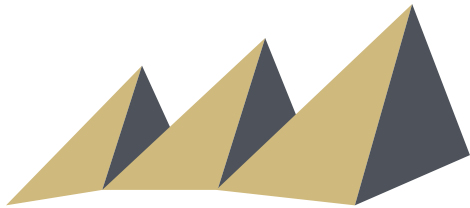


Brief report on the
"Educational Ecology"
of
the CU Physics department



PER

@ CU-Boulder

As observed by
SJP, Fall 2018

CREDITS/ACKNOWLEDGMENT/KUDOS – part 1

This presentation is an informal and personal accounting by Steve Pollock. There are many significant contributions to the "teaching ecology" of Physics that I either don't know about or have forgotten or have inappropriately left off. My apologies to all such parties!

More than half the faculty and many staff, researchers, and students in and out of the Physics department have actively and repeatedly participated in brown-bag lunches, faculty meetings, and/or engaged in the CU Physics "educational ecology" . I don't name them (I would miss too many who have helped if I tried) but for starters, see www.colorado.edu/physics/people

Alas, that pages still misses so many: all the many Learning Assistants, staff, people from other departments and other institutions who contribute significantly to the "ecology" and this story!

Current PER grad students who all make direct contributions to the efforts described in this presentation include:

[Julian Gifford](#), [Jessica Hoehn](#), [Simone Hyater-Adams](#), [Allie Lau](#), and [Katie Rainey](#).

Our PAST graduate students also all deserve shout-outs. They contributed materials, research, time, energy, support and ideas, and have a measurable impact on many aspects of teaching and department educational culture. See www.colorado.edu/per/people for some of them. But that page still misses many, e.g. non-PER students who contribute to our efforts.

CREDITS/ACKNOWLEDGMENT/KUDOS – continued!

The Research-based aspect of course transformations mentioned in this talk have also been supported directly by many people in the CU-PER group.

The list below is surely not inclusive, because many contributions happen in ways I do not always know about.

Charles Baily, Daniel Bolton, Stephanie Chasteen, Danny Caballero, Michael Dubson, Noah Finkelstein, Robert Hobbs, Heather Lewandowski, Kathy Perkins, Benjamin Pollard, Laura Ríos, Carl Wieman, and Bethany Wilcox.

Outreach, departmental-level transformation, Learning Assistant efforts and other elements (some mentioned in the final slide) have seen PER research-based contributions from Mike Bennett, Joel Corbo, Melissa Dancy, Brett Fiedler, Claudia Fracchiolla, Katie Hinko, Ed Johnson, Emily Moore, Valerie Otero, Ariel Paul, Alanna Pawlak, Gina Quan, and Jacob Stanley.

No TTT Faculty
"owns" a class

Undergraduate classes

- Service courses

 - 1110, 1120: PHYS1 &2 for engineers

 - 2010, 2020: PHYS 1&2 for other sciences

 - 1140: Lab 1 *

 - 2130: PHYS 3 for engineers *

 - 1010, 1020, 1230, 1240, 3070: A&S Core Electives for non-scientists

 - * = recently transformed

- Majors courses

 - 1115, 1125: NEW PHYS1 &2 for majors *

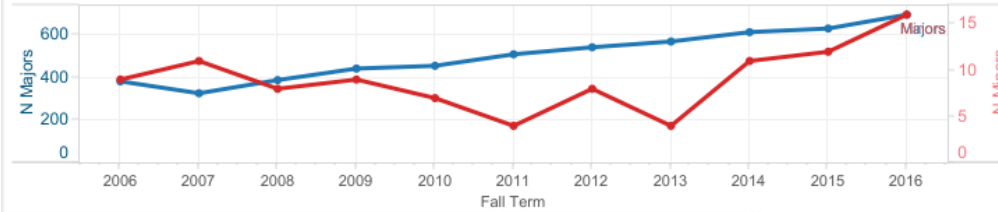
 - 2170: PHYS 3 for majors

 - Total 36 PHYS credits (some *)

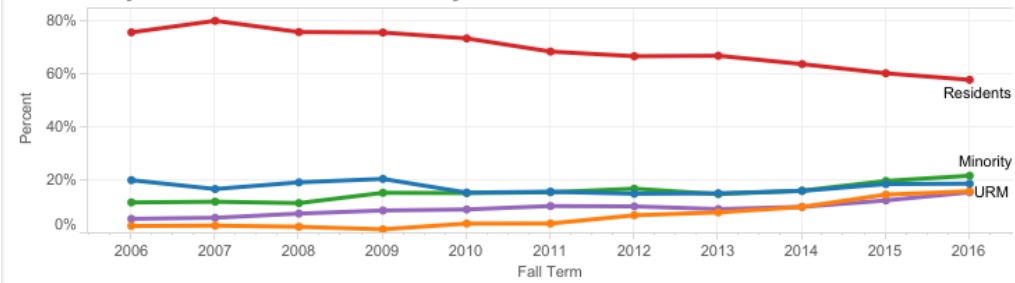
 - + 9 PHYS elective + 10 Chem + 16-21 Math

 - Research experience required for "Plan 1"

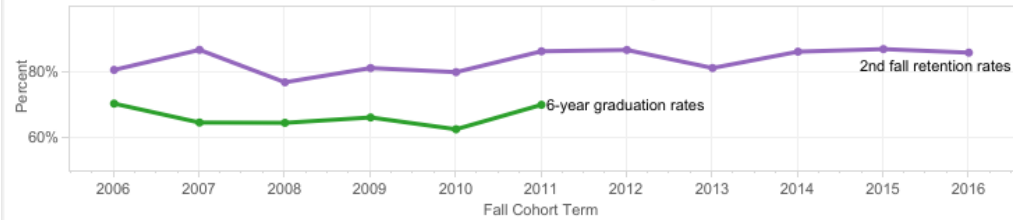
Fall UG Enrollment - PHYS-Physics



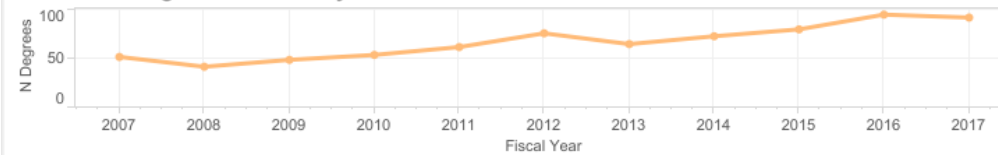
Fall UG Majors Characteristics - PHYS-Physics



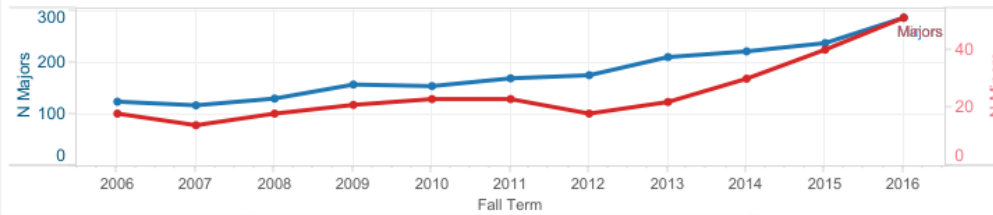
UG 2nd Fall Retention & 6-Year Graduation Rates - PHYS-Physics



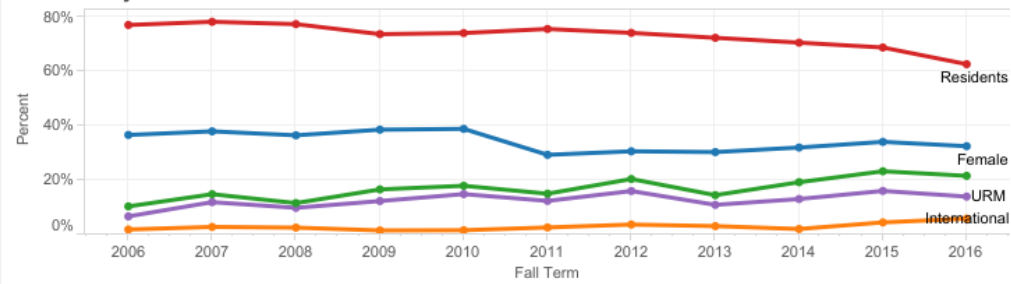
Bachelor's Degrees - PHYS-Physics



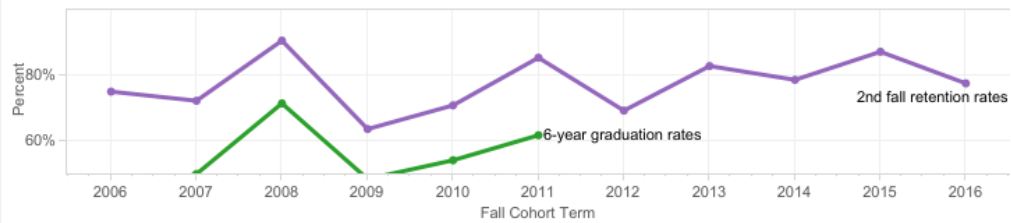
Fall UG Enrollment - APS-Astro Plnt Sci



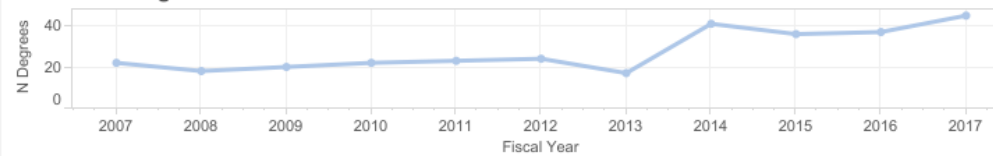
Fall UG Majors Characteristics - APS-Astro Plnt Sci



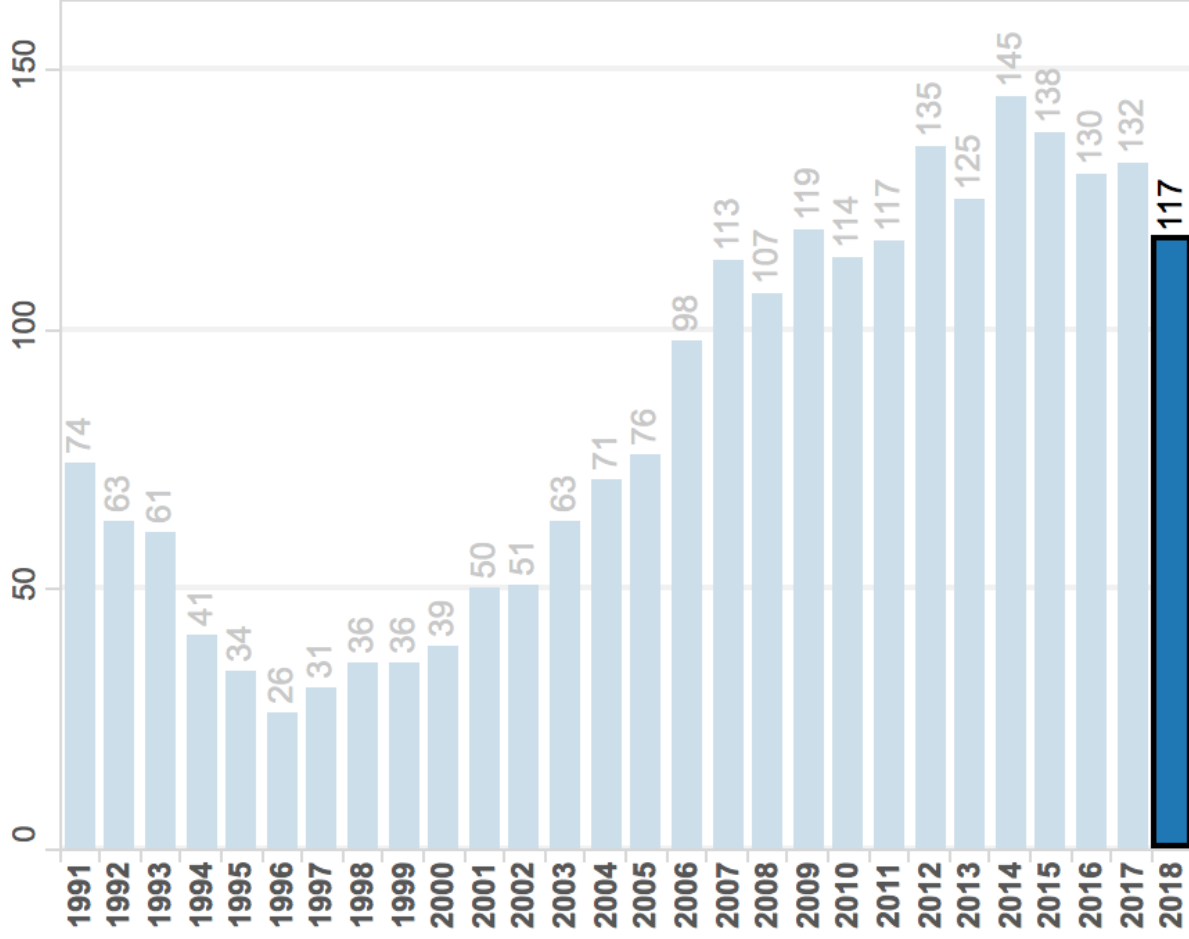
UG 2nd Fall Retention & 6-Year Graduation Rates - APS-Astro Plnt Sci



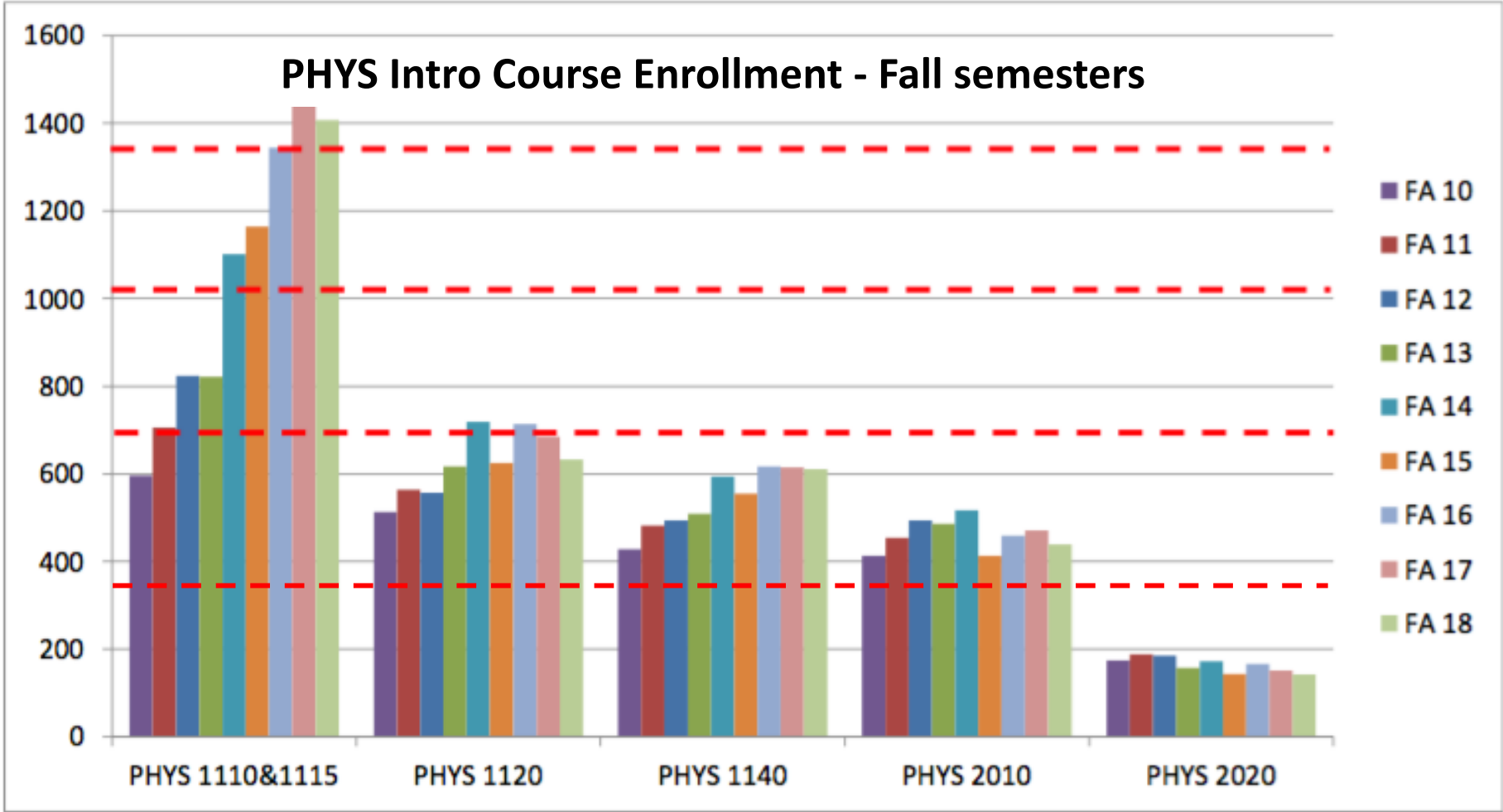
Bachelor's Degrees - APS-Astro Plnt Sci



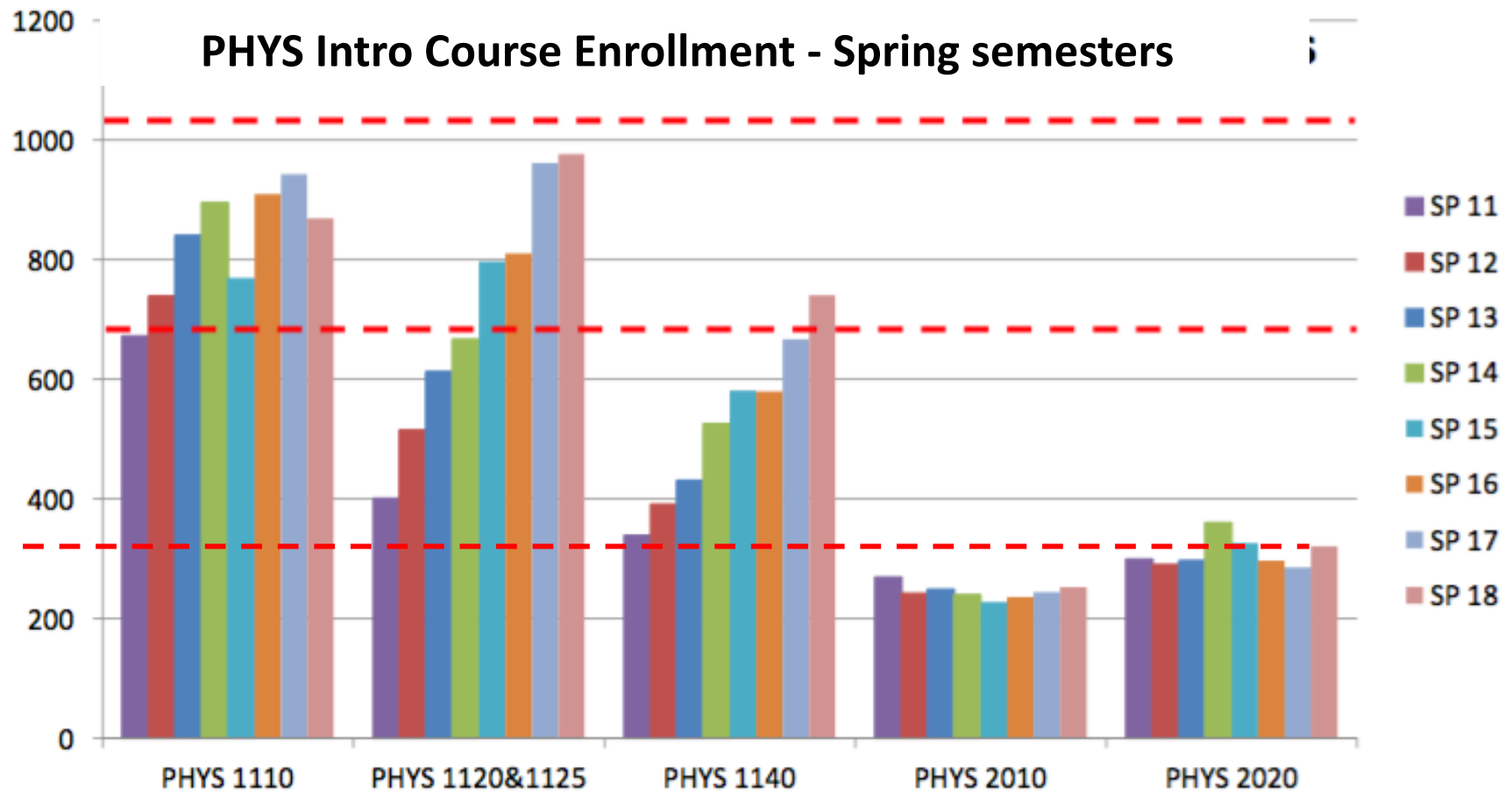
Fall Headcount (please select a term)



PHYS Intro Course Enrollment - Fall semesters



PHYS Intro Course Enrollment - Spring semesters



Service courses - pedagogy

4 instructors,
2 new this year

ALL: - 3x lectures with clickers and extensive demos

- Help Room staffed 9-5 M-F
- Online (computer based and graded) homeworks

ALL large: - Team teaching, typically instructor or experienced teamed with newer or inexperienced faculty

MOST large - Pre/post conceptual tests

- Additional paper homework graded by TAs

- **1110/15/20/25:** - 1 hr/week Tutorials (UW PER) with LAs
 - Prelecture videos (from Illinois PER)
- **2010/20:** 2 hr/week lab/Tutorials (homebrew), no LAs
- **1140 labs:** LA supported

PHYSICS MAJORS

- New/reformed classes (last 1-4 years)

1115, 1125: Phys 1 and 2 for majors (PHYS, EPEN, APS) ~130-150

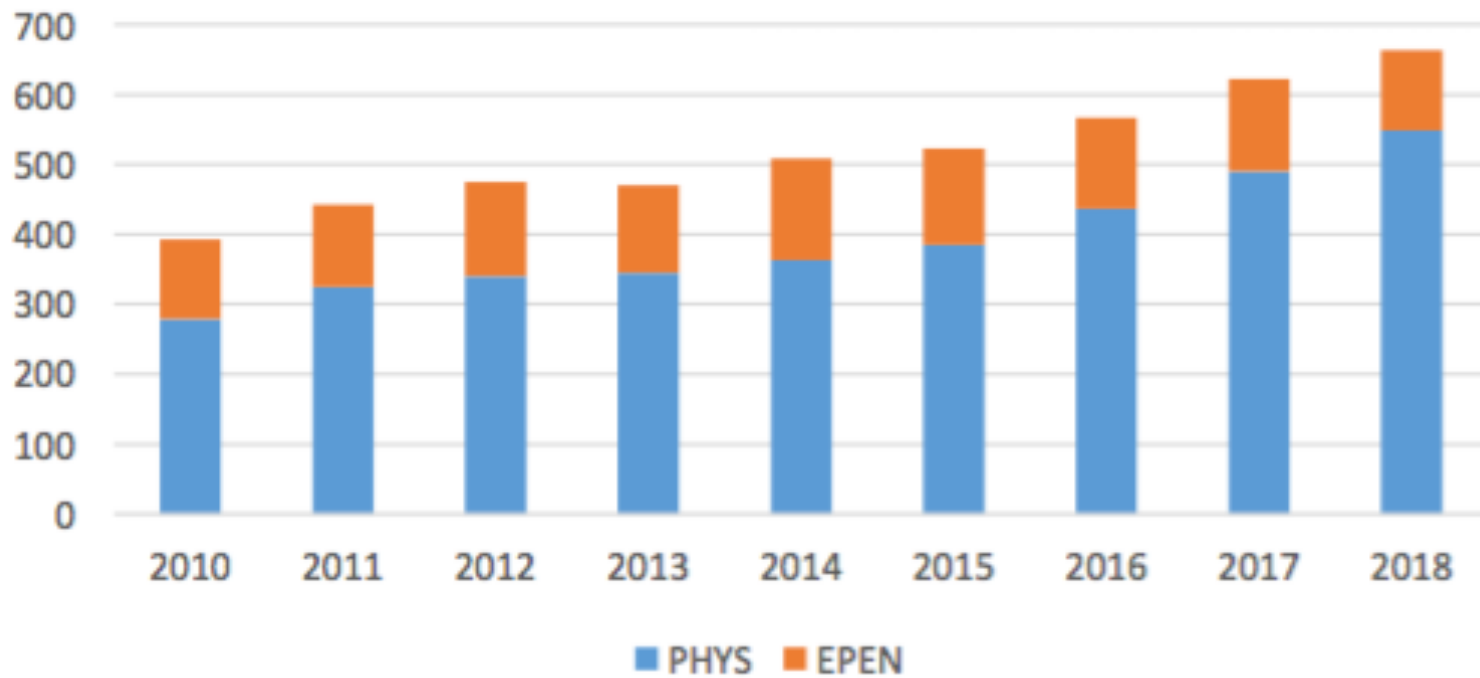
1140: Freshman lab (PER effort, led by Lewandowski and Bolton)

2600: Scientific Computation (led by Neil)

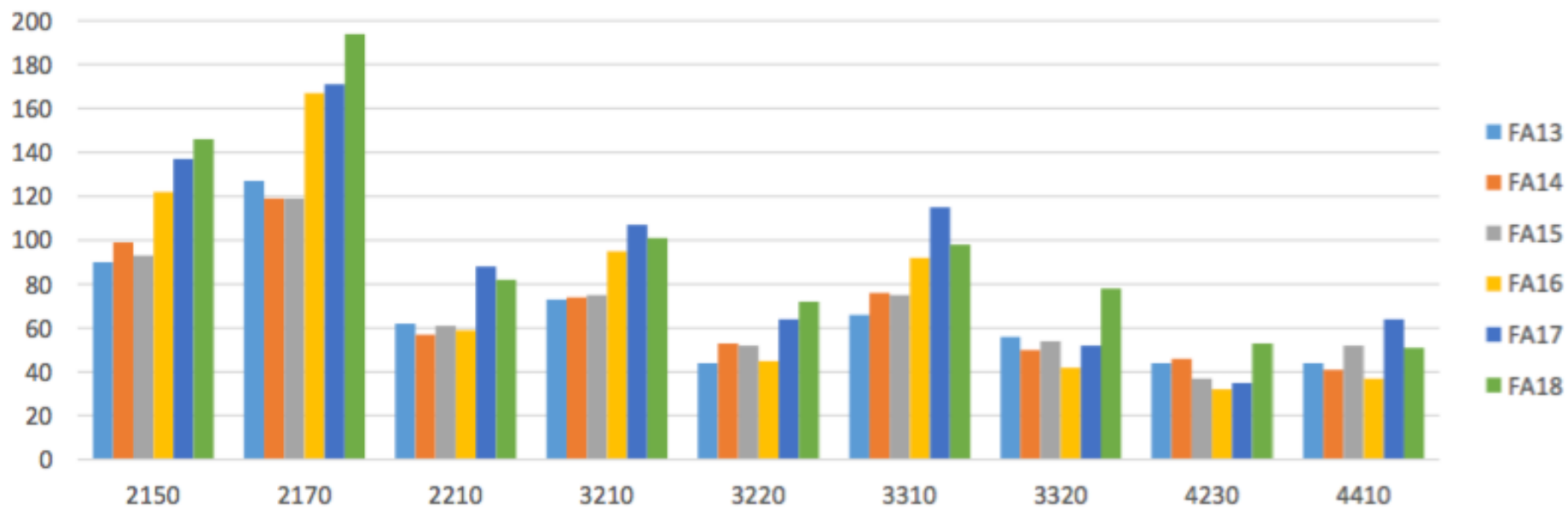
3220: Spins-first Quantum (led by SJP)

- 6 Modified courses (SEI effort) (Upcoming slides)

PHYS & EPEN Majors at Fall Census



PHYS/EPEN Major required course enrollment – Fall semesters



Transformed courses

The screenshot shows a web browser window displaying the website www.colorado.edu/sei/departments/physics. The page is titled "Physics" and is part of the Science Education Initiative at the University of Colorado Boulder. The navigation menu includes "About Us", "Departments", "Resources", "Research", and "Contact Us". The main content area features a paragraph about the SEI's focus on improving physics courses, a link to a proposal, and a list of introductory courses. A sidebar on the right lists various scientific fields, with "Physics" highlighted. A green text block at the bottom right provides additional information about curriculum transformation work in specific physics courses.

3220 Canvas Old 3220 Accellion CU Portal Overleaf Ti

www.colorado.edu/sei/departments/physics

PER@CU editing IRB Submissions CU-Mail-365 CISCO phone Google colorado Mac iCloud

Physics | Science Education Initiative | University of Colorado Boulder

Science Education Initiative
UNIVERSITY OF COLORADO BOULDER

About Us **Departments** Resources Research **Contact Us**

Home > Departments > Physics

Physics

The primary focus of the science education initiative in the physics department is the improvement of courses beyond the first year. These courses are characterized by a higher degree of mathematical rigor and sophistication than the lower division courses, and populated by majors who have made some level of commitment to the physical sciences. The department has a strong history of course transformation, using research-based interactive techniques such as peer instruction, "clicker" questions, and small group tutorials, but these efforts have been primarily directed towards lower-division introductory courses. The aim of the SEI is to investigate the application of these techniques to the junior-level courses, and to research student learning at this level.

[Review our accepted Science Education Initiative proposal.](#)

The [Physics Education Research Group](#) at CU-Boulder (PER@C) also has course materials for a wide variety of introductory courses.

- Phys 2210: Classical Mechanics / Math Methods
- Phys 3220: Quantum I
- Phys 2130: Modern Physics
- Phys 3310: Electricity & Magnetism I (statics)
- Phys 3320: Electricity & Magnetism II (dynamics)
- Phys 3340, 4430, 5430: Advanced Lab

Astrophysics and Planetary Sciences

Chemistry and Biochemistry

Ecology and Evolutionary Biology

Geological Sciences

Integrative Physiology

Molecular, Cellular, and Developmental Biology

Physics

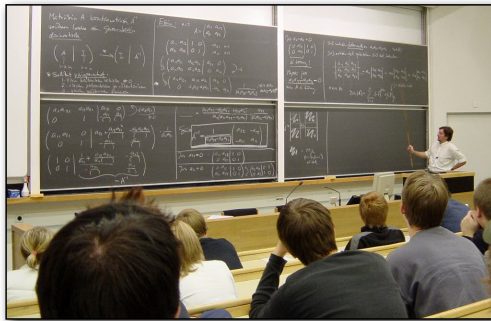
- People
- Activities
- Course Resources
- Department of Physics

Additional significant curriculum-transformation work in Phys 1400 (CU-Prime, a grad-student driven initiative), Phys 1140 (Freshman lab) and Phys 3330 (Junior/Electronics Lab) are not listed on this SEI page.

See also <http://jila.colorado.edu/lewandowski/research/physics-education-research>

What Changed?

- Faculty collaboration
- Explicit learning goals
- Collect student data!
- Interactive classroom techniques
- Concept Tests
- Modified Homework
- Tutorials
- Homework Help Sessions



Students debate a concept test

Upper-Level Course
Transformation

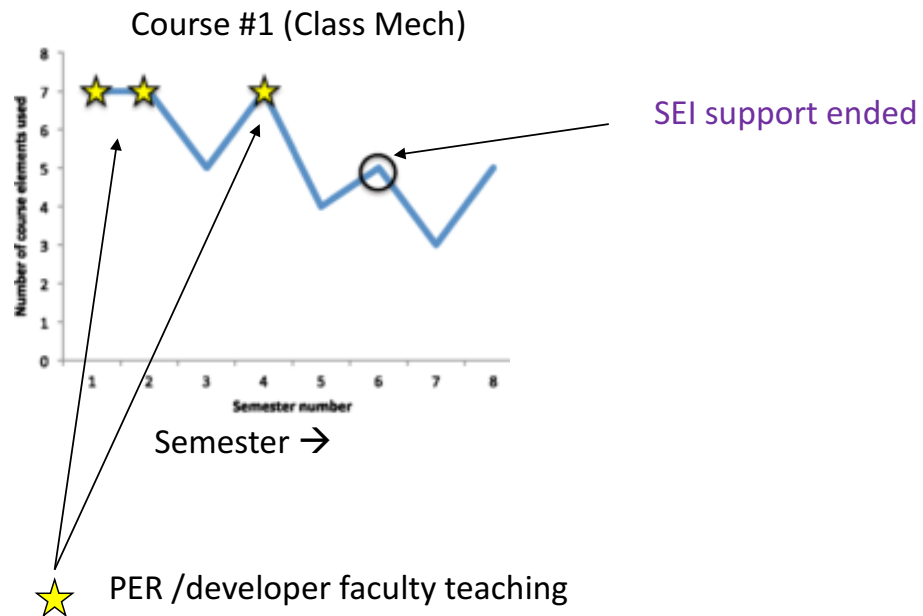
Upper-div Clickers at CU

Term	04 S	F	05 S	F	06 S	F	07 S	F	08 S	F	09 S	F	10 S	F	11 S	F	18 F	
Mech Math I							✓		✓						✓	★	✓	✓
Mech MathII								✓			✓		✓					✓
EM I										★	★	✓	✓			✓	✓	✓
EM II											✓	✓	✓		✓	★		✓
QM I										★	★	✓	✓	✓	✓	✓	✓	✓
QM II											✓		✓					✓
Stat Mech	★		✓			✓	✓			✓	✓	✓	✓	✓	✓	✓		✓
Solid State		■		■		■		■	✓	■	✓	■	✓	■	✓	■	■	■
Plasma	■		■		■		■		■		■		■		■		■	■
Nuclear/HE		■		■		■		■		■		■		■		■		■

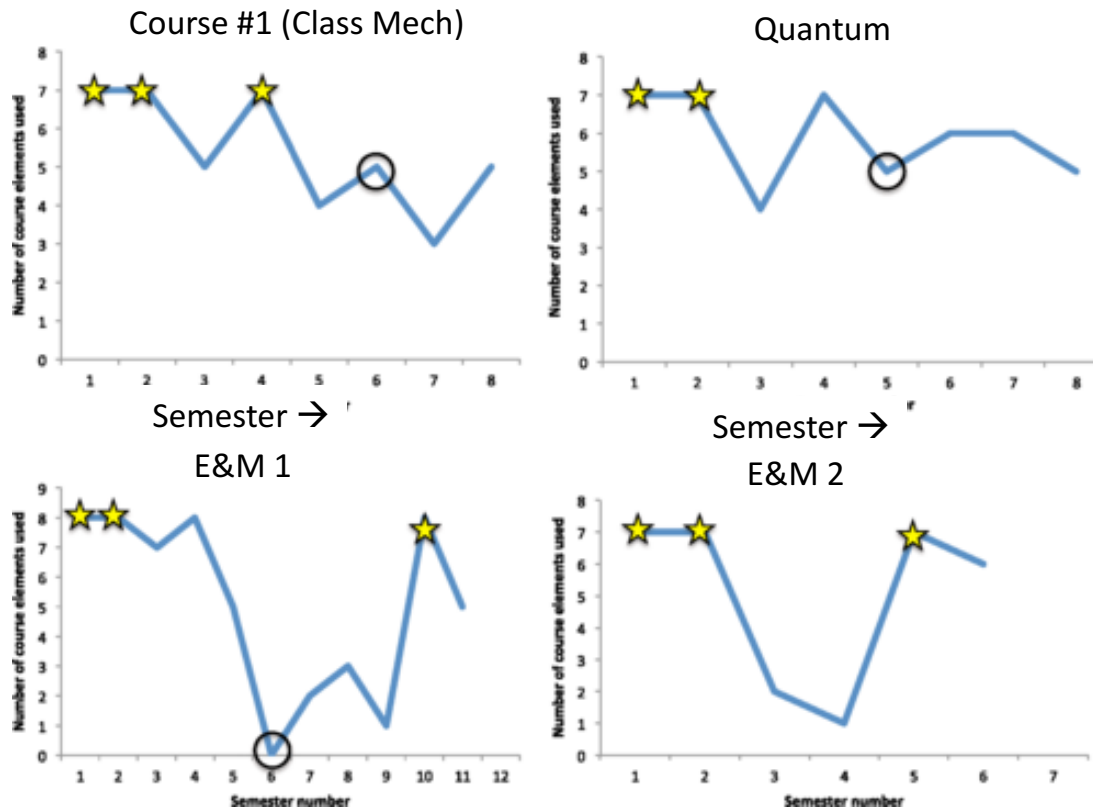


Upper-Level Course Transformation

Spread of transformations



Spread of transformations

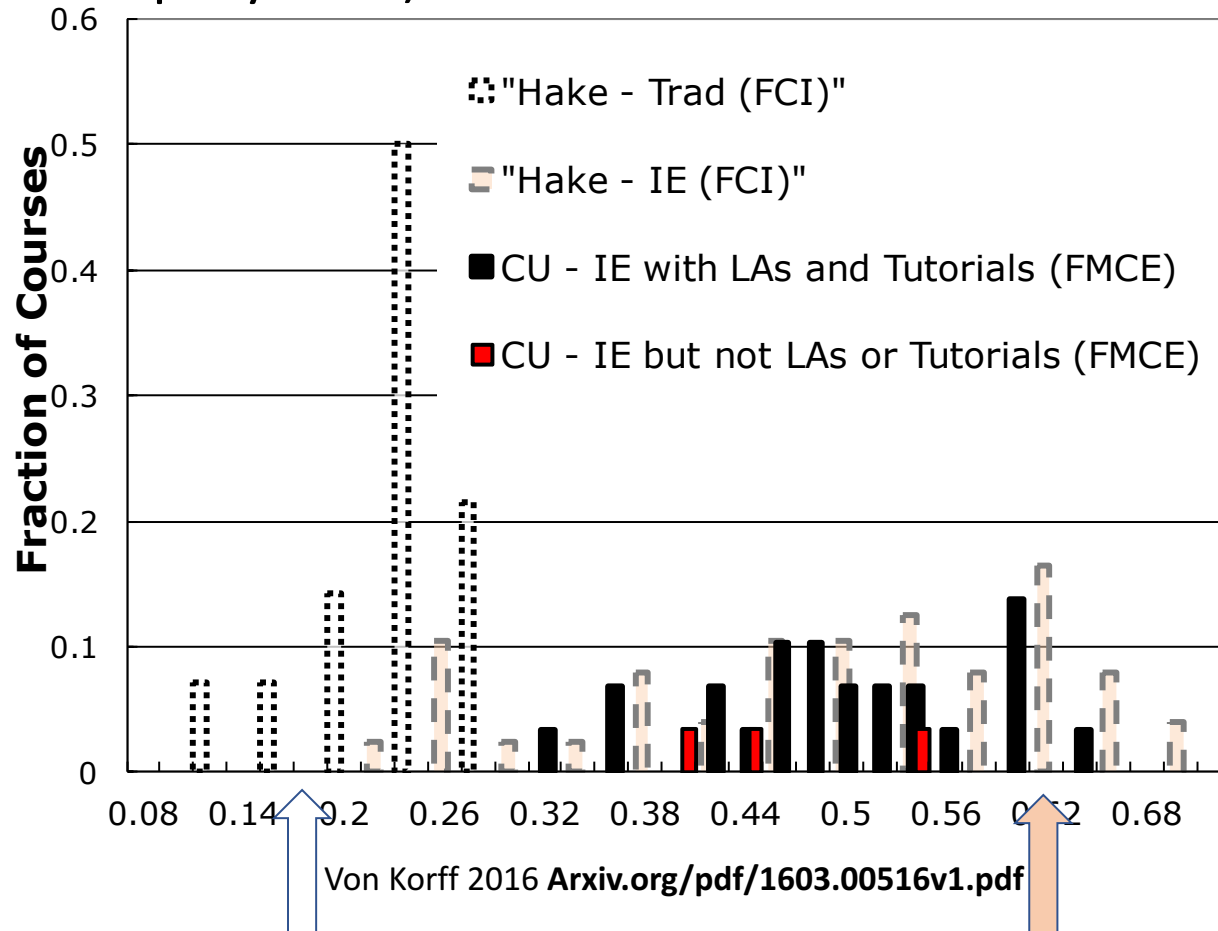


Chasteen et al, Phys. Rev. ST Phys. Educ. Res. **11**, 020110

ASSESSMENTS

- FMCE and BEMA (Phys 1&2, every term for 12 years)
- FCI and CSEM (Phys 1&2 for other majors, most terms)
- ECLASS and PMQ (1140, every term recently)
- Upper division (4 of them, most terms, ~10 years)

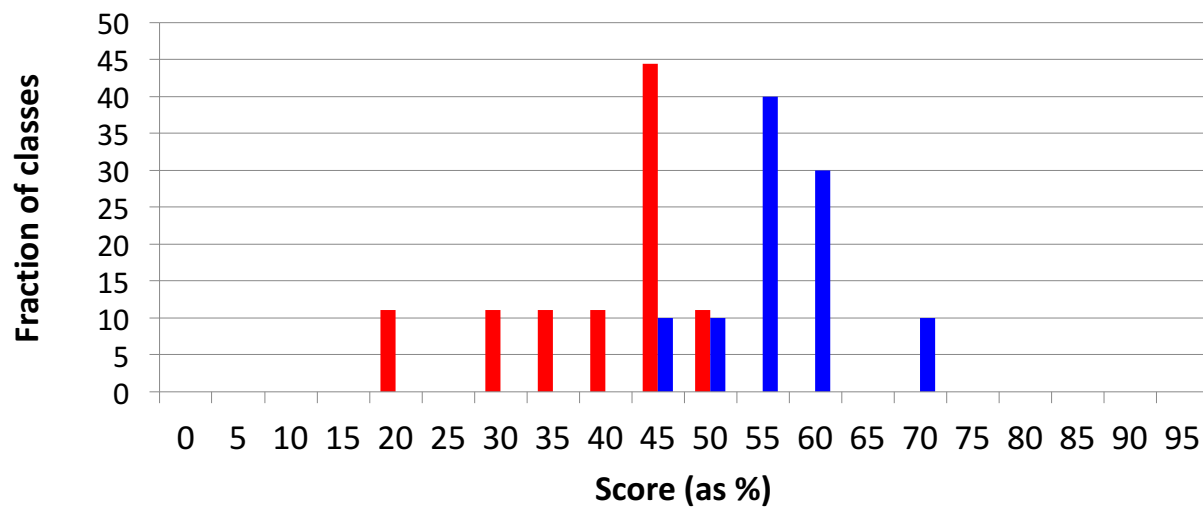
FMCE (intro physics)



UPPER DIVISION: CUE score distribution

traditional lecture

interactive engagement



$N_{\text{tot}}=540$

Wilcox et al., Phys. Rev. ST Phys. Educ. Res. **11**, 020115 (2015)

Other (education related) notes:

- DAT -> R³ committee (Recruitment, Retention, Representation)
- Department self-initiated a "vision" statement with 1/3 pillars focused on undergrad education
- Mandatory mentoring each semester for all majors
- New freshman group mentoring sessions (this semester)
- Active SPS, CU', Women in Physics, PISEC groups.
- I must still be missing lots!

QUESTIONS!

Thanks.