Transformation of PHYS 1140 - Experimental Physics I

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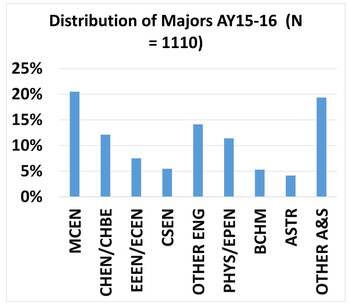
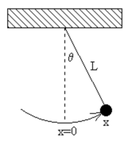
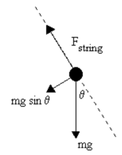
Pre-transformation State

- 1 credit course
- 2 hour lab each week + 6 standalone lectures
- Typically taken when a student is also taking PHYS 1120 (E&M)
- Approximately 600 students every semester
- 1 professor (rotating) + TAs

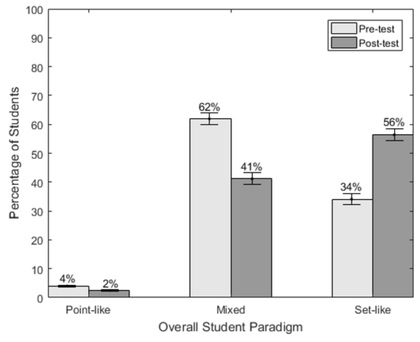


- Students work in pairs
- "Verification" labs
  - Simple pendulum
  - Physical pendulum
  - Simple harmonic motion
  - Series and parallel resistors
  - Parallel plate capacitors





- One week data collection, then one week analysis/report
- FCQ avg for "Course overall" over past 4 yrs:
  - 3.8 (compare with 4.4 for PHYS 1110)
- E-CLASS: student beliefs become *more novice-like* after course!
- PMQ: students retain point-like reasoning



Survey and Interviews

- Faculty interview questions (a sample)
  - Which of the following are important?

Technical skills	Physics concepts
Experimental skills	Skill in modeling expts
Attitudes about expts	Communication skills

  - Verify knowns (i.e. measure $g = 9.8\ {}^{\mathrm{m}}/_{\mathrm{s}^2}$) or measure unknowns (i.e. measure conductivity)?
  - Students choose/design own expts or guided labs?
- College of engineering survey (~90 responses)
  - What concepts do you rely on us to teach?
    Error analysis (11 people)
  - What learning goals would you suggest?
    Experimentation technique (11 people)
  - What input would you like to provide?
    Consider workload on students (20 people)
    Create more novel experiments and allow for more fun (14 people)
- Round Table Discussions

Learning Goals

1. Students' epistemology of experimental physics should align with the expert view
   Assessment: E-CLASS epistemology items. For example, students' are asked if they agree with the statement: "The primary purpose of doing a physics experiment is to confirm previously known results**".**
2. Students should have a positive attitude about the course
   Assessment: FCQs with additional tailored questions
3. Students should have a positive attitude about experimental physics
   Assessment: E-CLASS affect items with additional tailored questions
4. Students should be able to make a presentation quality graph (model/data)
   Assessment: Course artifacts

Learning Goals

5. Students should demonstrate a set-like reasoning when evaluating measurements
   Alternative Definition: Students should understand that a measurement has an associated uncertainty and is not the "true" value. They should understand that repeated measurements form a distribution with a mean and a standard deviation.
   Assessment: PMQ

Not Learning Goals:

- Writing
- Computer skills
- Calculus-based error propagation
- Experimental design

New Course Structure

- Digital lab notebooks
  - OneNote and Excel on laptops at lab table
- Prelecture-style videos replace homework
- Semester divided into 5 units:
  - Skills (notebooks, graphing, statistics)
  - Projectile motion
  - Capacitive sensors
  - Fiber optic communication
  - Projects