STEM Alliance Update: Introductory Physics Lab Transformation

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Overview

- Transform the Introductory Physics Labs (PHY251/PHY252)
  - Algebra-based
  - Non-majors
    - Science majors
    - ~25% pre-med
  - Independent of lecture
- Current labs are in traditional format
  - “Cookbook” style
  - Procedurally focused to obtain a final result
- Goal for labs (from faculty): create a more research-focused, true-to-practice experience
  - Develop a valuable set of skills to bring with them in their other majors
Lab Transformation

Curriculum Development

- Learning Goals
- Obtain Baseline Data
- E-CLASS

Evaluation

- Evaluation design in progress (w/ Carl Wieman)
- Current (FS2015) Curriculum Evaluations
- Filming/Observing
- Lab Development
- Assessment

(Near completion)
Baseline Data - Filming/Observing

- Current semester
  - PHY252
    - Two 110-min/week sections
    - Exceptional TAs
    - Data from ~40 students
  - PHY170
    - One section
      - 2 days/week
      - 170-min/day
    - Led by instructor (one day) and TAs (one day)
    - Entire semester focused on two projects
      - Vacuum systems
      - Optics
    - Data from six students

- Interested in interactions with partners, TA, environment

- First viewing: seeking “Aha” science moments
  - What elicits that response
  - Replicate the environment moving on
Current Evaluation - E-Class

- Gauge student opinions on the nature of experimental physics
- Relate views held by students with those they think are held by professional physicists
- Relate views with how they were assessed in the class
- Involve a pre- and a post-semester survey
Baseline Data - E-Class Survey

- **Pre-Survey at the start of the semester**
  - 170: 9/20 (45%)
  - 251: 580/762 (76.1%)
  - 252: 233/301 (77.4%)

- **Post-Survey recently closed**
  - 170: 9/20 (45%)
  - 251: 564/709 (79.5%)
  - 252: 164/292 (56.2%)

- **Results should be in shortly**
Developing New Evaluation

- Collaborating with Stanford Group (C. Wieman, N.G. Holmes)
- Suitable for introductory lab courses
- Probe understanding of experimental procedures and decision-making
  - Modeling
  - Uncertainty
- Current status:
  - Data being collected from a number of sources (Open-Response)
  - Developing closed-response version
    - Coding current responses
    - Collecting common themes
  - Closed-response with interviews expected in winter semester
Learning Goal Development - Faculty Interviews

14 faculty members gave their views on physics research and introductory labs

Focused on faculty that:

- Attended HHMI meeting in May
- Have familiarity with the introductory labs
  - Instruct/develop 251/252
  - Instruct/develop 170
- Made comments of interest in passing, accepted an invite to sit and talk

Seeking cross-cutting responses

- Views of research
- Views of lab courses

Learning goals developed from responses
Interviews → Learning goals

- Mirror the responses of what faculty value in their research
- Compared to goals set forth by others
  - Consider university goals in process
    - Analytical Thinking
    - Integrated Reasoning
    - Effective Communication
  - National Lab Committee (AAPT - Joe Kozminski)

- Overarching goals
  - Measurable and immeasurable

- Used to guide creation of individual labs
  - Course-scale goals are NOT goals for specific labs
Timeline

Fall 2015 - Begin large-scale assessment (E-CLASS); Develop goals through consensus; Design preliminary 252 labs

- Spring 2016 - Teach initial 252 labs (3 sections); Refine 252 goals and labs
- Summer 2016 - Teach all 252 labs (6 sections); Develop TA/LA professional development; Refine 252 goals and labs; Design preliminary 251 labs
- Fall 2016 - Teach all 252 labs; Teach initial 251 labs (3 sections); Refine 251 goals and labs

- Spring 2017 - Teach subset of 251 labs (6 sections); Develop 251 TA/LA professional development; Refine 251 goals and labs
- Summer 2017 - Teach all labs (12 sections)
- Fall 2017 - Teach all labs
Outline of course-scale goals (from faculty interviews)

1. Developing skepticism in their own work, in science and the media
2. Understanding that measurements have uncertainty
   a. Demonstrate understanding of sources, random vs systematic
   b. Model vs experimental data; limitations/assumptions that go into each
3. Developing professional research attitudes
   a. Develop agency over their own learning
   b. Promote scientific integrity, honesty, an ethic
4. Communicating their results to a wider variety of audiences
5. Learning how to use multiple sources of information to develop their understanding
   a. Apply multiple approaches, determine an effective and precise solution with forethought/critical thinking
6. Demonstrating ability to use and understand equipment
   a. Determine effective uses of the equipment
   b. Troubleshoot problems through a methodical process
7. Documenting their work effectively
8. Becoming reflective of work, building on prior experiences

In an environment where students feel empowered to develop their own understanding.