By 1950, enrollment expanded by more than 10x, to 43,683
- Michigan became a model for a modern public research university
- Graduation indoors became impossible...
- Today: students from all 50 US states and 125 countries

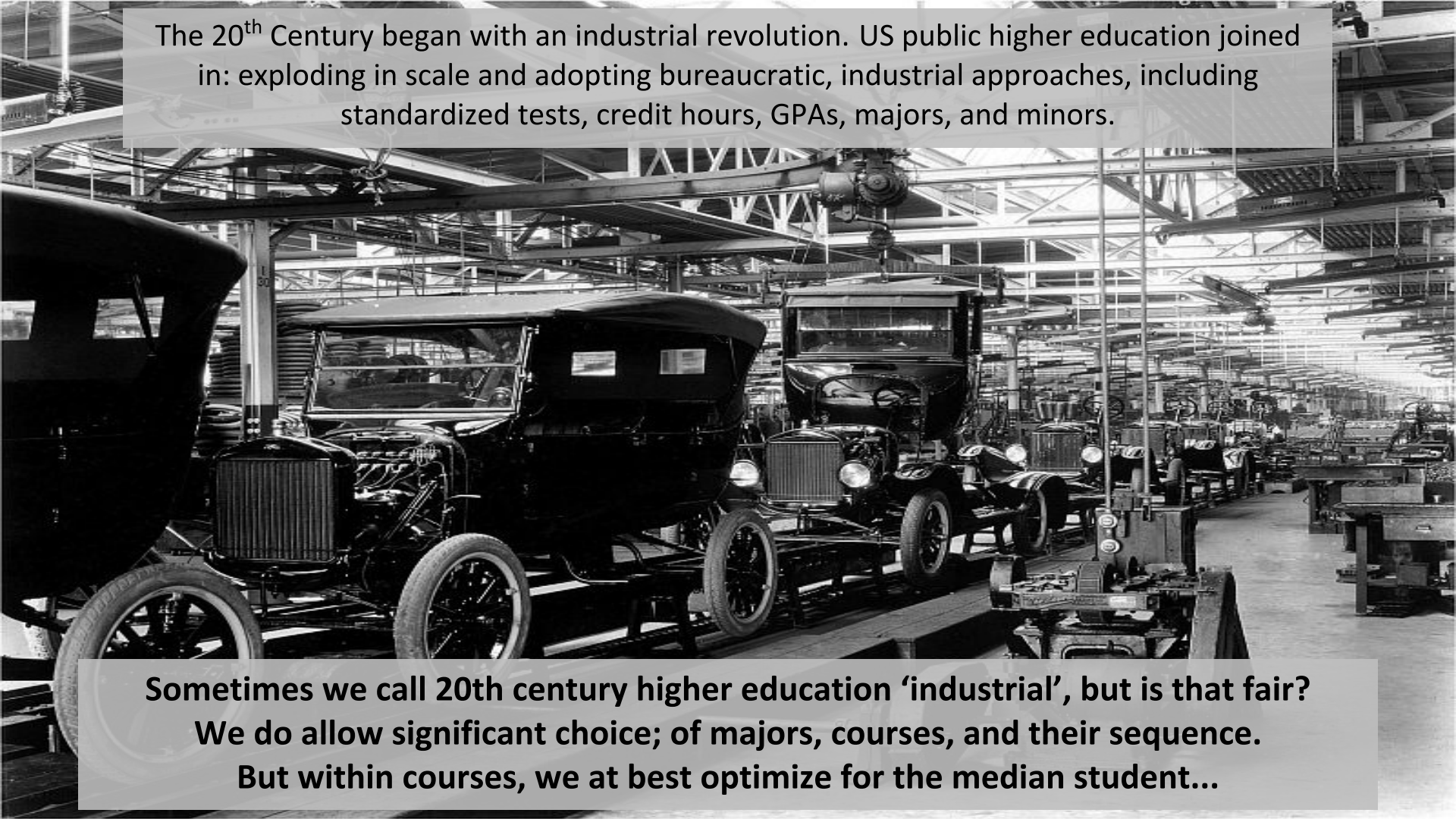


# 1949 Graduation at Ferry Field





- 202 yr old public research intensive university w/19 Schools and Colleges & 6,800 faculty
- Highly selective w/30,000 undergrads and 16,000 graduate students
- Annual budget of \$9.5 billion, w/\$1.6 billion in funded research (#1 public)
- 4,800 courses per term. Most are small, but 110 enroll 200+



The 20<sup>th</sup> Century began with an industrial revolution. US public higher education joined in: exploding in scale and adopting bureaucratic, industrial approaches, including standardized tests, credit hours, GPAs, majors, and minors.

**Sometimes we call 20th century higher education ‘industrial’, but is that fair?  
We do allow significant choice; of majors, courses, and their sequence.  
But within courses, we at best optimize for the median student...**



The 21<sup>st</sup> Century began with an information revolution.

*We know more about our students than we ever have.*

This data will support a revolution through **personalization**.

Our goal today is a 21st century, information age form of optimization: adapting the system to *individually* optimize learning for every student.



# The purpose of Learning Analytics?

“understanding and optimizing learning and the environments in which it occurs”

We can use data improve (perhaps even optimize) the experience of **every individual** we educate.

Not just in principal, but in practice.

Not just for some students, but for all, even at scale.

# Data allows us to personalize at scale

- With it, we can attend to every student:
  - As a **student**: we need to see what they do, assess what they know, represent their skills and accomplishments
  - As a **person**, with evolving background, interests, goals, identity, concerns, purpose, affect, well-being
- We need to use the student record to act at scale:
  - Learn from everyone, attend to all in real time, deliver actionable information to students, faculty, and staff, communicate in effective, humane ways

Challenges in creating a  
faculty/staff environment for LA  
innovation...

Simon Buckingham Shum and Tim McKay,  
EDUCAUSE Review, March/April 2018

# Architecting *for* Learning Analytics:

Innovating for Sustainable Impact

Simon J. Buckingham Shum and Timothy A. McKay

For more on LA at Michigan:  
see Lonn, McKay, & Teasley.  
**"Cultivating Institutional  
Capacities for Learning  
Analytics."** *New Directions  
for Higher Education*  
2017.179 (2017): 53-63.

# Four ways to use data

Data for decision support

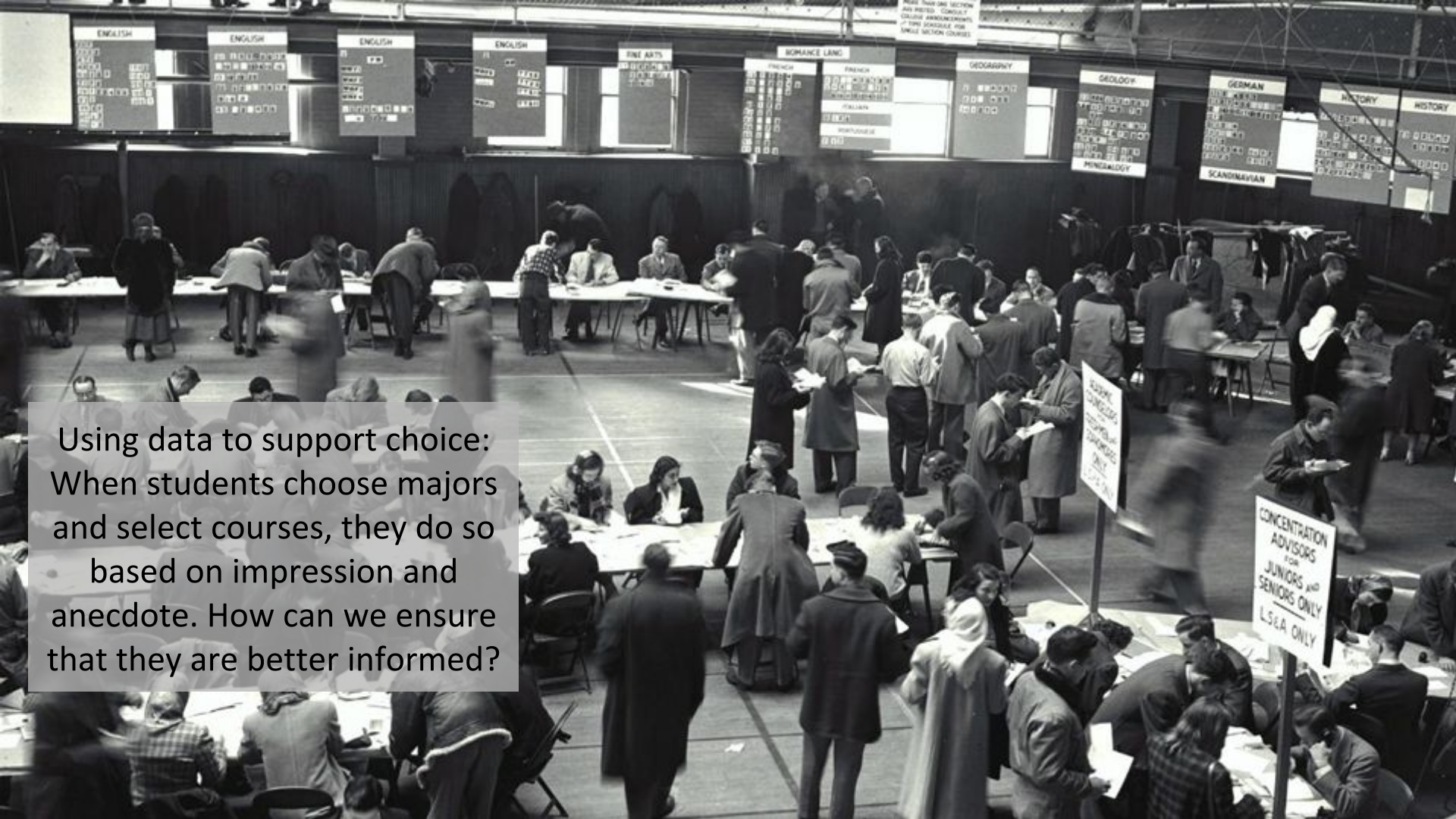
Data for discovery

Data for personalization

Data to drive change

# #1: Data for decision support

Providing data to students helps to support better decision making.



Using data to support choice:  
When students choose majors  
and select courses, they do so

- based on impression and anecdote. How can we ensure that they are better informed?

# Atlas.

navigate your academic world

Atlas shows past enrollment data about U-M courses, instructors, and majors to guide U-M students, instructors, and staff in decision-making.



## Search for Courses, Instructors, and Majors.

Select which category you would like to search and enter course numbers, title, or keywords.

Courses

Instructors

Majors

Search by Course Numbers, Title, or Keywords

Atlas provides students, faculty, and staff with historical data about courses, instructors, and academic majors.

The goal is to support better decision making by all.

## Academic Spotlights

Curated data to offer different perspectives into the different courses, majors, and instructors that the University of Michigan has to offer.

### Course Spotlights

- [Wild Card Courses](#)
- [U-M's Largest Courses](#)
- [Surprising Courses](#)
- [Entrepreneurship Courses](#)

### Instructor Spotlights

- [Thurnau Professors](#)

### Major Spotlights

- [Fast Growing Majors](#)



Course Profile

## General Physics I

PHYSICS 140 offers an introduction to classical mechanics, the physics of motion. Topics include: ve...

[Show more >](#)

[Save to My Dashboard](#)

### PHYSICS 140

4.0 Credits

Median Grade: **B**

**Advisory prerequisites:**

MATH 115, 120, 185 or 295.

[↓ Scroll down for more information](#)

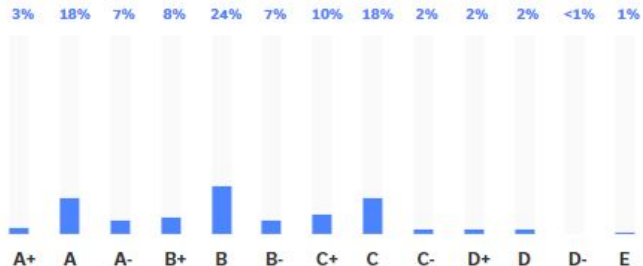
Course profile data represents the past 5 academic years with the addi...

Atlas course reports describe who takes a course, how they do, what they take before and after, what they go on to major in...

### Grade Distribution

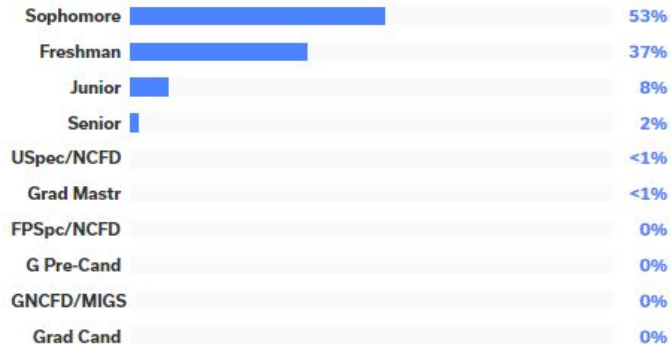
For students who earned letter grades other than W, I, P or F, this graph shows the percentage of students who received each letter grade.

Median Grade: **B**



### Incoming Student Level

This graph shows students' academic level when they started PHYSICS 140.





## Course Instructors

This table shows instructors who have taught ; adjunct lecturers are not included in this list.

Show  entries

Course Instructors	Terms Taught	Most Recent Term
<a href="#">Melnichuk, Mike</a>	10	Winter 2019
<a href="#">Popov, Yuri</a>	10	Winter 2019
<a href="#">Riles, Keith</a>	6	Winter 2017
<a href="#">Uher, Ctirad</a>	5	Fall 2016
<a href="#">McKay, Timothy</a>	4	Winter 2019

Previous  Next

### Why is a specific instructor not showing up?

Instructors are only shown if they are considered full-time and have taught this course in the past 5 academic years.

## Declared Degrees

This list shows what degree students who took PHYSICS 140 eventually declared.

<a href="#">Engineering: First Year</a>	14%
<a href="#">LSA Undeclared</a>	13%
<a href="#">Computer Science BSE</a>	12%
<a href="#">Mechanical Engineering BSE</a>	9%
<a href="#">Industrial &amp; Oper Eng BSE</a>	6%

previous 1 / 10 next

## School/College Affiliation

This list shows what colleges or schools students were affiliated with when they took PHYSICS 140 . Students may have changed their program or plan after taking this course but that change is not being reflected in this list.

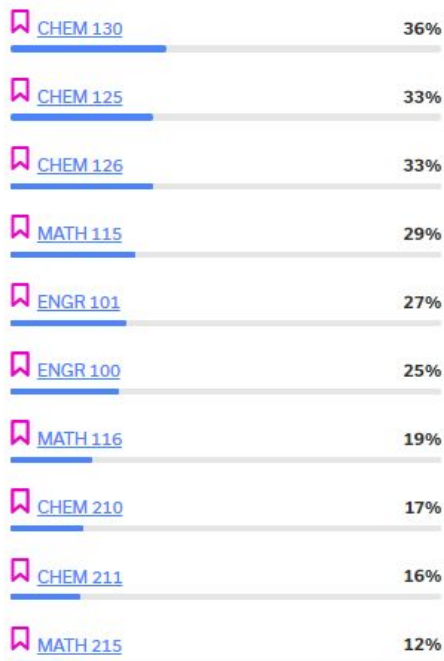
<a href="#">Undergraduate Engineering</a>	74%
<a href="#">Undergraduate L S &amp; A</a>	25%
<a href="#">Undergrad Music, Thtre &amp; Dance</a>	1%
<a href="#">Undergraduate Art and Design</a>	1%
<a href="#">Undergraduate Kinesiology</a>	1%

previous 1 / 3 next

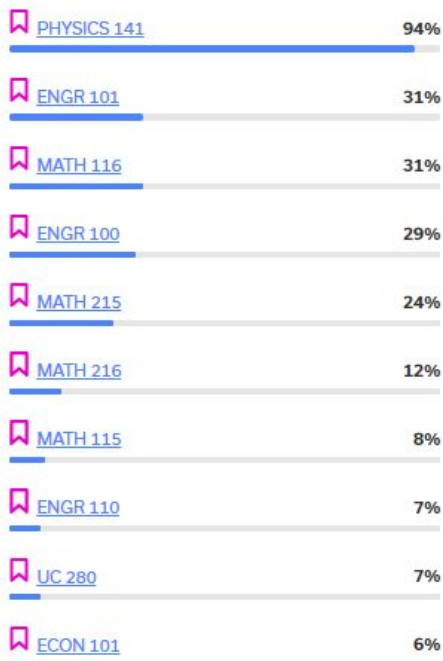
## Common Course Pathways

This panel shows the most common courses students took before, during, and after being enrolled in PHYSICS 140. The percentage next to each course represents the percentage of students that have taken PHYSICS 140 that also took the specified course.

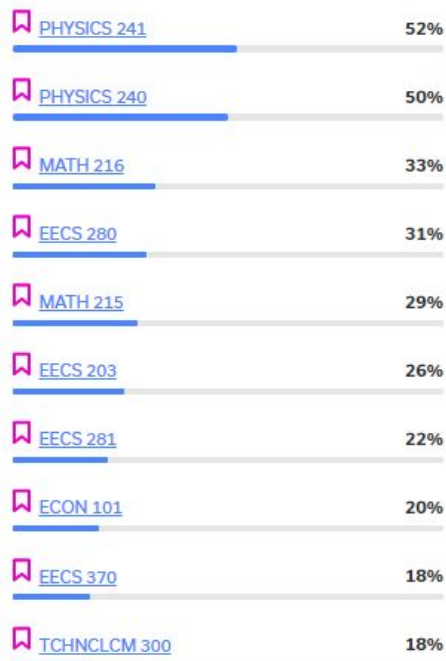
### Taken at any time before PHYSICS 140



### Taken at the same time as PHYSICS 140



### Taken at any time after PHYSICS 140



# Bachelor of Science in Computer Science



Electrical Engr & Computer Sci  
Program In Computer Science

Save to My Dashboard

Major profile data represents the past 10 calendar years with the addition of the current active year.

## Annual Graduates with Bachelor of Science in Computer Science

This graph shows how many students have graduated with this degree each year, subdivided by semester.

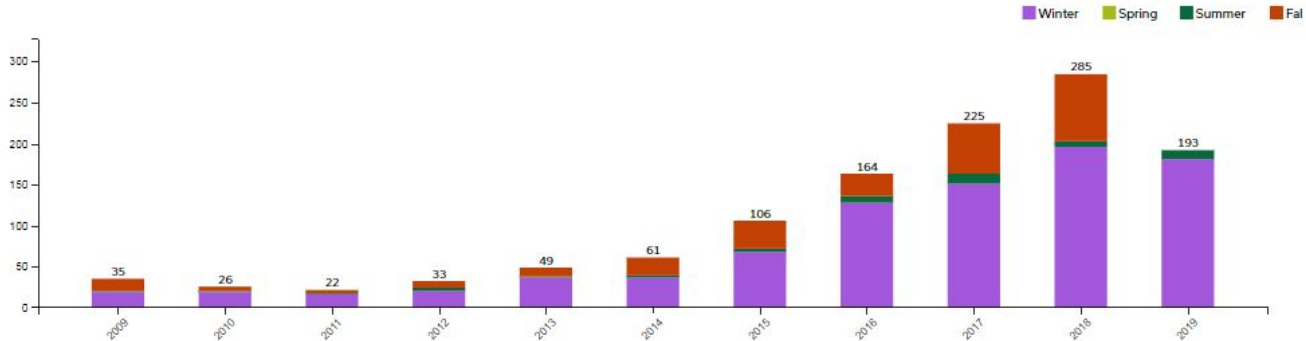
Students currently enrolled: **802**

Graduates: **1199**

### Pro Tip

Click on the graph bars below to filter the data to see how different years impacted graduates in regards to semesters to completion, co-majors, and minors. Filters do not impact "Most Commonly Taken Courses" graphs.

Atlas major reports describe who majors in a subject, what they take along the way, how long it takes for them to complete their degree...



## Semesters to Completion (Computer Science BS)

This graph shows the total number of semesters **Bachelor of Science in Computer Science** graduates were enrolled at UM.



## Semesters to Completion with Multiple Degrees

This graph shows the total number of semesters **Bachelor of Science in Computer Science** graduates who were awarded multiple degrees were enrolled at UM.



## Co-Majors

This graph shows the number of **Bachelor of Science in Computer Science** graduates who graduated with more than one major.

Total number of students who graduated with a co-major: 342



## Minors

This graph shows the number of **Bachelor of Science in Computer Science** graduates who graduated with at least one minor.

Total number of students who graduated with a minor: 232



# Data for decision support

How can we extend this beyond course and major selection to support decision making for life?

Intellectual  
Breadth

Disciplinary  
Depth

Range of  
Experience

The Mellon Foundation College and  
Beyond II project: making the case  
for liberal education using data.



Traits of Liberal Education



Let  
15  
years  
pass

Civic & arts  
Engagement  
Well-being  
Employment  
Income

Engagement &  
Effort

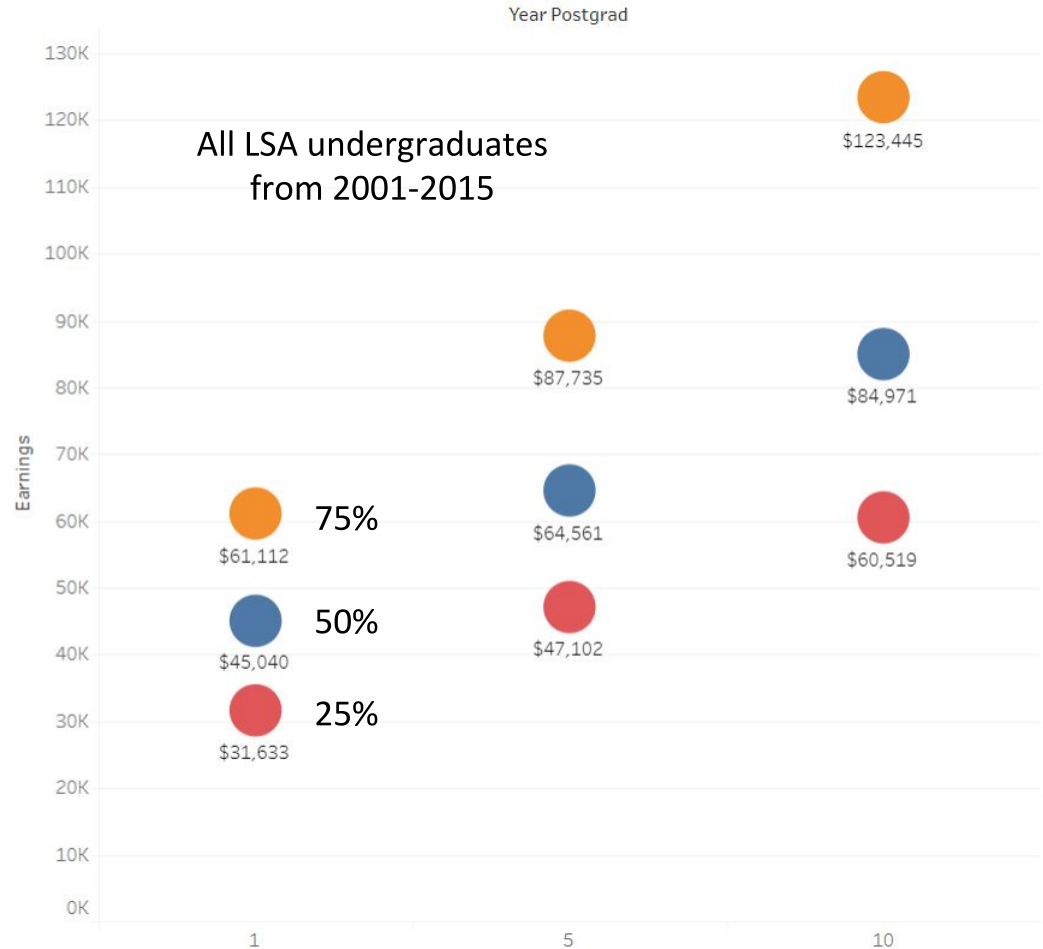
Social &  
Professional  
Networks

Academic  
Performance

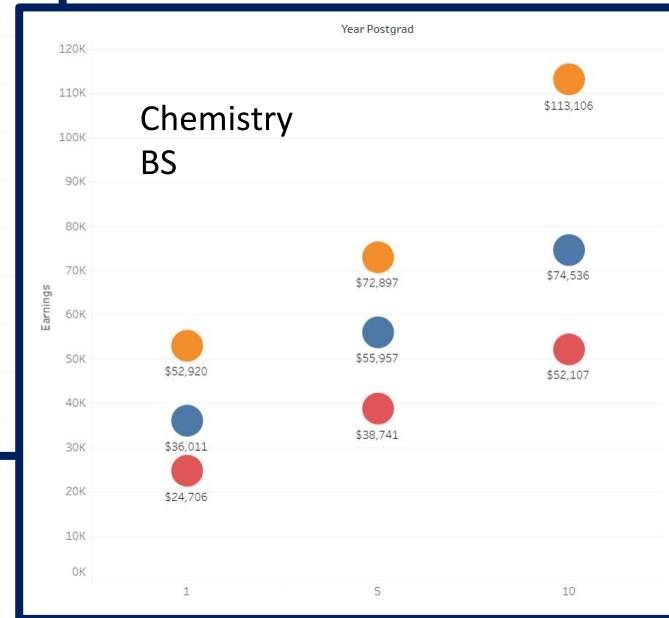


Data from the “Post Secondary Employment Outcomes” project, a collaboration between UMich and US Census.

This is an early example of the use of administrative data to understand life outcomes.



Variations in income *by major* 1, 5, and 10 years after graduation are modest – much smaller than the variations *among* students who majored in each area.





# A caution about decision support...

Data like this can also be used to make forceful recommendations, as is regularly the case in the commercial world.

We should be careful to preserve student exploration and support real freedom of choice.

## #2: Data for personalization

How can use data and behavioral science to tailor messaging and shape more successful students, even when teaching thousands?

Large foundational courses present a challenge.  
How to provide every student w/personalized feedback, encouragement, & advice?



# ECoach for personalization at scale

- Aggregates extensive information about student background, interests, goals, & current state
- Provides deeply tailored feedback, advice, and encouragement
  - Tailor everything: *what* to say, *how* to say it, even *who* says it
  - Testimonials from identity-salient peers
- Key tool for *humane* personalization: lets us interact in natural ways

The screenshot displays the ECoach interface for a student named Kathleen in a STAT250 course. The top navigation bar includes the ECoach logo, the course name 'STAT250', and the student's name 'Kathleen'. The main content area is divided into several sections:

- Personalized Greeting:** "Hey, Kathleen." followed by a message: "Kathleen, thanks for answering those questions... now let's make some sense of it all."
- Course Grade:** A gauge chart showing a current grade of 83% and a goal of 96%. A button labeled "Go to Grade Calculator" is below the gauge.
- Lecture Challenge:** A section titled "Lecture Challenge" with the question "Did you attend your STAT250 lecture today?". Two buttons are provided: "Yes! I was there" and "No, I didn't make it".
- To Do List:** A section titled "To Do < Week of Oct 17 >" with a "Sort by" dropdown. It contains three items:
  - Gear up for lab:** Due Tomorrow. Task: "Complete the One Mean Prelab Assignment before Mon, Oct 31 at 8AM. Video shows how to generate a confidence interval or hypothesis test about a population mean using R. Bring your 250 coursepack or a printed copy of Lab 6 pages on One Population Mean, your Clicker, and the Stats Help Card." Buttons for "Homework" and "Labs" are at the bottom.
  - Lab 7 Groundwork:** Due Tomorrow. Task: "Watch the Paired Mean PreLab and complete the Assignment. Use R to assess if there is a difference in the population mean wear for two tire brands." A "Review" button is at the bottom.
  - Finish off HW:** Due Oct 02. Task: "Finish off those required HW 5 questions. Note: Q5 and Q9 require using R/Minitab to perform data analyses on fuel efficiencies for 2016 passenger cars and salaries for..."
- Quick Links:** A list of links: "Message Center", "Grade Calculator", "Exam Playbook", "Journal", "Name that Scenario", "Canvas", "Problem Roulette", and "Coursework".
- Message Center:** A section titled "Message Center See all >" with three notifications:
  - Name That Scenario:** Oct 02. "Your new best friend"
  - Everyday stats:** Oct 02. "Cryptography"
  - Exam 1:** Oct 02. "Your personal plan"

Tailored content is delivered in a timely way through multiple channels including the web, email, texts. Strong focus on encouraging the behaviors and attitudes that lead to student success.



Expertise of dozens of **instructors**, hundreds of **students**, and **behavior change experts**



**Detailed information about students:** grades, motivations, goals, and current status



# MTS

**The Michigan Tailoring System:** a mature open-source software system built in the U-M SPH for creating content designed specifically for an individual based on data about that individual



**Individually personalized messages:** getting the right message to the right person at the right time in the right way

## WHAT WE DO

ECoach is a personalized coaching tool that supports students in large courses, where one-on-one communication between instructors and students is otherwise impossible.



## EXAMPLE SCENARIO

### Imagine.

Five very different students are in line for your office hours right after an exam. What do you want to know about each student? What would you say to them, in response to their differences?

**This is the thinking that drives ECoach.**



## FEATURE HIGHLIGHTS

### Tailored Messaging

Using student data, the tailoring system lets you personalize anything in ECoach—emails, messages, to-do list items—based on important student characteristics.

Exam 1 Reflection | How'd it go?

Kirsten, thanks for answering those questions... now let's make some sense of it all.

**FIRST, LET'S THINK ABOUT THE EXAM**

**Exam 1**

At 70.0%, you're not happy with your score... Maybe you're not used to getting scores that are less than (basically) perfect. But please don't get too discouraged. We'll help you figure out where to go from here.

**What worked for you this time?**

Think about what you've done during the first half of the course that has worked for you, like your:

- Homework process
- Prelab and lab approaches
- Review and study strategies
- Use of available resources

### Exam Playbook

An evidence-based metacognitive intervention that helps students reflect on their learning, use course resources more effectively, and perform about half a letter grade better than non-users.

### Grade Calculator

The Grade Calculator shows students the scores they've already earned, and lets them guess about future scores to see the impact on their final grade.

**Grade breakdown**

**CALCULATE GRADE**

Select the grade categories below for each individual course and then submit with your current grade.

Grade	Percentage
A	10%
B	15%
C	20%
D	25%
E	30%
F	10%

Category	Score	Weight
Participation (50% of total grade)	100	50%
Assignment 1	100	10%
Assignment 2	100	10%
Assignment 3	100	10%
Assignment 4	100	10%
Assignment 5	100	10%
Assignment 6	100	10%
Assignment 7	100	10%
Assignment 8	100	10%
Assignment 9	100	10%
Assignment 10	100	10%

**most favored course grade**

### To-Do Lists

ECoach enables you to provide students with tailored, week-by-week lists of the most important tasks for the course.

**To-Do** < WEEK 5 (6/2 - 6/8) >

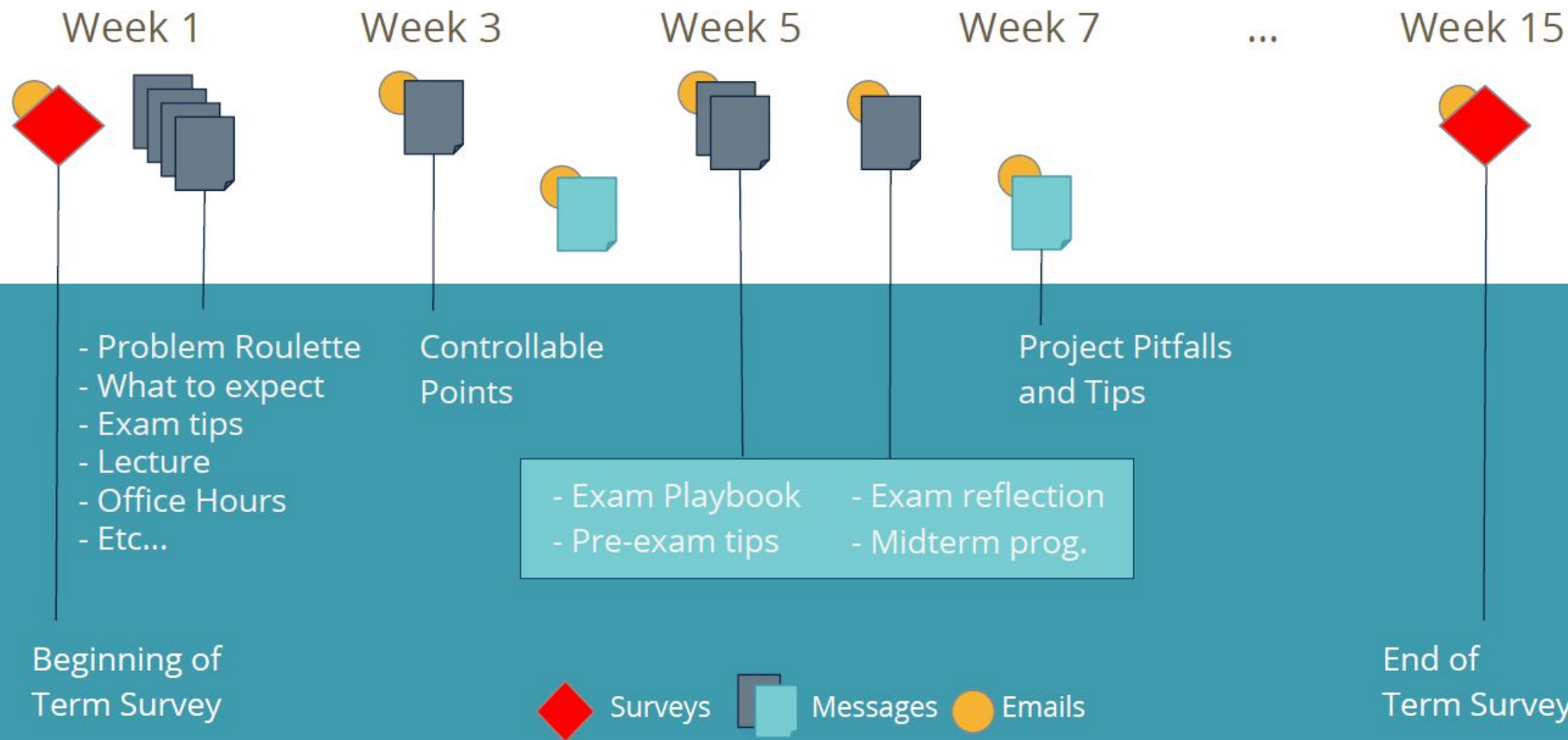
**Lab 6 and 7 Prep** Jun 02

Check that your **Mean Prelab** is submitted before **Mon, June 5, 8am**; and after **Monday** lecture try the **Paired Mean Prelab**. Bring your coursepack or a printed copy of **Lab 6 (Monday)** and **Lab 7 (Wednesday)**.

LABS



# Typical term



# Designing and testing research-based interventions

- Values Affirmation
- Growth Mindset
- Utility Value
- “Better than” vs “Average” nudges
- Goal setting survey
- Commitment devices
- “Why didn’t I get a higher grade” intervention

STATS Homework 4: When did you start?



What, if anything, might you do differently next time?

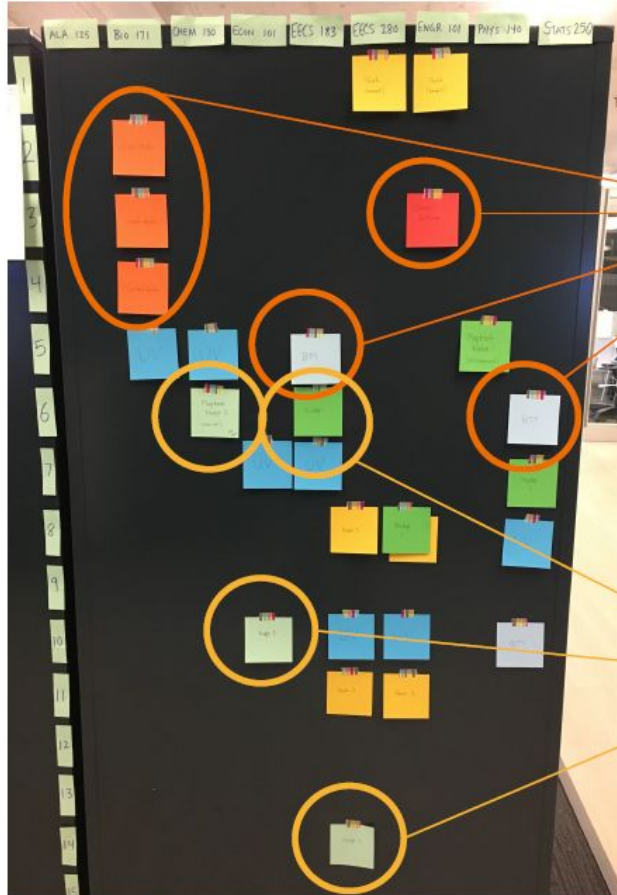
- Start earlier
- Start later
- Nothing
- Get help with my approach

Confirm



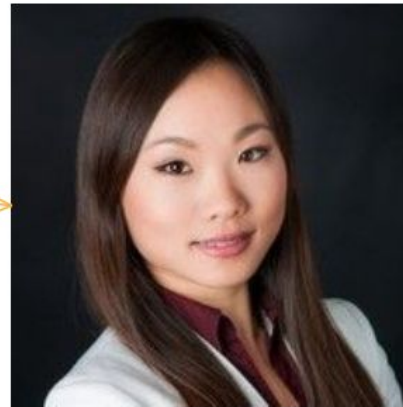
**You** said you usually do less than half in this category





Dr. Michael  
Brown

IOWA STATE  
UNIVERSITY



Stanford  
University



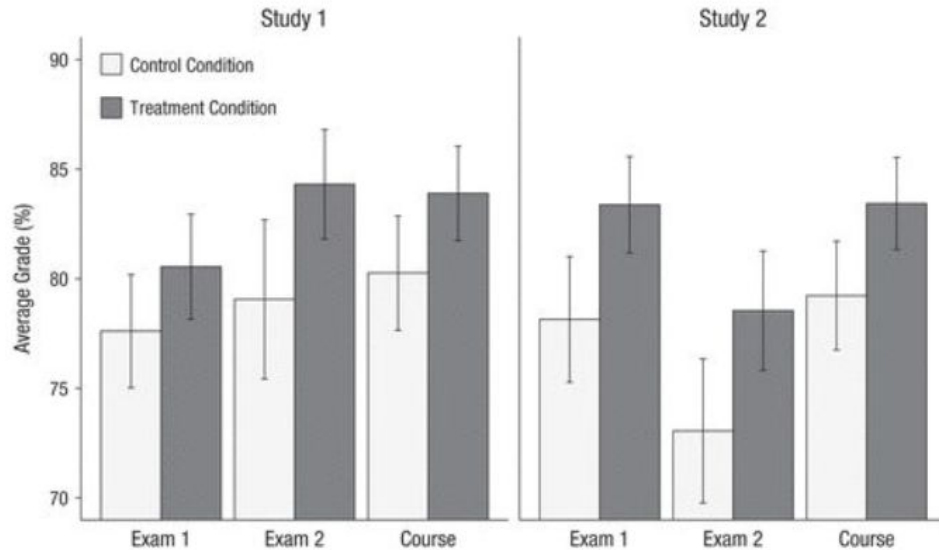
NUS  
National University  
of Singapore

Dr. Patricia  
Chen

# Opening the black box

Students randomly assigned to the treatment condition:

- more self-reflective about their learning
- used resources more effectively
- outperformed students in the control condition by an average of **one third of a letter grade in the class.**



# Ecoach expansion underway now

- **Building a multi-institutional R&D team to explore scalable, tailored coaching**
- Currently focused on R&D within the 'course coach' model
  - Questions of research and practice:
    - How best to use tailoring to improve student performance?
    - How to support self-efficacy, sense of belonging, motivation?
    - What elements of tailoring are most important?
    - How to use texting, nudges, reflection, & other new tools?
  - Adding new courses at existing institutions: working to understand how to make running a course coach easy
  - Adding new partner institutions: working to understand how to make onboarding a new institution easy

‘Personalize’ with caution:  
Datafication of individuals...

# Who am I?

1490

Second tenor

Astronomer

SAT  
53 years old

Tim McKay

Cosmologist

Midwesterner

Male

PhD in Physics

B.S. in Physics

3.78

Cook

White  
GPA

tamckay

Professor

Physicist

Cyclist

Data Scientist

Early riser

Birder

Education Researcher

SSN: xxx-xx-xxxx



# Identity & Reputation

- Sometimes identity as a list of traits and experiences we've had: labels for categories which make us like some people and different from others
- To control your identity:
  - You want to be placed in the categories you think you belong in
  - You want the world to know what membership in these categories really means to you
  - You want the world to understand that you're not exactly like all the other people in that group
  - You want these labels to evolve sensibly

The most important point:

Each of us is the unique, intersecting  
combination of all our experiences  
and traits.

An individual.

## #3: Data for discovery

Careful analysis of prior student experiences can be used to explore student success and test learning environments for equity.



How do you know what's happening,  
when you teach a class of 700+?

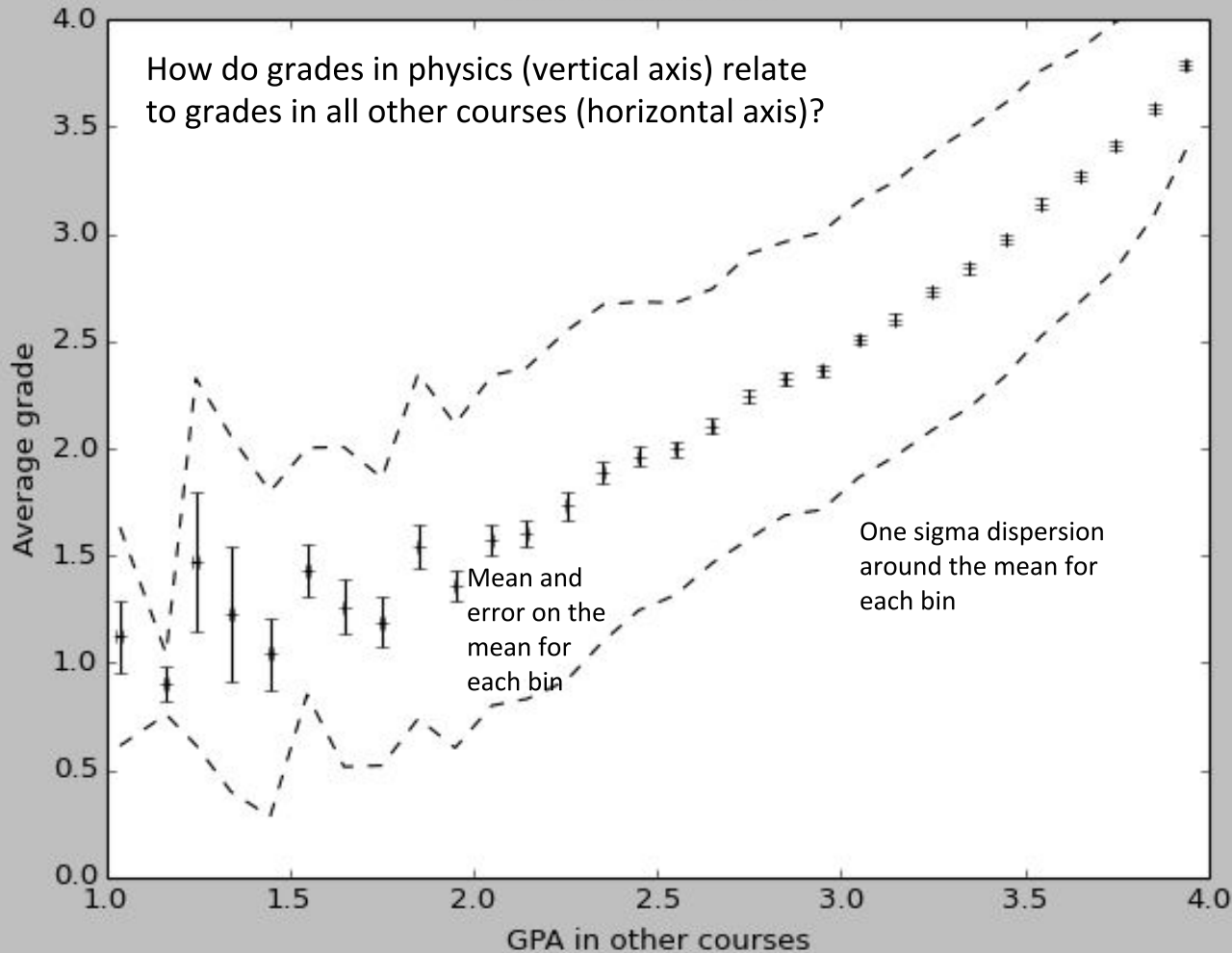


7. Choose the appropriate conservation law (if any)

6. Decide which forces are internal (between within the system) and which forces are external (exerted by outside bodies: earth, pivot, ...)

7. Choose the appropriate conservation law (if any)

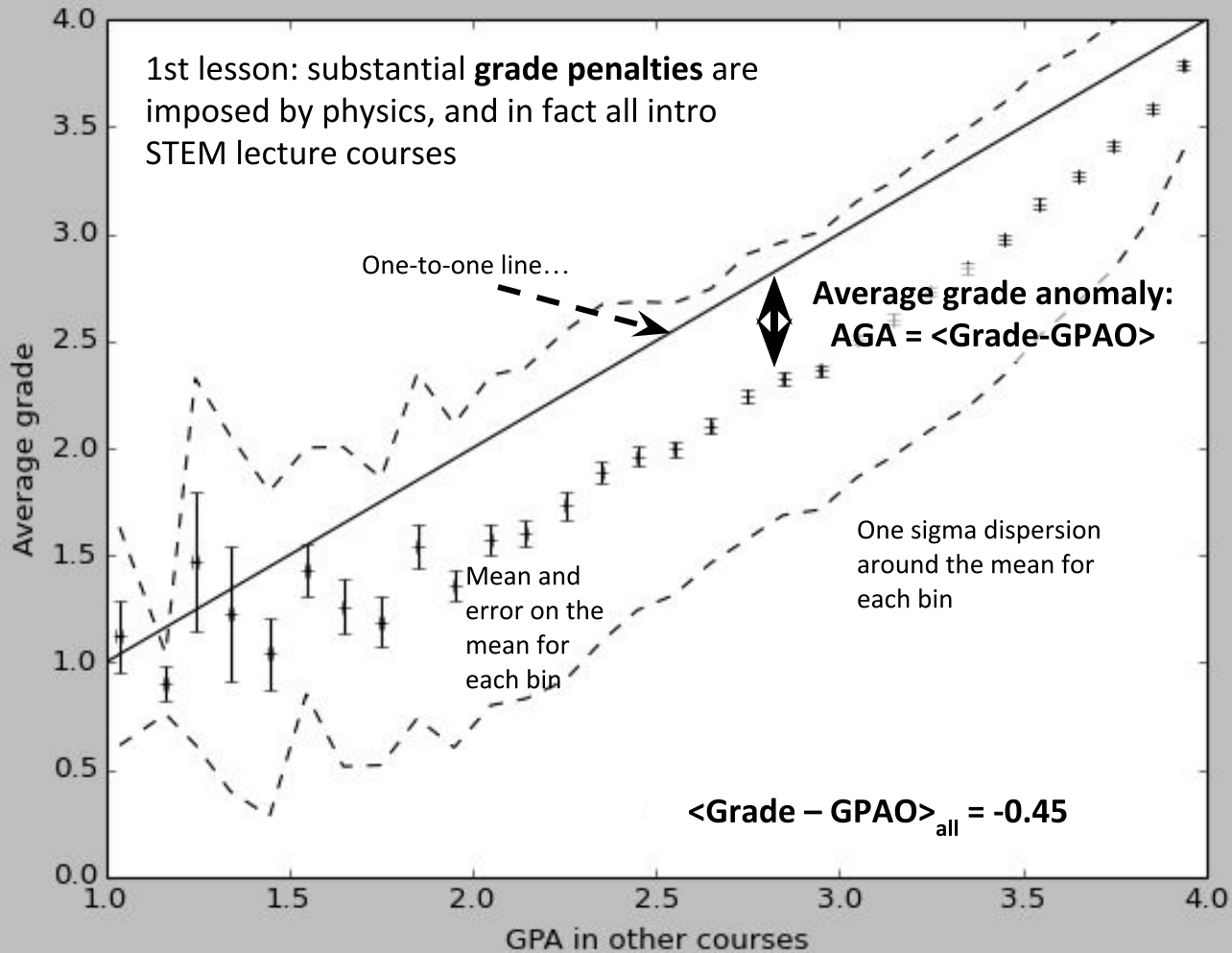
# PHYSICS 140



Start by learning from experience.

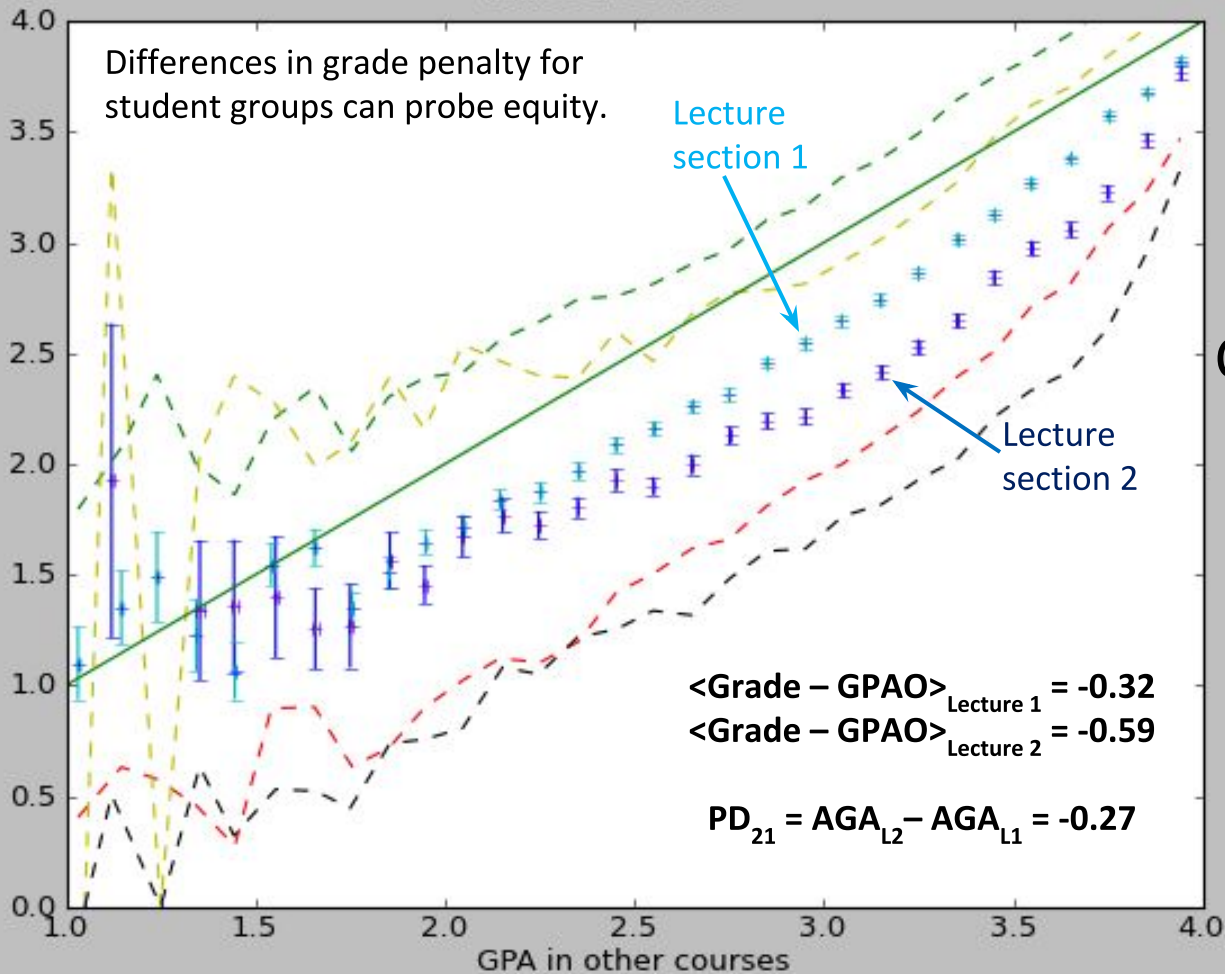
Who performs well?

# PHYSICS 140



Who does better than expected?  
Who does worse?

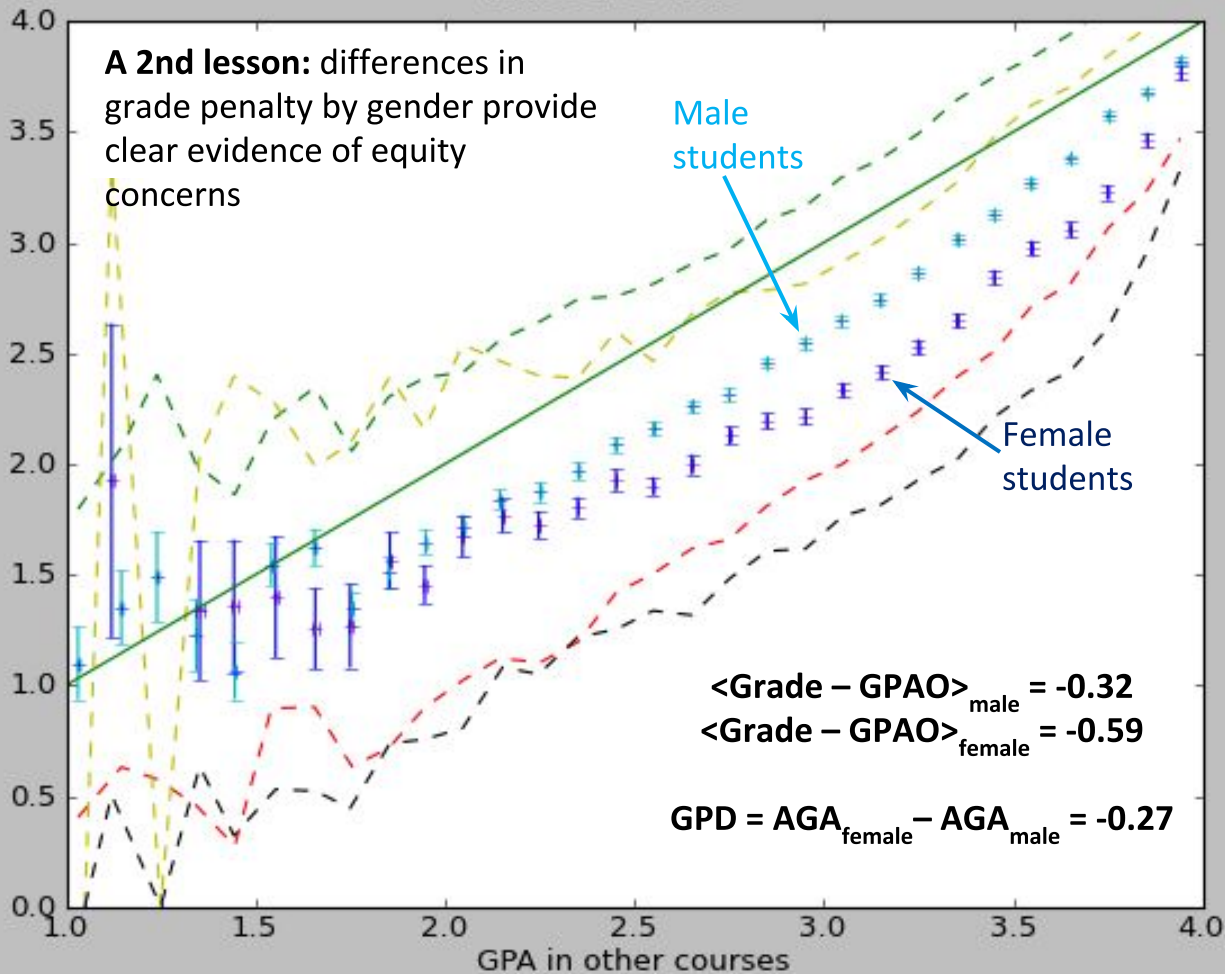
# PHYSICS 140



Could this be an equity problem?

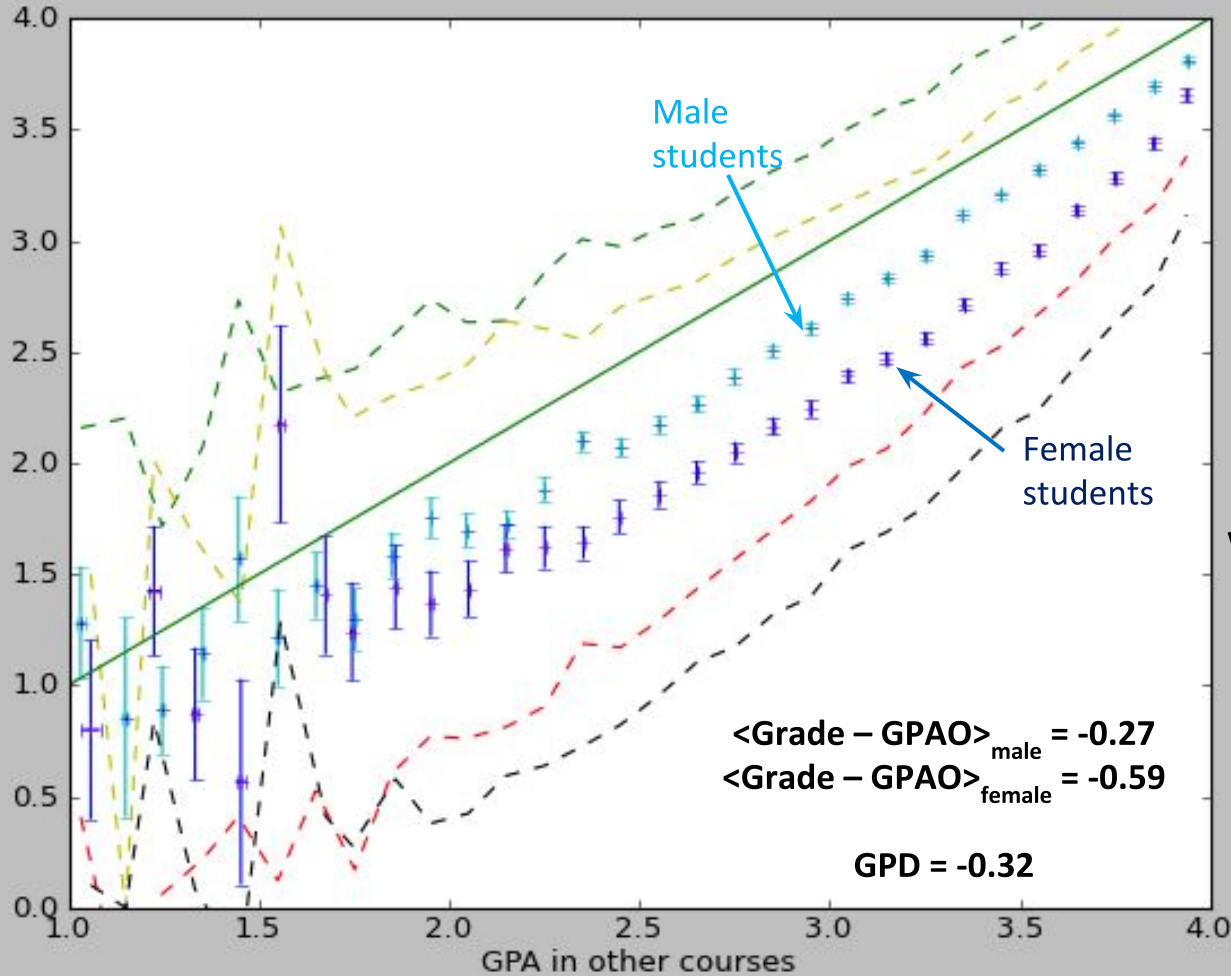
# PHYSICS 140

**A 2nd lesson:** differences in grade penalty by gender provide clear evidence of equity concerns



In fact, this figure compares male & female students

Is this only a problem for physics?



It's not just physics.

Equity problems are widespread, but *only* in certain kinds of classes



## #4: Data to drive change

Discoveries based on robust data can motivate change, both within an institution and across the landscape of higher education.



Data drives local change: UM launched a \$5 million Foundational Course Initiative.

Redesigning courses w/data to turn weed-out exits into deep-roots mastery experiences.

## The Foundational Course Initiative (FCI)

A Program for 21st-Century Support for Teaching at Scale

<http://www.crlt.umich.edu/fci>

By establishing a new standard for collaborative course design and delivery, Michigan can lead the world in teaching foundational topics at scale on a research university campus.

### What are Foundational Courses?

- FCs are gateways to the major or the primary introduction to a discipline.
- FCs enroll large numbers of students with very diverse backgrounds, interests, and goals.
- Student success in FCs can vary widely.
- FCs are often taught by multiple faculty over time and/or in a given semester.
- FCs are time consuming to teach and manage.

*FCs generate \$150 million in tuition every term.*



\*Courses with enrollments of 200+

### Goals for the FCI

1. **A 21st Century Approach to Student Success:** Foundational courses should maintain rigor and have the success of all students as their goal.
2. **Evidence-Based Course Design:** Disciplinary experts and education professionals address course-specific challenges as a team while adding to our theory and knowledge of teaching and learning.
3. **A New Standard for Excellence:** Michigan's foundational courses should be the best in the nation, continuously innovating, assessing success, and setting the standard for higher education.

In 5 years, we will transform 30 courses, and impact 80% of undergrads.

### Why Participate?

Motivations for participating in the FCI will vary among courses and disciplines, but for any foundational course, there are a number of possible reasons to participate.

**Explore** possibilities for course design and pedagogy that leverage emerging technologies.

**Support**, evolve, and institutionalize reforms pioneered by early adopters.

**Create** opportunities for intergenerational mentoring on teaching.

**Develop** new course models that highlight the benefits of a residential research setting.

**Infuse** evidence-based pedagogies that:

- Support the learning and success of all students.
- Improve motivation and engagement.
- Increase student perception of educational value.

**Collaborate** to tackle challenges, such as:

- In some courses, student success and satisfaction are low.
- Teaching these courses alone is difficult, and team support can help make improvements possible.

### Collaborative Course Design Teams

CCD teams draw expertise from the department, college, and from CRLT staff and others with a substantial investment in the course.



### Collaborative Course Design Process

#### Consultation & Proposal

FCI works with department stakeholders on a formal proposal to enter the CCD process.

#### Exploration & Design

CCD team meets regularly to study the course and its students and to develop learning objectives, select pedagogies, and design assignments.

#### Development & Testing

CCD team meets regularly while the pilot version of a reformed course is taught. The course becomes a learning laboratory, as new approaches are implemented and assessed.

#### Delivery & Reporting

Faculty teach the "final" revised course and work with the CCD team on a report describing evidence of success and ongoing needs for support.

#### Certification & Foundational Status

FC status is granted by a Faculty Advisory Board after review of the CCD team report. FCs receive ongoing support and, after 3 years, the course is reviewed to identify opportunities for further innovation.



# SEISMIC: Sloan Equity and Inclusion in STEM Intro Courses



Data drives collective change:

We are also leading SEISMIC, a US national collaboration using data to transform large introductory STEM courses everywhere.



UC SANTA BARBARA



University of Pittsburgh



A three+ year collaboration of STEM reform efforts at ten large, public research universities enrolling a more than 350,000 students.

# What will SEISMIC do?

- Participating institutions will connect for 3+ years through:
  - **Parallel data analyses and comparison of results** focused on studies of STEM equity and inclusion
  - **Coordinated classroom experimentation** in multiple disciplines across multiple campuses with thousands of students
  - **Continuous collaboration** w/scientific and technical working groups focused on measurement, experimentation, & structures
  - **Extended annual meetings** involving faculty, staff, students, discipline-based education researchers

# Four ways to use data

Data for decision support

Data for personalization

Data for discovery

Data to drive change

# A few closing requests...

- Share data broadly: it can support informed decision making by everyone involved in education
- Remember that students are individuals: treat their reduction to datafied representations with critical care
- Use the data you have to probe equity; encourage your institutions to do so in collaboration with others
- Work together as educational institutions and use your data to drive change

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