Transformation of Experimental Physics 1 at CU Boulder

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Transformation of PHYS 1140: Team Members

- Faculty: Daniel Bolton, Heather Lewandowski, Mike Dubson, and Colin West (CU); Robert Hobbs (Bellevue College)
- Postdoc: Ben Pollard
- Apparatus construction: Adam Ellzey
- Lab staff: Michael Schefferstein and Skip Woody

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Outline

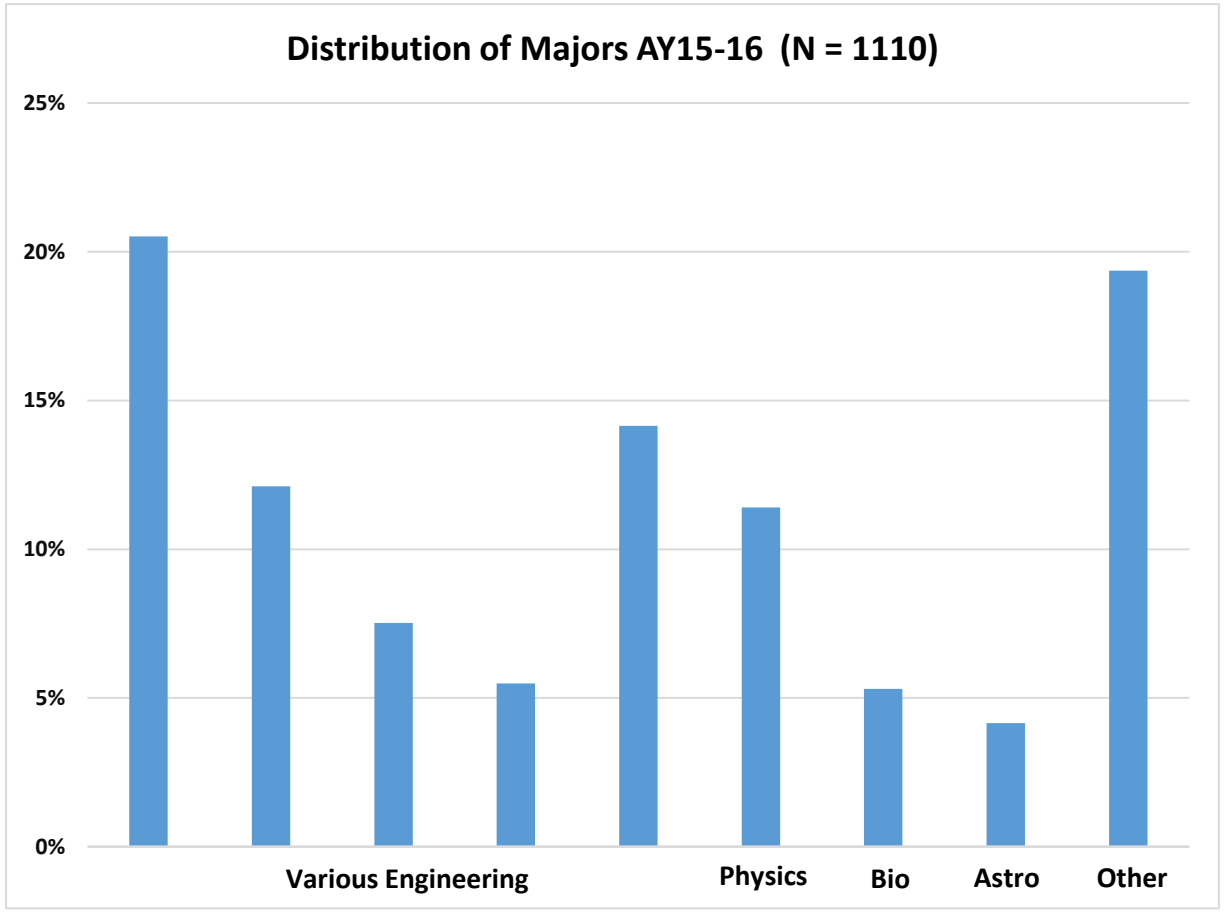
- Context of Experimental Physics 1 (PHYS 1140)
- Prior State of Course
- Learning Goals
- New Course Structure
- Initial Results

*acronyms used:

- E-CLASS = Colorado Learning Attitudes about Science Survey for Experimental Physics
- PMQ = Physics Measurement Questionnaire

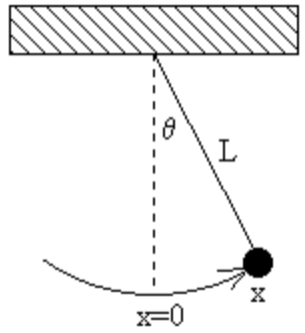
Experimental Physics 1 (PHYS 1140) at CU

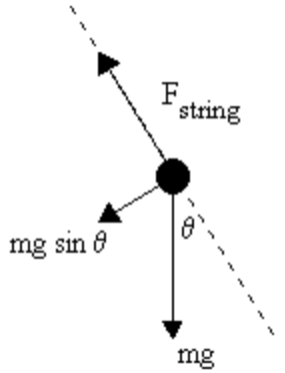
- Standalone, 1-credit course
- Meets once a week for 2 hours
- Approx. 700 students/semester
- One Professor (!) + 22 TAs



Prior State of Course

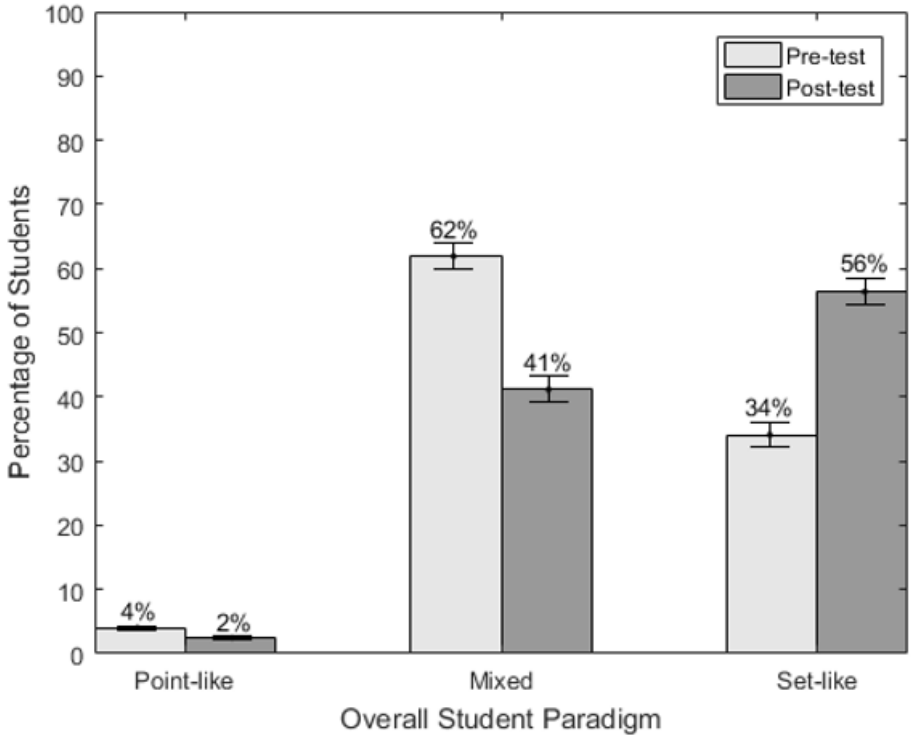
- Potpourri of “verification labs” (i.e. measure g with a simple pendulum)
- Detailed lab manuals given to students
- One week hands-on data collection + one week in-class analysis/report
- Heavy focus on analytic propagation of error





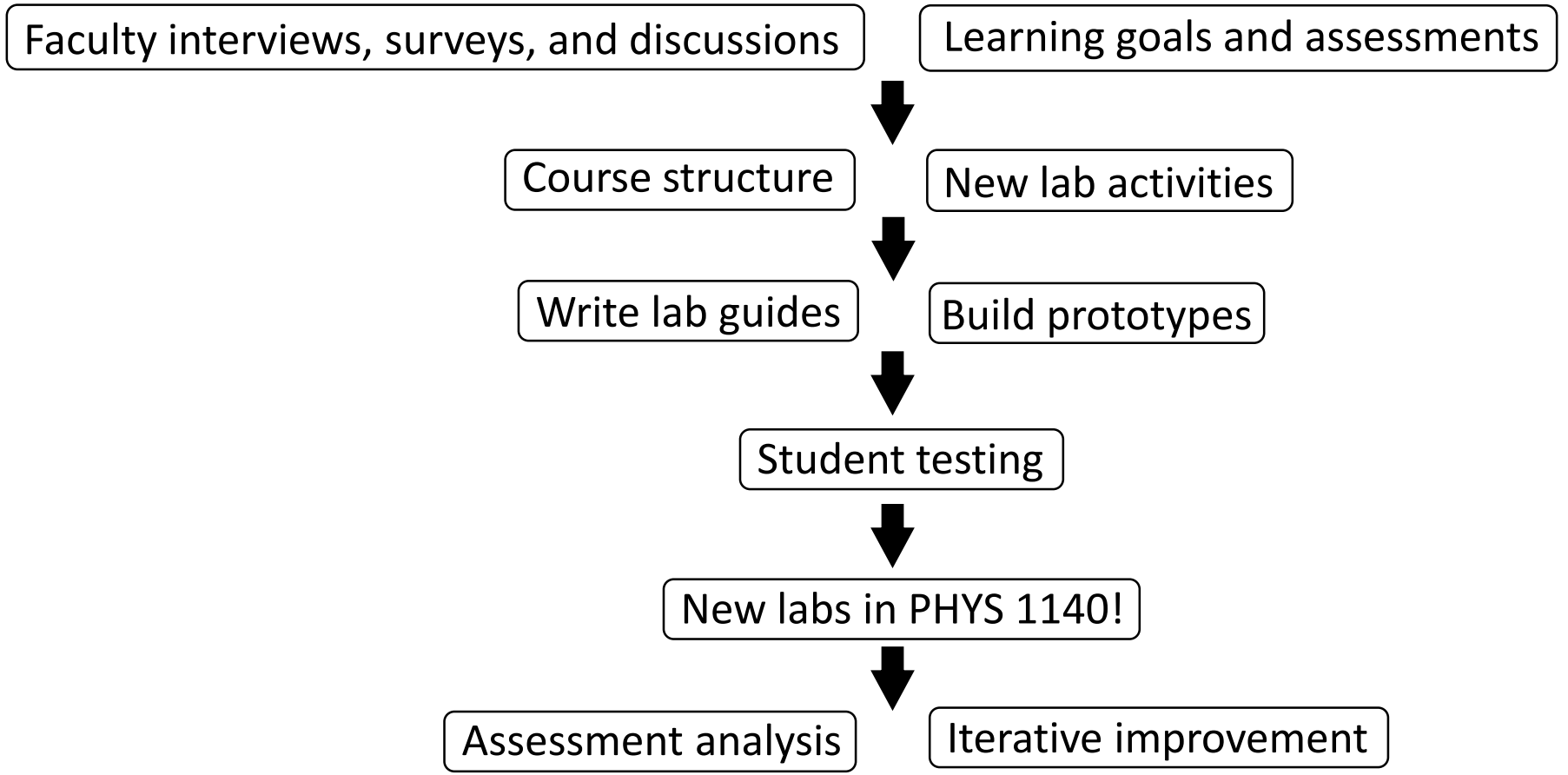
Prior State of Course

1. CU student evaluations over past 4 yrs:
   - Experimental Physics 1 scored 3.8 out of 6
   - General Physics 1 scored 4.4 out of 6
2. E-CLASS shows that students' beliefs shift to *more novice* views after instruction!
3. PMQ shows that many students maintain somewhat "point-like" reasoning



*from B. Pollard, PERC 2017

Transformation Process



New Learning Goals

1. Students' epistemology of experimental physics should align with the expert. (*Assessment*: E-CLASS epistemology items)
2. Students should have a positive attitude about the course. *(Assessments*: Student evaluations)
3. Students should have a positive attitude about experimental physics. (*Assessments*: E-CLASS affect items)
4. Students should be able to make a presentation quality graph showing a model and data. (*Assessments*: Course artifacts)
5. Students should demonstrate a set-like reasoning when evaluating measurements. (*Assessment*: Physics Measurement Questionnaire)

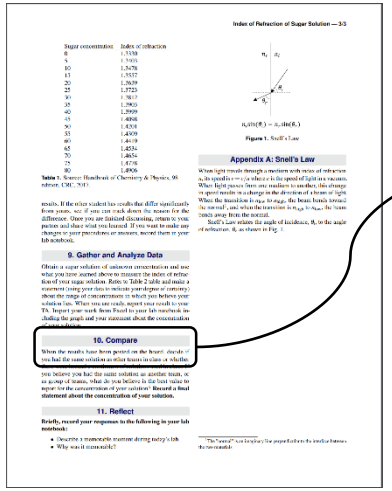
New Learning Goals

As requested by our constituents, what are NOT learning goals?

1. Reinforcing physics concepts
2. Writing
3. Computer skills
4. Analytic error propagation
5. Experimental design

New Course Structure

- Digital lab notebooks: OneNote and Excel at lab table
- Prelab videos with embedded questions replace homework
- Explicit “compare”, “discuss”, and “reflect” sections in lab guide

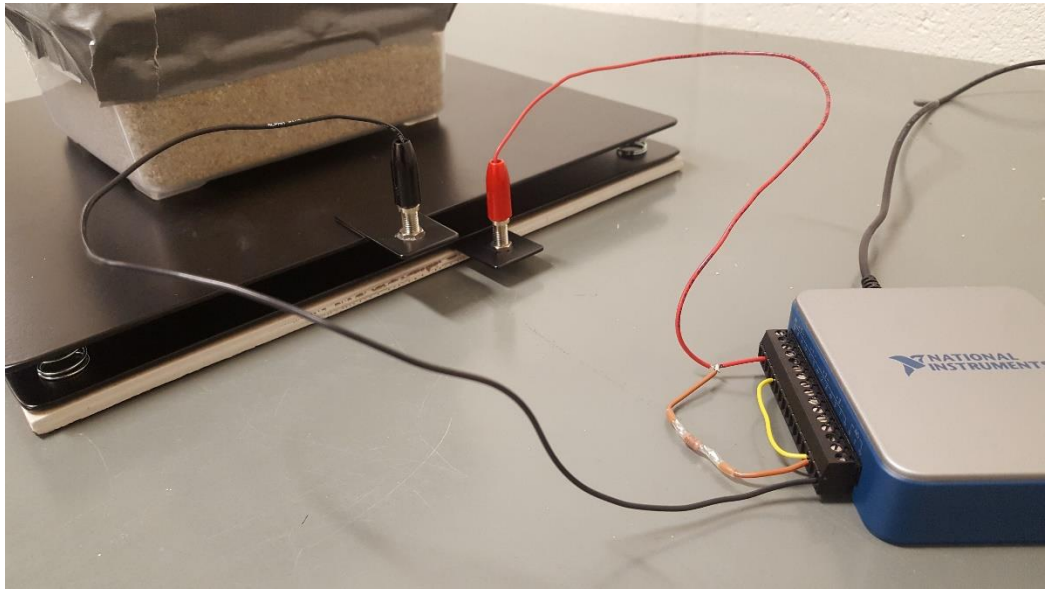


10. Compare

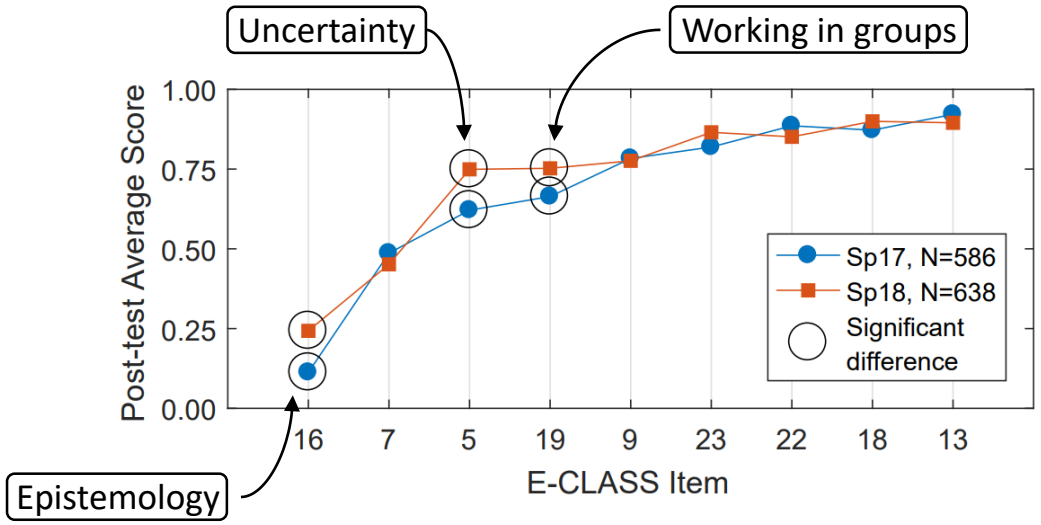
When the results have been posted on the board, decide if you had the same solution as other teams in class or whether

New Activities

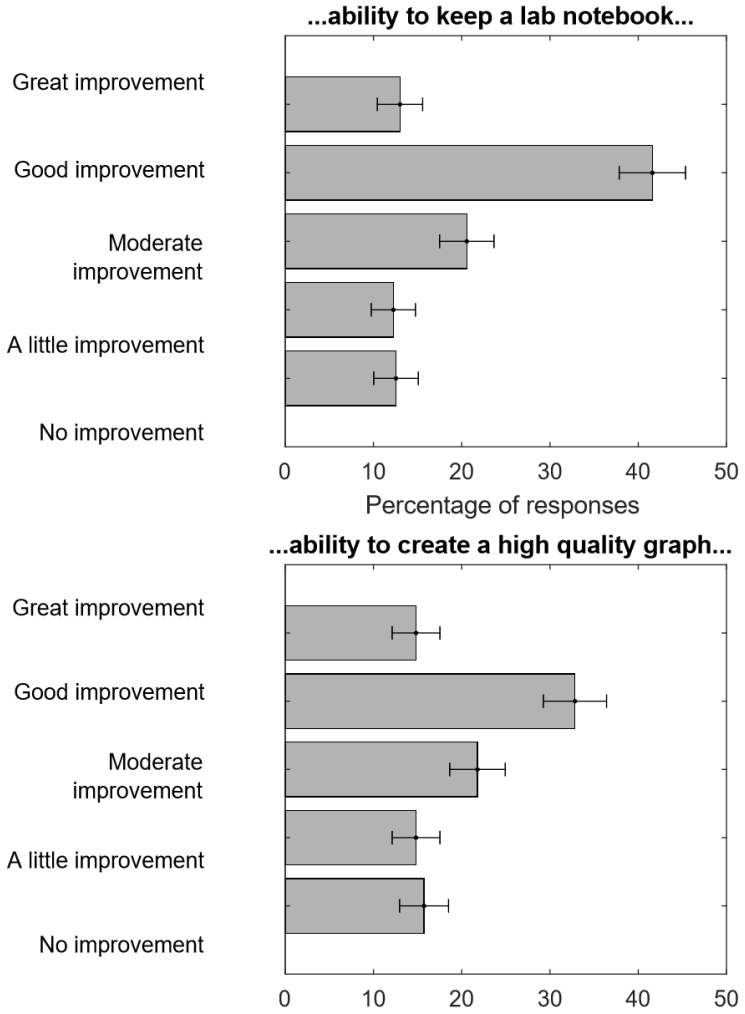
- Epistemology: Measure *unknowns* (i.e. mass of box of sand via capacitive sensor)
- Affect: Real-world (photovoltaics) and “whimsical” (tissue toughness) labs
- Set-like reasoning: Make a decision based on uncertainty (projectile target window)



Initial Results



E-CLASS data
(from B. Pollard, PERC 2018)



Self-reported learning gains
(from H. Lewandowski, PERC 2018)

Summary

- Experimental Physics 1 at CU Boulder underwent a research-based transformation.
- New learning goals emphasize epistemology and set-like reasoning.
- New activities promote group work and other authentic lab practices.
- See Ben Pollard's poster – Mon 8:30-9:15 pm.