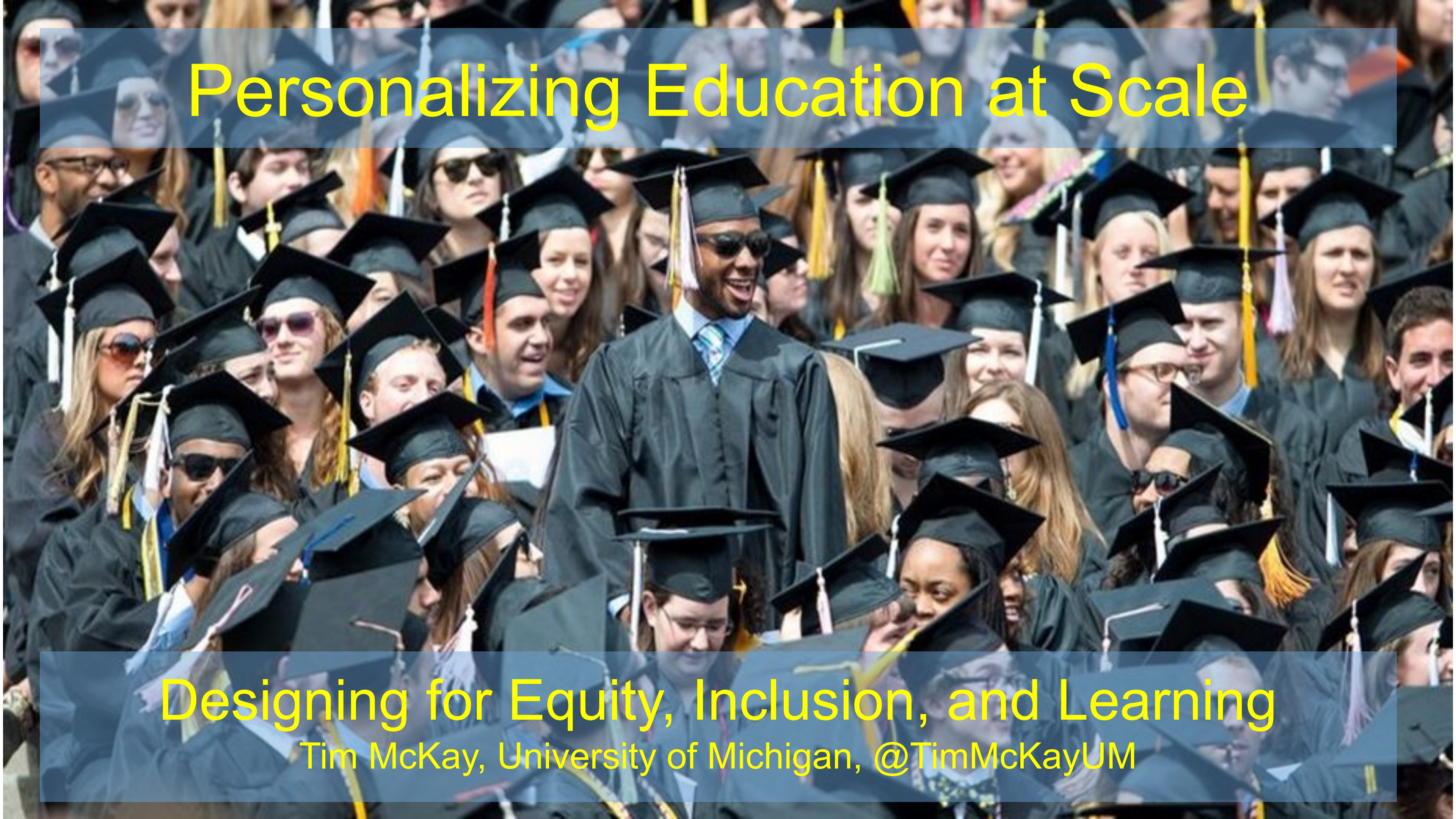


Personalizing Education at Scale

Designing for Equity, Inclusion, and Learning

Tim McKay, University of Michigan, @TimMcKayUM

Some background to provide context

- Detroit auto family, 1st 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

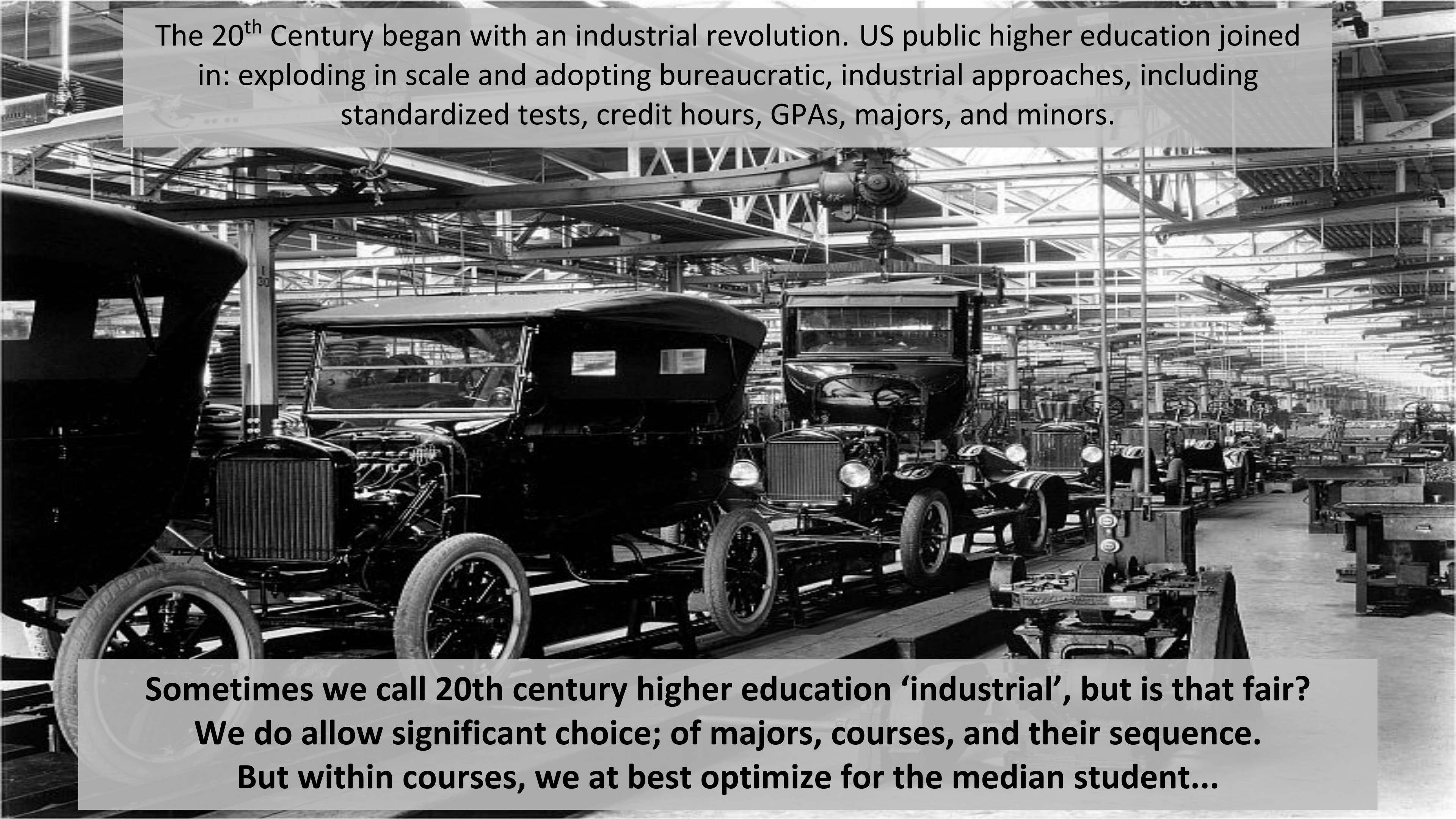
1949 Graduation

1949 Graduation at Ferry Field

2010 Graduation - at the Big House

- 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 20th 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 21st Century began with an information revolution.

<u>We know more about our students than we ever have</u>.

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.

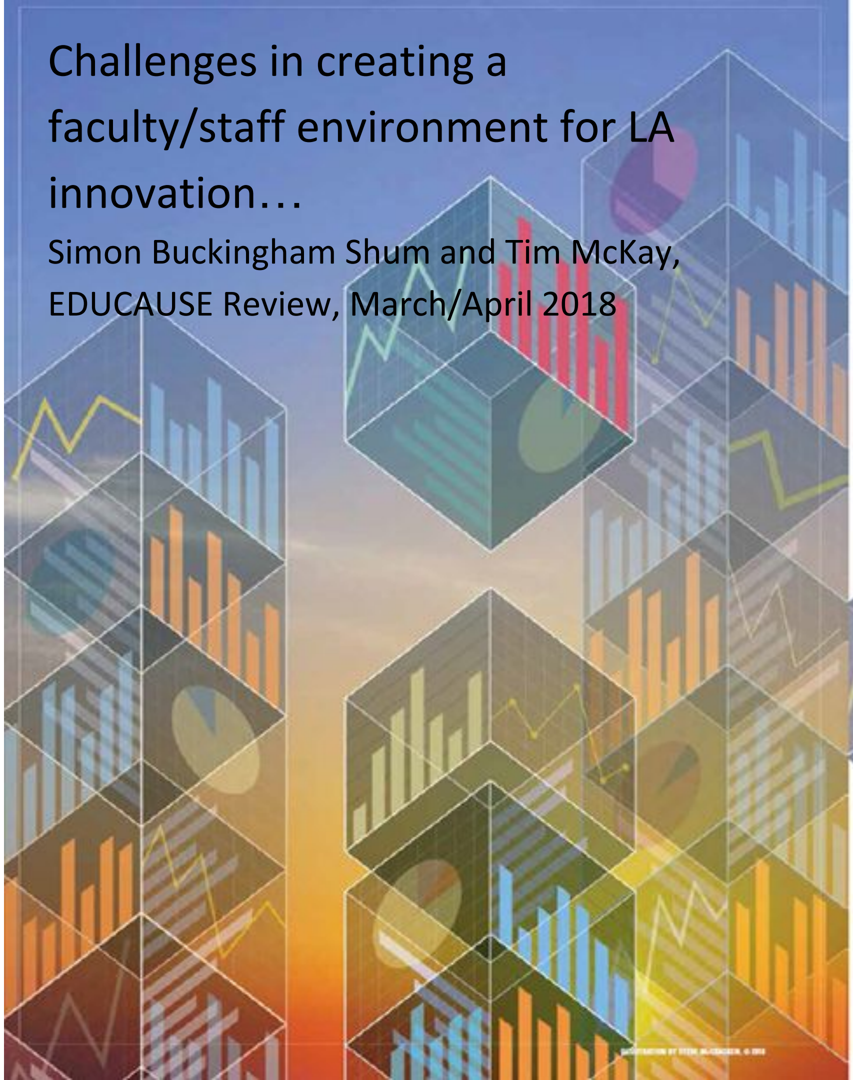
The purpose of Learning Analytics?

"understanding and optimizing learning and the environments in which it occurs"

We can use data improve (perhaps even optimize) the 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 <u>attend to every student</u>:
  - 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 <u>act at scale</u>:
  - 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

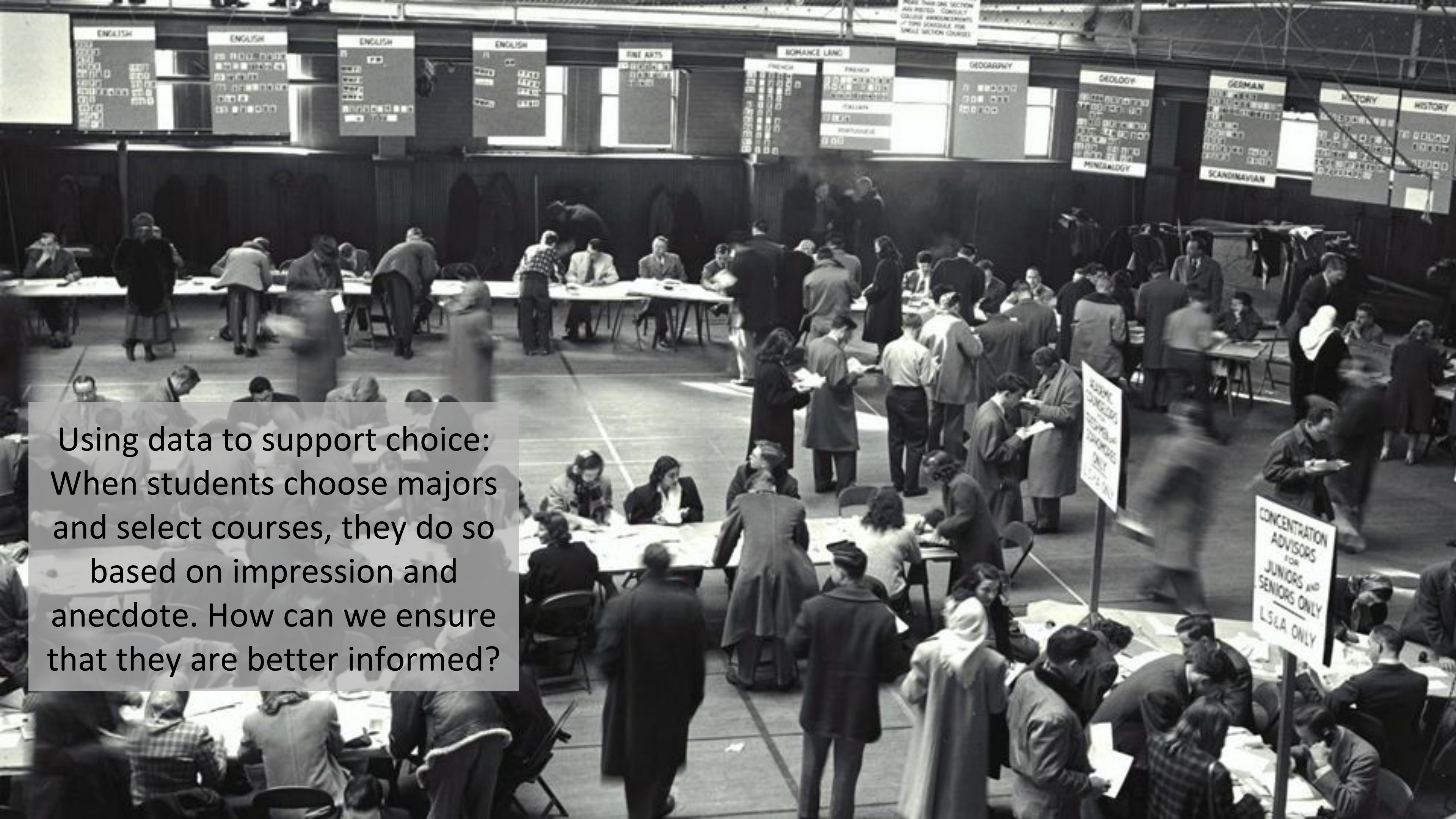
Data for discovery

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

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

Course profile data represents the past 5 academic years with the a

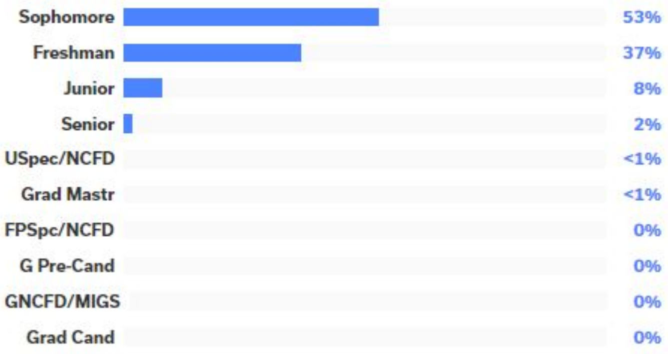
Grade Distribution

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 .



previous 1 / 2 next

Course Instructors

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

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.

Show 10 entries

Course Instructors	Terms Taught	Most Recent Term
Melnichuk, Mike	10	Winter 2019
Popov, Yuri	10	Winter 2019
Riles, Keith	6	Winter 2017
Uher, Ctirad	5	Fall 2016
McKay, Timothy	4	Winter 2019

Previous 1 Next

Declared Degrees

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

- Engineering: First Year 14%
- LSA Undeclared 13%
- Computer Science BSE 12%
- Mechanical Engineering BSE 9%
- Industrial & Oper Eng BSE 6%

previous 1 / 10 next

School/College Affiliation

This list shows what colleges or schools students were affliated 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.

- **Undergraduate Engineering** 74%
- **Undergraduate L S & A** 25%
- **Undergrad Music, Thtre & Dance** 1%
- **Undergraduate Art and Design** 1%
- **Undergraduate Kinesiology** 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

CHEM 130	36%
CHEM 125	33%
CHEM 126	33%
MATH 115	29%
ENGR 101	27%
ENGR 100	25%
MATH 116	19%
CHEM 210	17%
CHEM 211	16%
MATH 215	12%

previous 1 / 10 next

Taken at the same time as PHYSICS 140

PHYSICS 141	94%
ENGR 101	31%
MATH 116	31%
ENGR 100	29%
MATH 215	24%
MATH 216	12%
MATH 115	8%
ENGR 110	7%
UC 280	7%
ECON 101	6%

previous 1 / 10 next

Taken at any time after PHYSICS 140

PHYSICS 241	52%
PHYSICS 240	50%
MATH 216	33%
EECS 280	31%
MATH 215	29%
EECS 203	26%
EECS 281	22%
ECON 101	20%
EECS 370	18%
TCHNCLCM 300	18%

previous 1 / 10 next

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

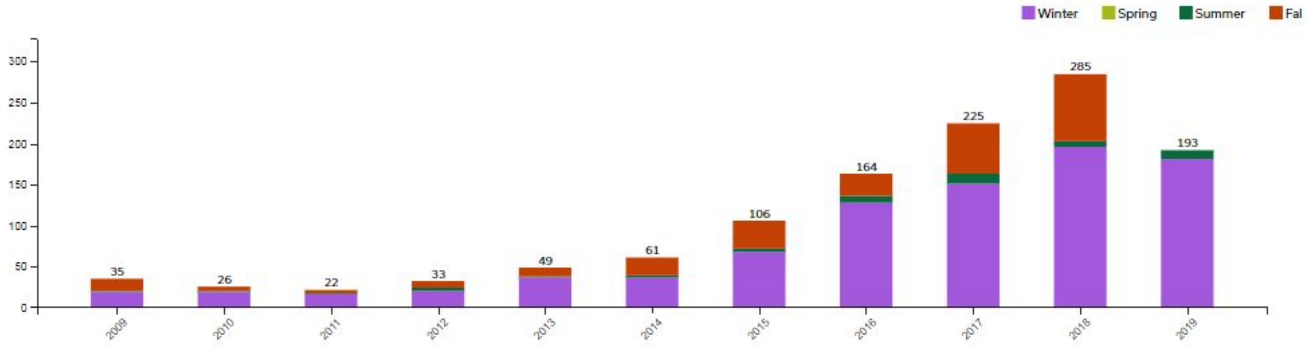
This graph shows how many students have graduated with this degree each year, subdivided by semester.

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.

< 7 semesters	57 (6.9%)
7 semesters	77 (9.3%)
8 semesters	273 (32.9%)
9 semesters	187 (22.5%)
10 semesters	120 (14.4%)
11 semesters	37 (4.5%)
> 11 semesters	80 (9.6%)

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.

< 7 semesters	14 (3.8%)
7 semesters	23 (6.3%)
8 semesters	87 (23.6%)
9 semesters	54 (14.7%)
10 semesters	57 (15.5%)
11 semesters	38 (10.3%)
> 11 semesters	95 (25.8%)

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

Mathematics BS	110 (32.2%)
Economics BS	47 (13.7%)
Business Administration BBA	35 (10.2%)
Data Science BS	24 (7.0%)
Statistics BS	14 (4.1%)
Physics BS	13 (3.8%)

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

Mathematics BS	46 (19.8%)
Asian Lang & Cult BS	19 (8.2%)
Music BS	17 (7.3%)
Economics BS	16 (6.9%)
German Studies BS	14 (6.0%)
Physics BS	14 (6.0%)

Data for decision support

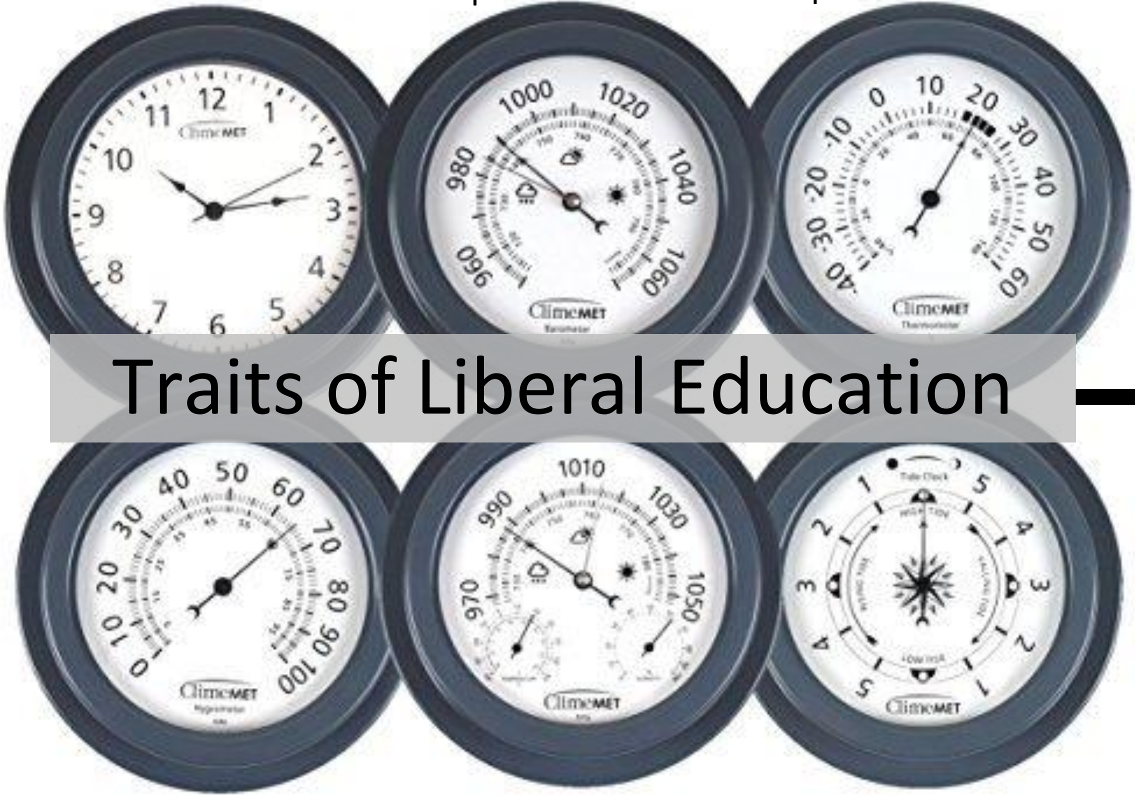
How can we extend this beyond course and major selection to support decision making for life?

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

Intellectual Breadth

Disciplinary Depth

Range of Experience



Traits of Liberal Education

Engagement & Effort

Social & Professional Networks

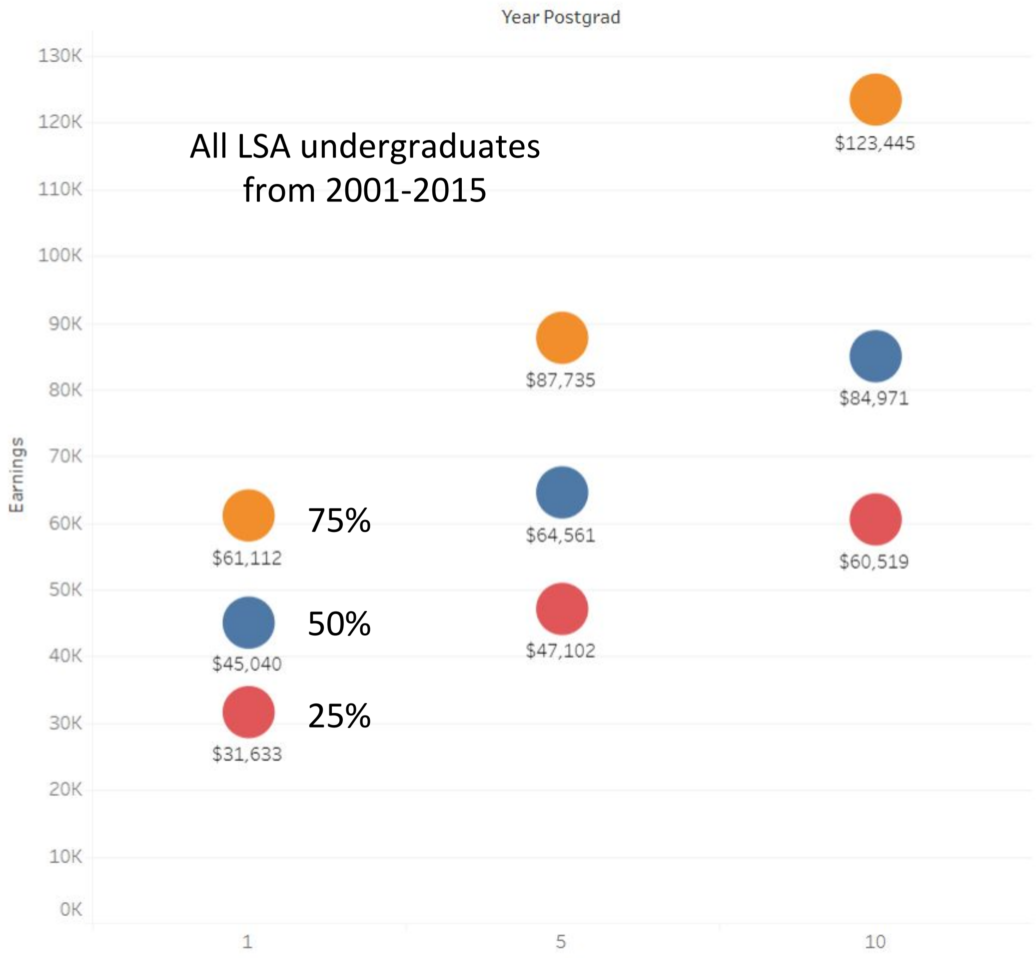
Academic Performance

Let 15 years pass

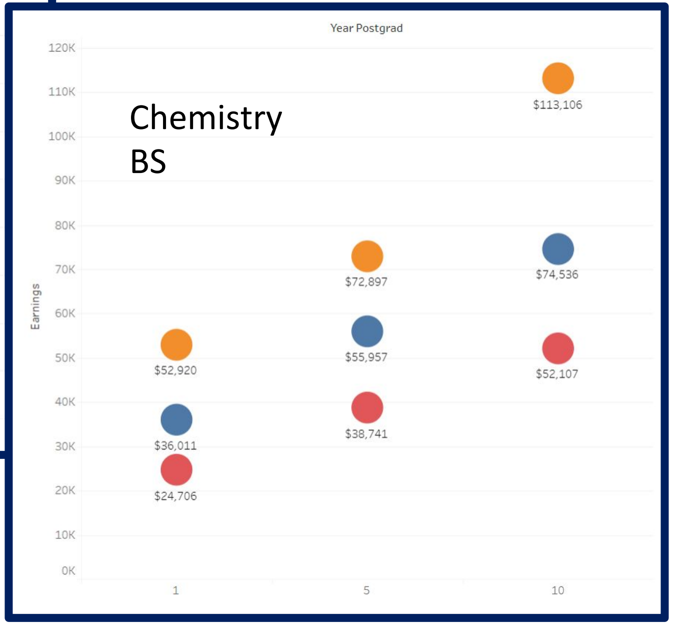
Civic & arts Engagement
Well-being
Employment
Income

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

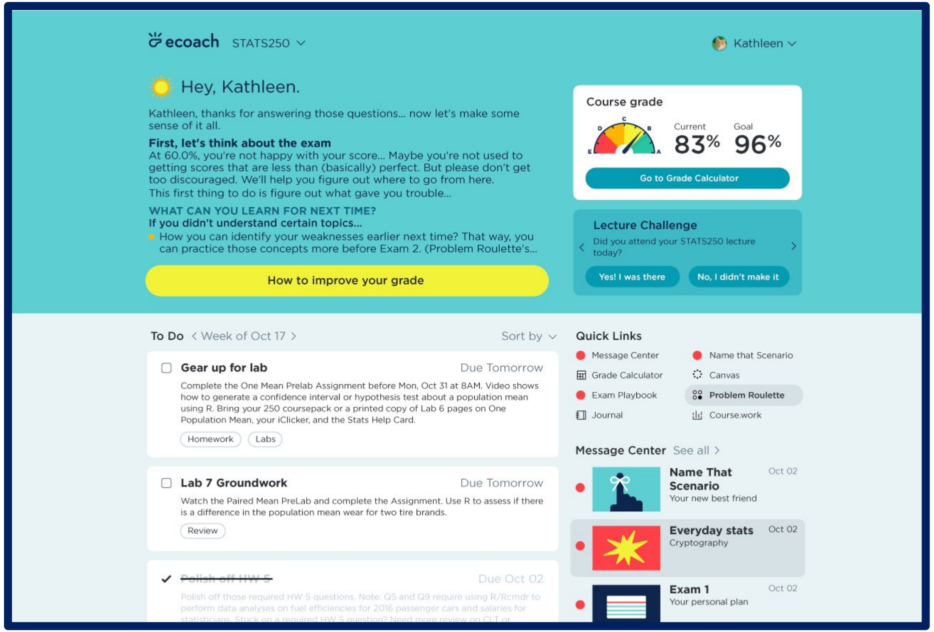
How can use data and behavioral science to tailor messaging and shape more successful students, even when teaching thousands?

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



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 ecoach

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.

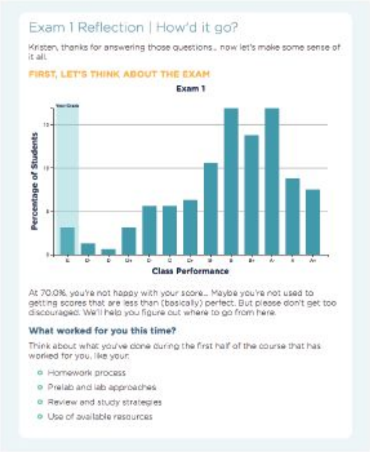
Five very different students are in line for your office hours right after an exam. What do you want to know about each student? What would you say to them, in response to their differences?

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 Playbook

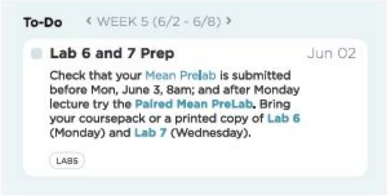
An evidence-based metacognitive intervention that helps students reflect on their learning, use course resources more effectively, and perform about half a letter grade better than non-users.

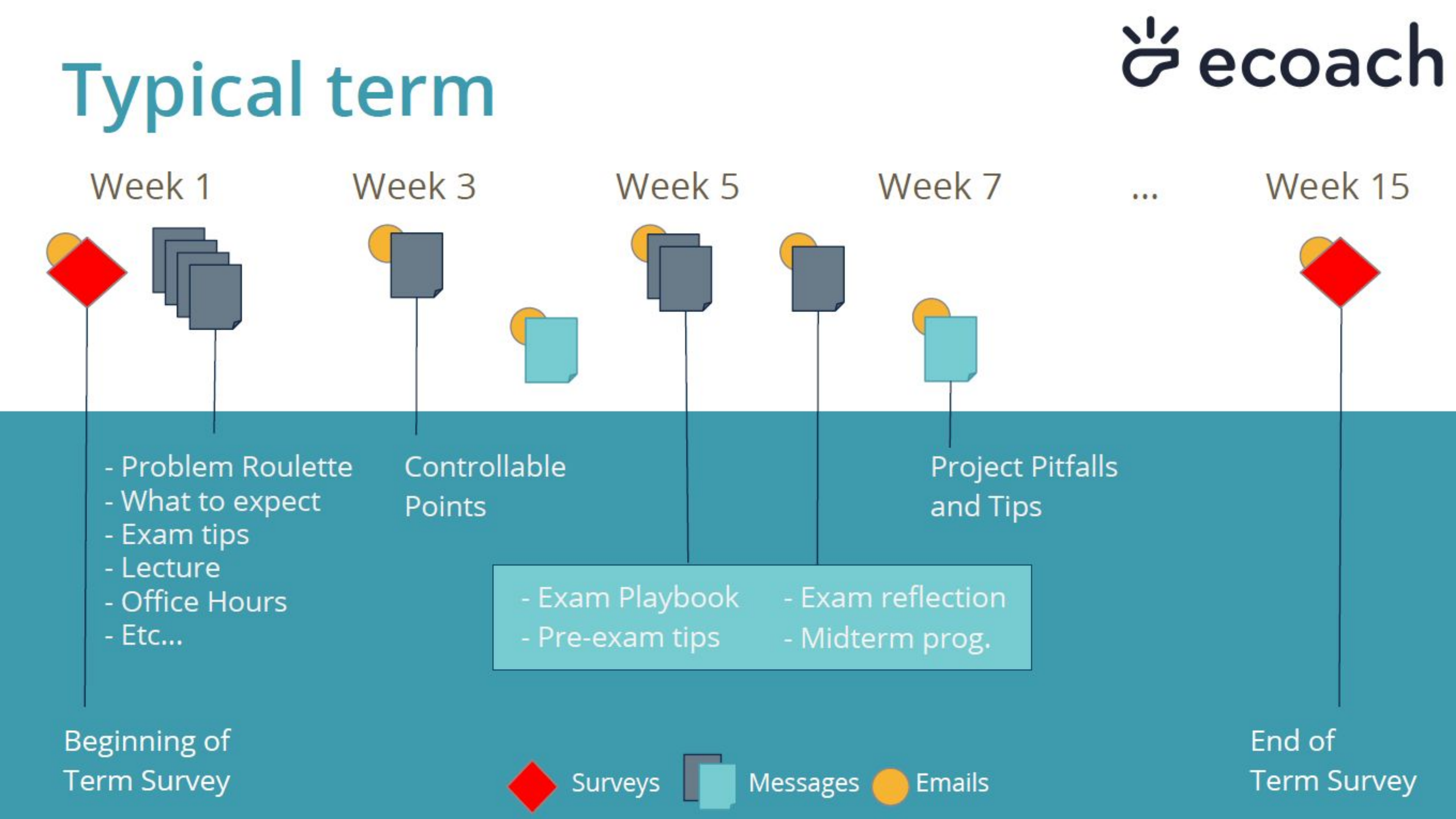
Grade Calculator

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.

To-Do Lists

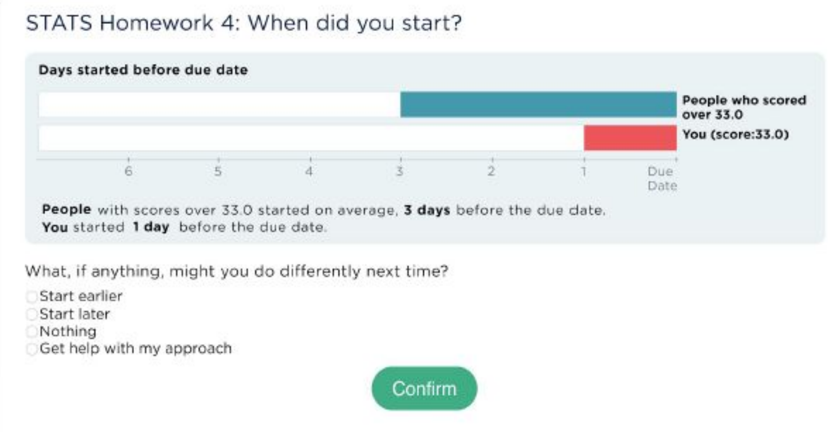
ECoach enables you to provide students with tailored, week-by-week lists of the most important tasks for the course.

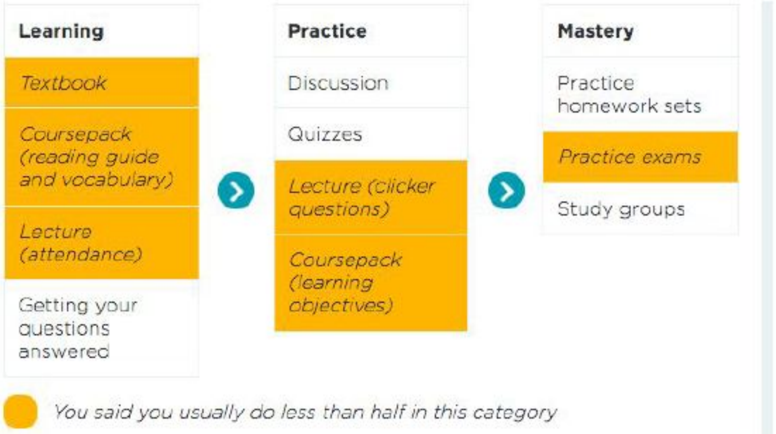



Typical term
ecoach
Week 1
Week 3
Week 5
Week 7
...
Week 15
- Problem Roulette
- What to expect
- Exam tips
- Lecture
- Office Hours
- Etc...
Controllable Points
Project Pitfalls and Tips
- Exam Playbook
- Pre-exam tips
- Exam reflection
- Midterm prog.
Beginning of Term Survey
End of Term Survey
Surveys
Messages
Emails

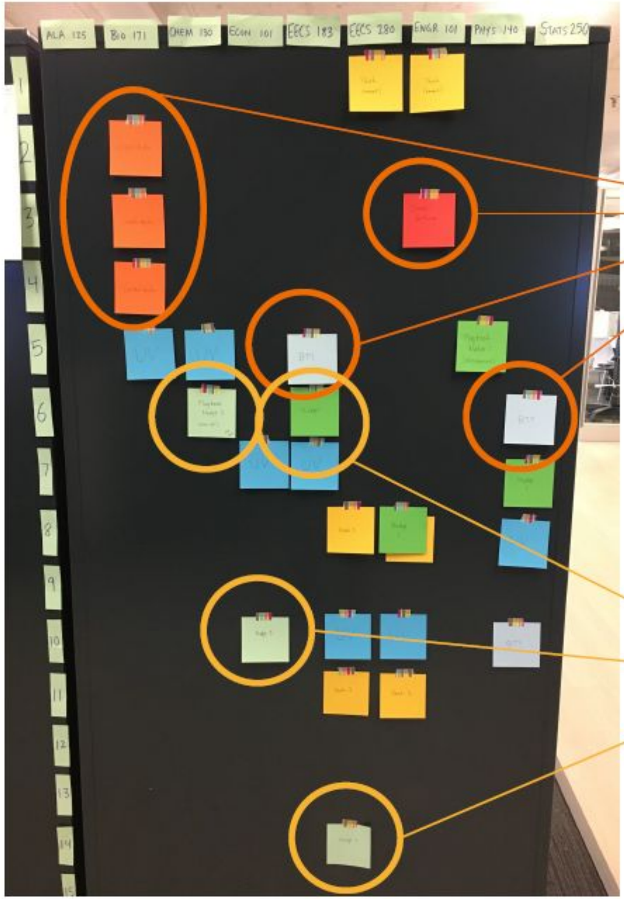
Designing and testing research-based interventions

- 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





ecoach



University of Michigan

Iowa State University

Dr. Michael Brown

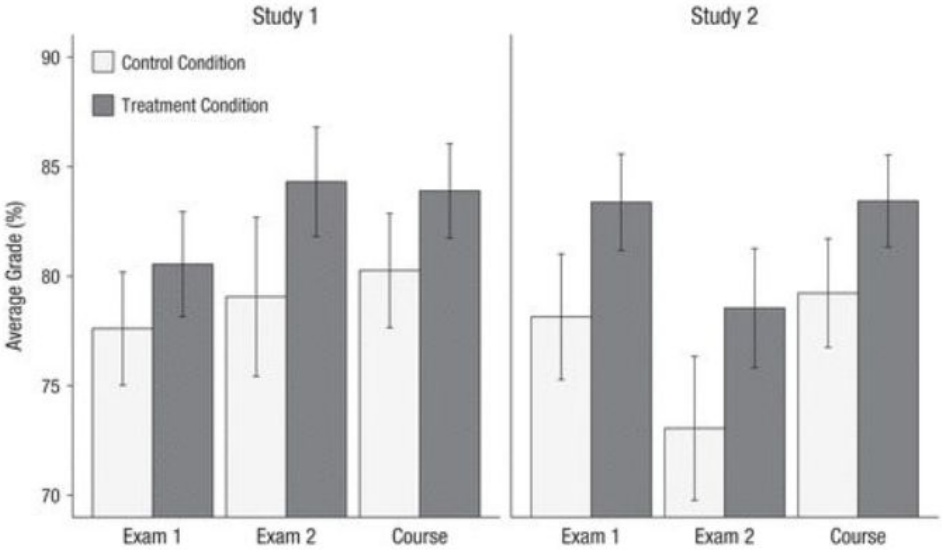
University of Michigan

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.**

Chen, P. et al., (2017). "Strategic Resource Use for Learning: A Self-administered Intervention that Guides Self-Reflection on Effective Resource Use Enhances Academic Performance." Psychological Science, 28, 774-785. DOI: 10.1177/0956797617696456

Ecoach expansion underway now

- **Building a multi-institutional R&D team to explore scalable, tailored coaching**
- <u>Currently focused on R&D within the 'course coach' model</u>
  - 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 SAT

Second tenor

Astronomer

53 years old

Tim McKay

Cosmologist

Midwesterner

Male

PhD in Physics

B.S. in Physics

3.78 GPA

White

Cook

tamckay

Professor

Physicist

Cyclist

Data Scientist

Early riser

Birder

SSN: xxx-xx-xxxx

Education Researcher

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:

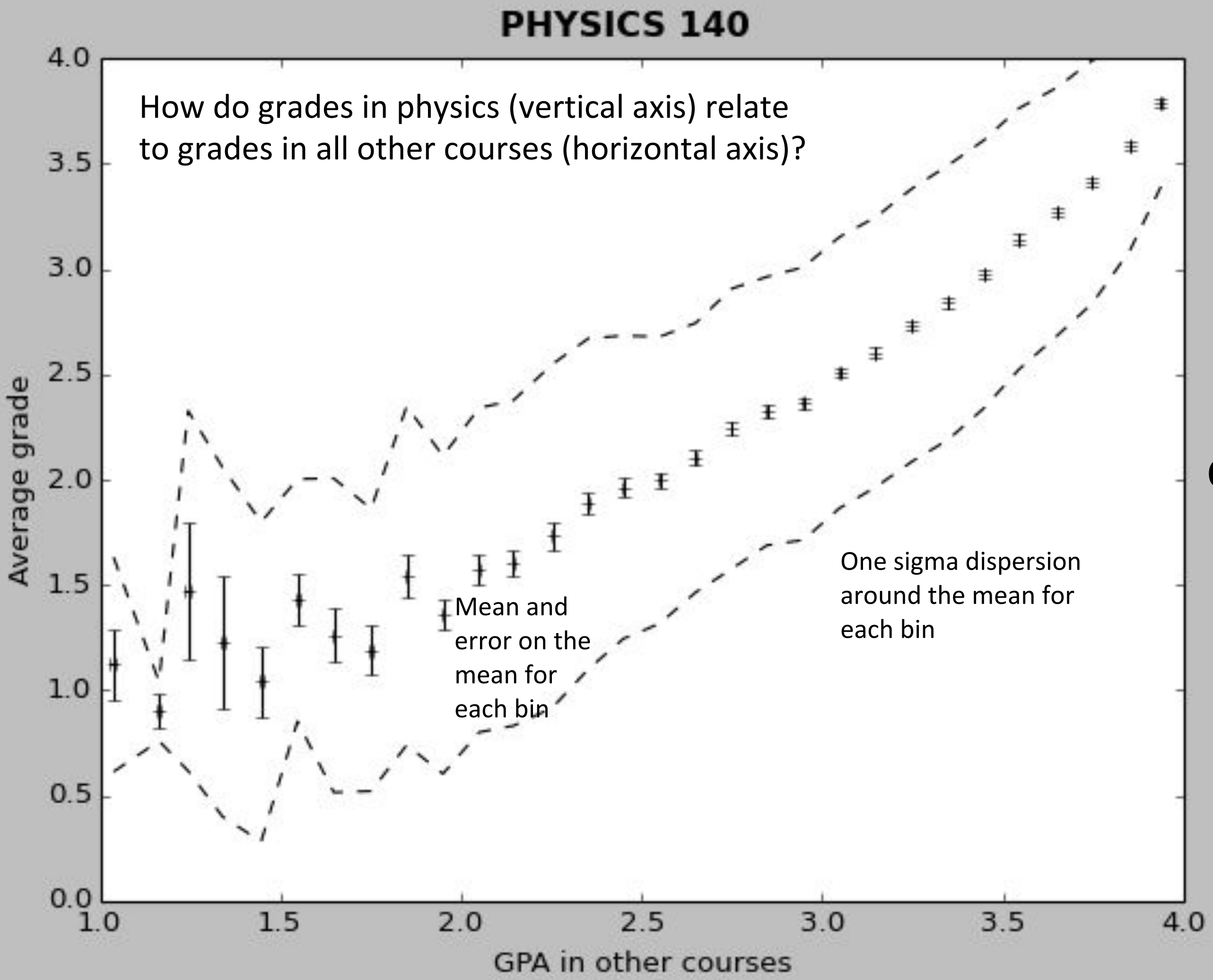
Each of us is the unique, intersecting combination of all our experiences and traits.

An individual.

#3: Data for discovery

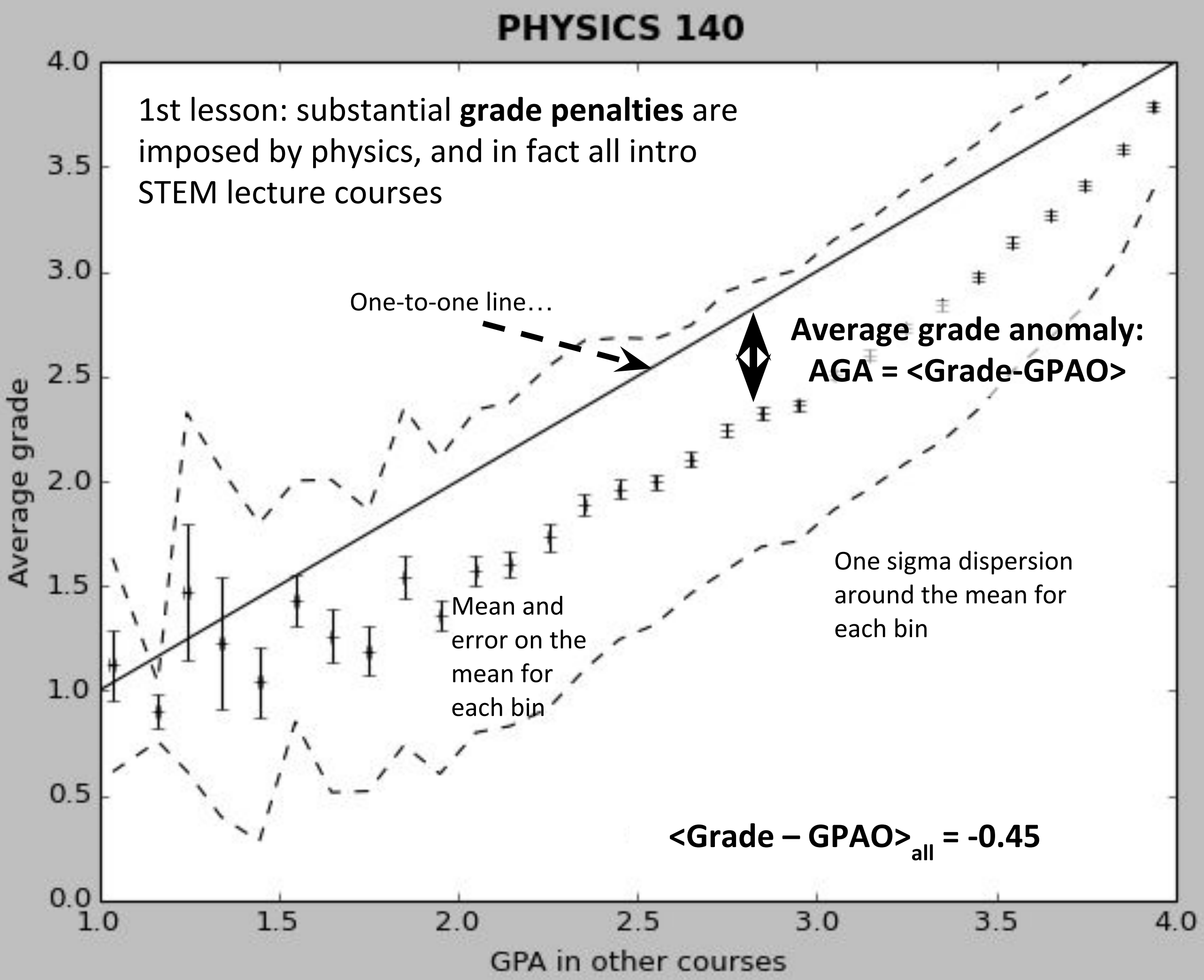
Careful analysis of prior student experiences can be used to explore student success and test learning environments for equity.

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

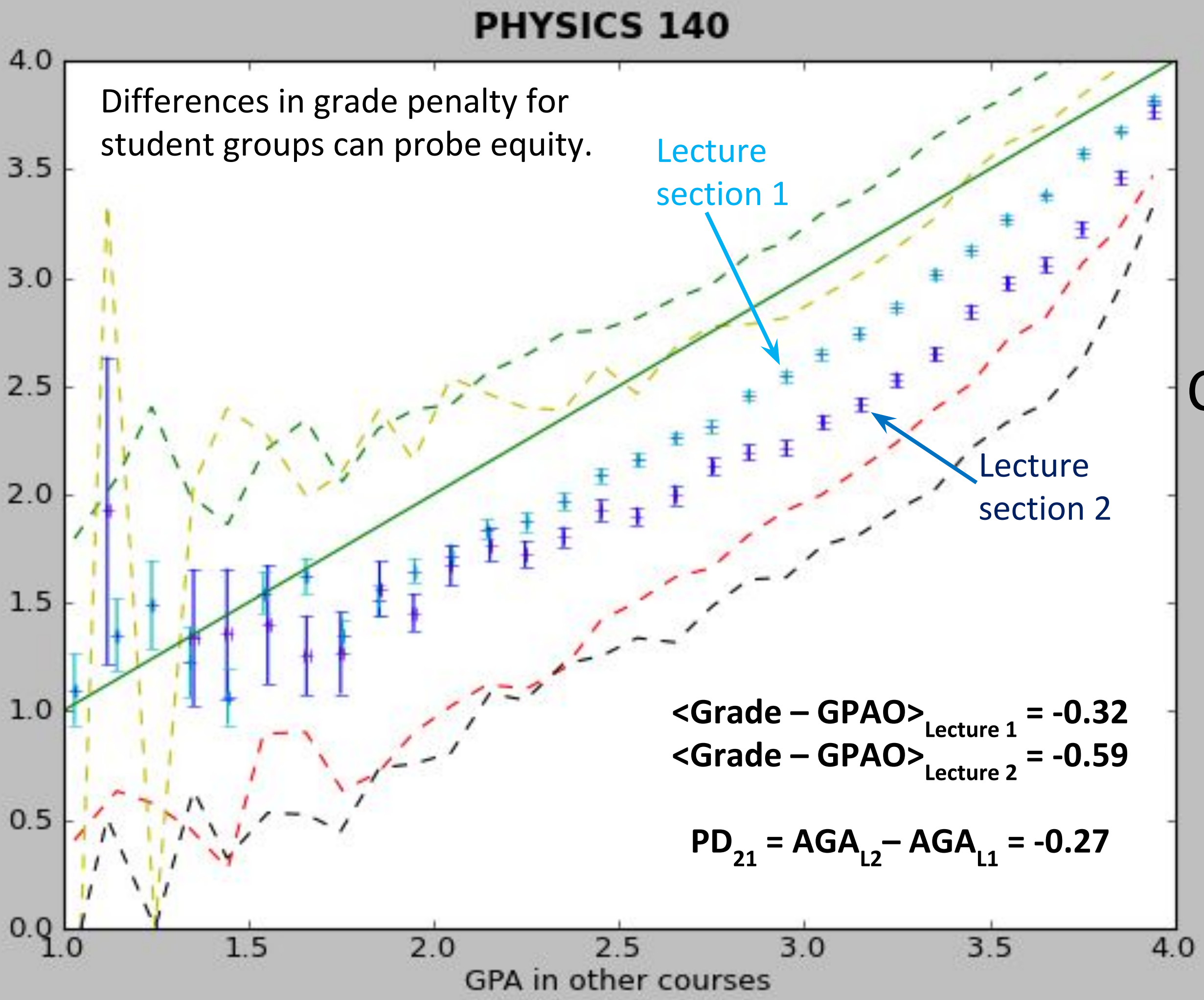


Start by learning from experience.

Who performs well?

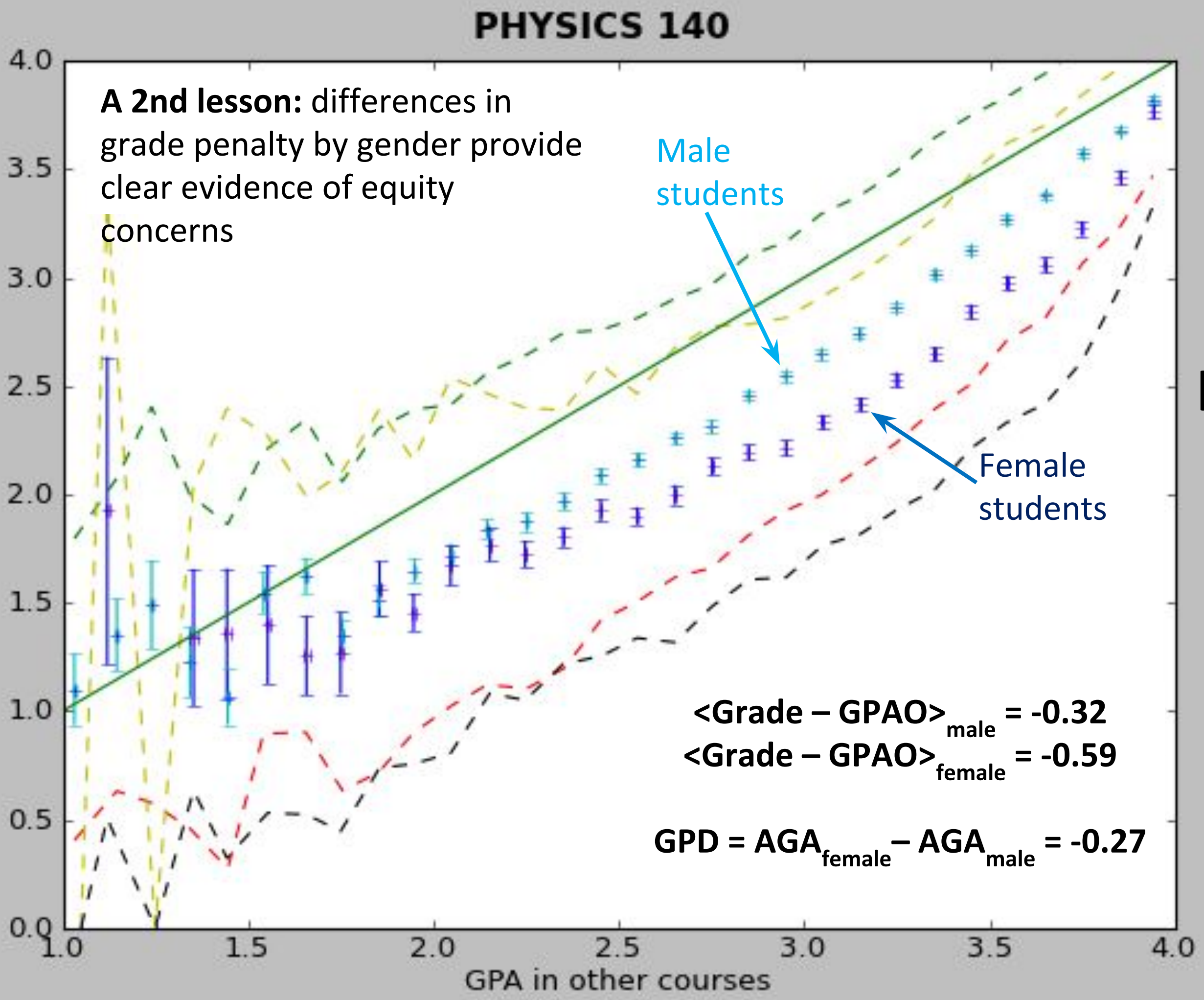


Who does better than expected? Who does worse?



Could this be an equity problem?

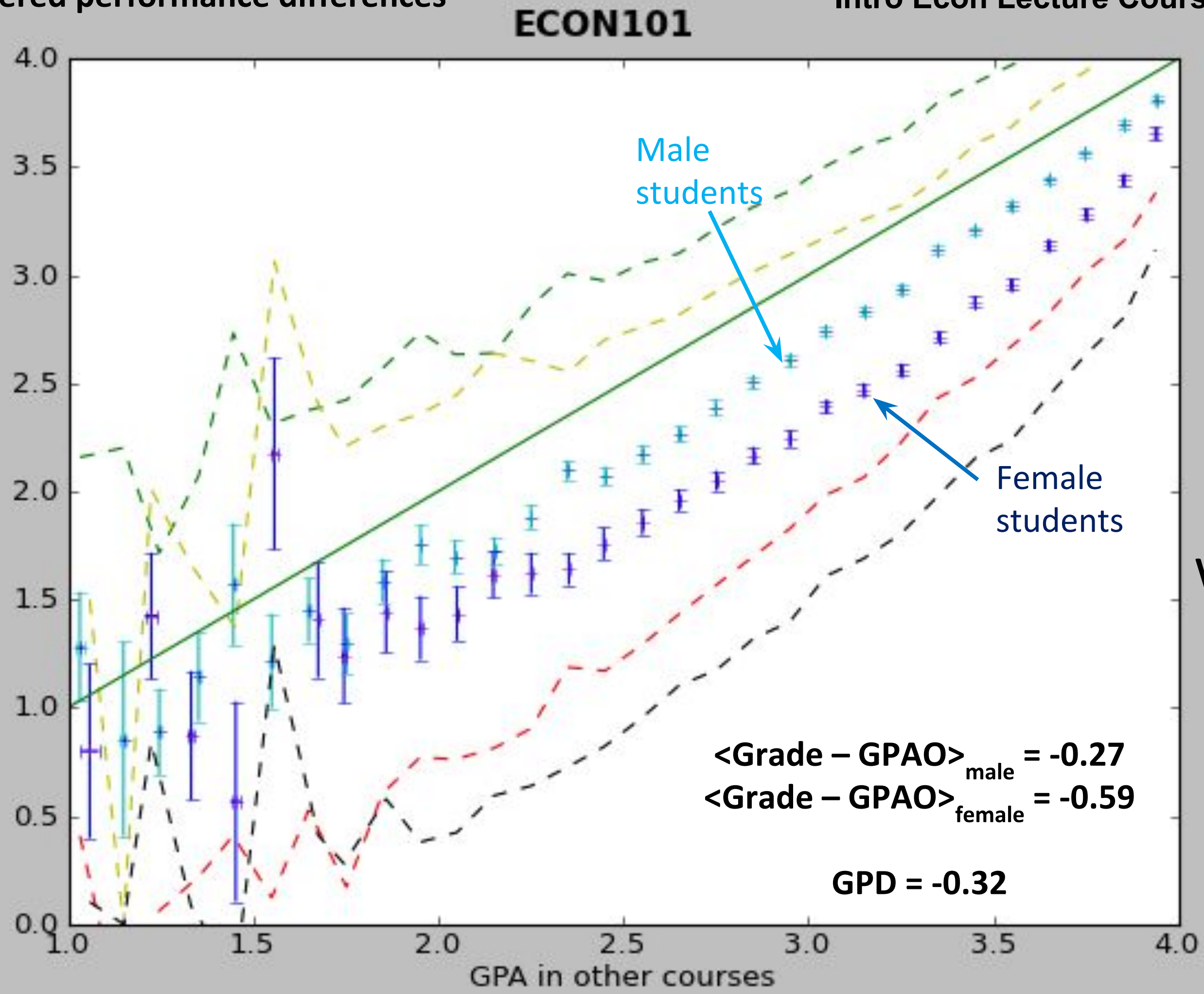
In fact, this figure compares male & female students



Is this only a problem for physics?

Gendered performance differences

Intro Econ Lecture Course



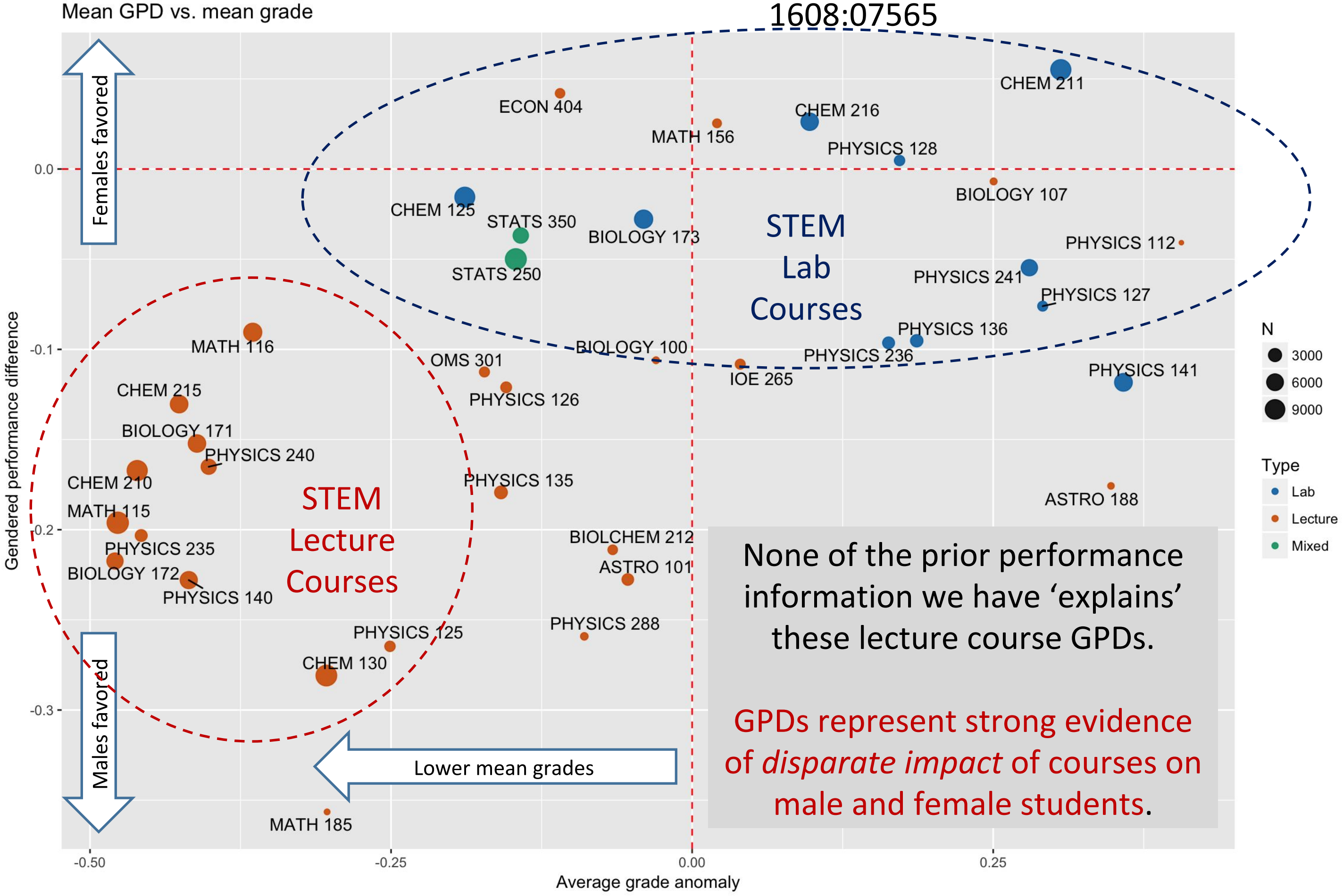
It's not just physics.

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

Koester, Grom, McKay, arXiv 1608:07565

Every large science and math *lecture course* shows big gendered performance differences.

Lab classes in exactly the same subjects don't show these inequities



None of the prior performance information we have 'explains' these lecture course GPDs.

GPDs represent strong evidence of *disparate impact* of courses on male and female students.

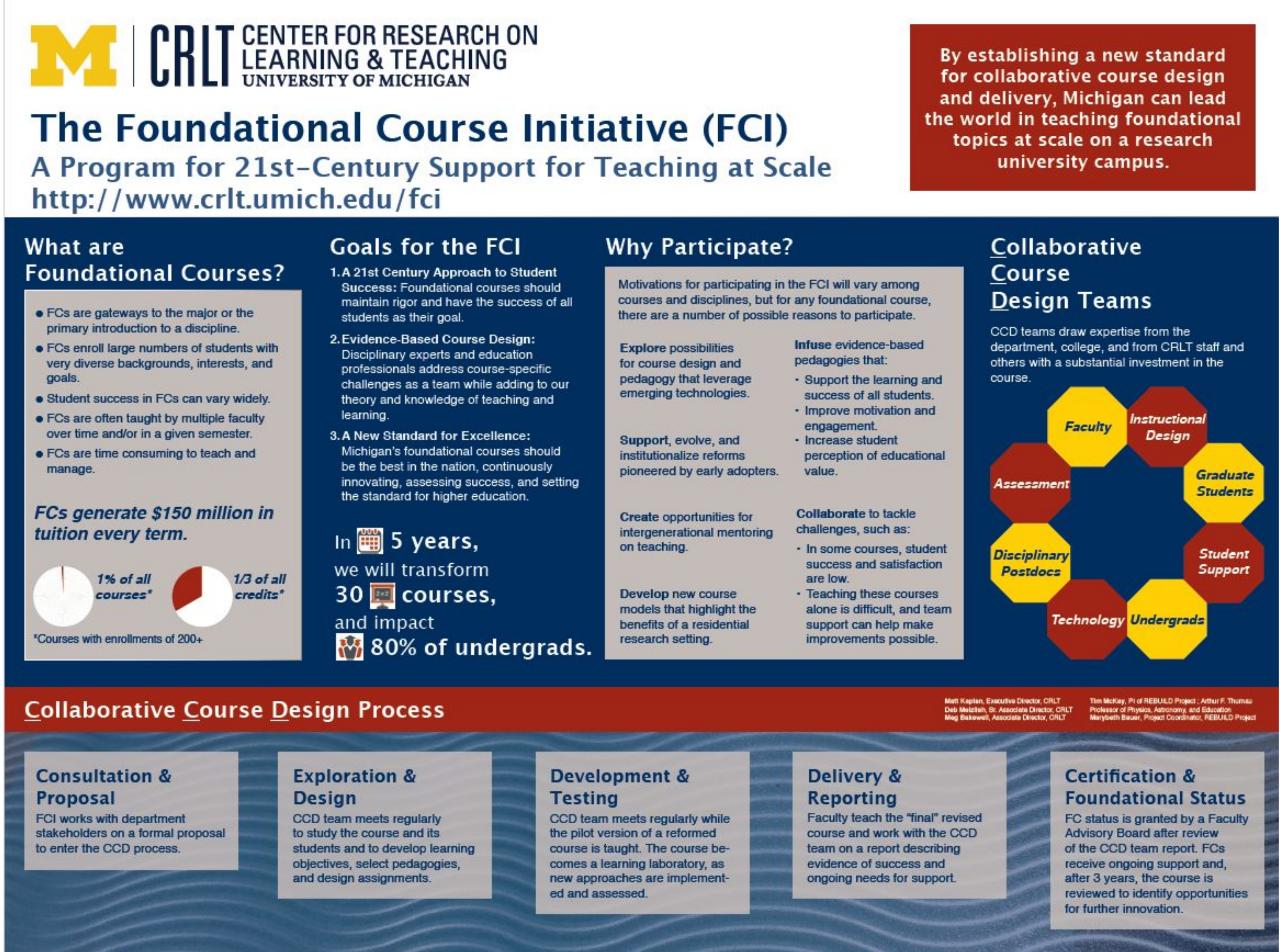
This pattern is *the same* at other large public universities…

#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.



SEISMIC: Sloan Equity and Inclusion in STEM Intro Courses

UNIVERSITY OF MICHIGAN

INDIANA UNIVERSITY

MICHIGAN STATE UNIVERSITY

UC SANTA BARBARA

University of Pittsburgh

UC IRVINE

Arizona State University

PURDUE UNIVERSITY

UNIVERSITY OF MINNESOTA

UCDAVIS UNIVERSITY OF CALIFORNIA

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

Data drives collective change:

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

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

Thanks to many collaborative teams

- The Foundational Course Initiative staff at UM’s Center for Research on Learning & Teaching and the entire ECoach team at UM’s Center for Academic Innovation
- UM LSA Undergrad Ed team, and our Institutional Learning Analytics Committee faculty and staff colleagues
- SEISMIC project manager Nita Kedharnath & colleagues from all ten partner institutions
- My team in physics: including Ben Koester, Juniar Lucien, Meaghan Pearson, Carson Byrd, & Uriah Israel