TRESTLE Course Transformation Report Outline

Estimated length: 3-4 pages

Date of report: 7 May 2018

Course name: Experimental Physics I (PHYS 1140)

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1. Intro

Hire dates of any personnel, history of the work within the department. Please set the general context.

Bolton: I've been in the department as a full-time Instructor for 3 yrs (started Jan 15). I typically teach large enrollment introductory physics. PHYS 1140 has received poor evaluations by multiple standards for years now, and the feeling in the department was that the course needed to be re-designed.

Lewandowski: Tenured prof. Hired in 2005

2. Course specific information

(repeat for any additional courses)

A. About the course

- Course Description
  1 credit (2 hours per week) standalone hands-on lab course. Taken by all physics majors and most engineering majors. Pre-transformation learning goals (not explicit, but inferred from looking at current implementation): Proper use of significant figures and propagation of error. Learn the basics of Mathematica. Reinforce concepts from lecture courses.
- Reason this course was chosen for transformation
  Low student evaluations, negative comments from graduating seniors on exit surveys, negative shifts in ECLASS inventory, negative impression of nearly all faculty.
- Course Structure (e.g., face-to-face lecture, hybrid, lab)
  2 hour hands-on lab each week + approximately 6 1-hour lectures spread throughout the first half of the semester.

B. What did you do in the course transformation?

- What happened and how was the work structured (in general, specific details below)?
  - In 2017: First, we conducted individual interviews with faculty (as requested, approximately 12 interviews). Next, we held 3 50-min round-table discussions. We then applied for funding. Then we worked in a small group to develop course

structure and decide on lab activities. Finally, Daniel spent Summer 2017 testing equipment and writing lab guides. In Fall 2017, Heather, Ben Pollard, Robert Hobbs, and Daniel continued designing labs, and Robert Hobbs and Benjamin Pollard conducted student testing, resulting in many changes to the labs as issues were identified. As of January 2018, all but 3 lab manuals had been written.
    - In Spring 2018, Heather created lectures. Colin West (a new lecturer) taught one of the three lecture sections and developed the pre-lab video assignments.
    - In Spring or 2018, we wrote 4 lab guides, did extensive off-line student testing, created prelab videos, and new lectures.
- Individuals Involved (List name and role)

  Daniel Bolton – Developer
  Heather Lewandowski – Big picture advisor, led funding proposals
  Mike Dubson – Big picture advisor, left the project after Sp17
  Ben Pollard – Developer, tester
  Robert Hobbs – Developer, tester
  Colin West – lecturer, new to project in Sp18, designing pre-lab video assignments
  Adam Eilzey- Machinist and equipment builder
  Skip Woody – Lab coordinator and equipment builder
  Michael Schefferstein- Lab coordinator and equipment builder

- Learning Goals Developed (List)
  1) Students' epistemology of experimental physics should align with the expert view
  2) Students should have a positive attitude about the course
  3) Students should have a positive attitude about experimental physics
  4) Studenst should be able to make a presentation quality graph showing a model and data
  5) Students should demonstrate a set-like reasoning when evaluating measurements
- Assessments Developed

  We are using assessments that are already accepted by the physics community:
  1) E-CLASS – attitudes pre/post survey
  2) PMQ – set-like vs. point-like reasoning pre/post survey
  3) Faculty course questionnaire

  Plus the following self-developed assessments:
  1) Focus groups
  2) Questions at end of PMQ, post-test
  3) Mid-course feedback survey
  4) Student lab testing
  5) TA Reflection sheets
- Pedagogies Used

  In lecture: clickers, peer instruction

At home pre-lab video assignments
In lab: peer instruction, reflection

C. What assessments or documentation of impact were or will be used?

- What measures were (or will be) used to monitor student learning related to the course transformation efforts? (e.g., attitudinal surveys, two-stage learning exams, pre-post course surveys, gains in learning on exams related to active learning activities, in-class participation ratings, faculty evaluations, case studies, student interviews, ratings of learning-level based on Bloom's taxonomy, evaluation of student samples/work)

  The three assessments listed above are what we used.

  1) E-CLASS – attitudes pre/post survey
  2) PMQ – set-like vs. point-like reasoning pre/post survey
  3) Faculty course questionnaire

  Additionally, in Fall 2017 there was extensive student testing of the labs. As part of the PHYS 1140 course redesign process, researchers tested new lab activities throughout the Fall 2017 semester. Pairs of student testers were recruited via email from the students currently enrolled in PHYS 1140. Each student was paid $30 to participate in a two hour testing session in which the students worked through a new lab activity and then answered some verbal follow-up questions. Researchers followed a written protocol throughout the session, and also played the role of fellow student or TA as necessary. The sessions were video recorded for later analysis. The students also produced an electronic lab notebook and marked pages during each session, which researchers analyzed as needed. Each new activity was tested in two separate sessions, revised based on observations from those sessions, and then re-tested at least once. Both the lab guides and the equipment were improved as part of this process. Testing continued in Spring 2018.

  In Spring 2018 we developed the following measures during the lab:
  Plus the following self-developed assessments:

  1) Focus groups and questions
  2) Questions at end of PMQ, post-test
  3) Mid-course feedback survey

- What were the results, if you have any?

  The student testing process measured how well aligned each lab activity was to the learning goals of the transformed course, and yielded improvements to better align each activity with those goals. For example, some of the follow-up questions probed whether the student testers enjoyed the activity, aligning with the "positive affect" learning goal of the transformed PHYS 1140 course. The testing process also resulted in many practical improvements to the labs by identifying equipment and software

problems, confusing wording in the lab guide, and even occasionally larger-scale issues with a lab activity overall. Researchers also paid attention to the time it took for students to complete each section and to how challenging each section was, and adjusted each activity accordingly.

There are no results yet on the transformed course outcomes, as the first transformed section was in Spring 18. Data analysis will be performed over the next 6-12 months.

D. How will you maintain the changes over time and across structures?

- Location of Course Material Archive (how will others access your work)?
  Daniel is working with the department IT staff to create a website on a university server that will be a repository.
- Plan for Sustainability
  1) Using LAs and creating a TA/LA training ritual similar to what we use in our large lecture course's recitations.
  2) Making the changes from the pre-transformed course so dramatic that it will take more effort to "switch back" than to stick with the new course.
  3) Make heavy use of permanent lab staff members in TA/LA training sessions.
- Challenges for sustainability
  1) There will likely be initial resistance to change, as there always is with anything!
  2) Although we tried to keep our learning goals limited to consensus items, some elements of the course structure will be controversial (for example, requiring that all students do the same experiment each week).

E. Plans for future work

What did and didn't work well in the course transformation? What would you like to do next? What are some unsolved challenges?

- Modify some labs for length and content.
- Increase the difficulty of pre-lecture video questions.
- Address student concerns about lack of partial credit for modifying answer in pre-labs.
- Make sure there is adequate grade differentiation among students.
- Make sure TAs are assigned to the course equitably (not all non-native speakers)
- Develop instructor guides and TA guides, but concerned they might not be read.

3. Community and expertise building in the department

- How did you use or generate broader expertise and/or community in your work?
  We involved faculty and postdocs from the beginning of this process and have been updating them as we go along. We have spoken one-on-one with many faculty as we encounter difficulties with equipment and/or pedagogy.
- Expertise you drew on (yours, others)
  Pedagogy – Steve Pollock, Robert Hobbs, Heather Lewandowski

Course structure – Mike Dubson and Heather Lewandowski
Optics – Heather Lewandowski
Nuclear physics – Ed Kinney and Jerry Peterson
Labview – Ben Pollard

- Community built – were faculty across the department adequately involved? Did you engage in community building across departments or institutions?
  In addition to the in-department activities Daniel described above, we also asked the college of engineering for their input and they formed a committee and ran a survey to give us input.
- Future plans or room for improvement in this area
  Presentation to the physics faculty and engineering faculty in Fall 2018.

4. The process and structure of the work in the department

- What worked well about the process and structure of the work? What could be improved? Consider the role of various experts leading and completing the work, whether you had adequate resources to do the work, whether roles were clear, and whether there was adequate leadership within the project and the department. What are your open questions or concerns?
  The in-person interviews brought consensus (and contentious) items to light. The round-table discussions were very productive in determining learning goals. Engaging Steve Pollock once we began testing equipment was extremely helpful.

  Heather and I reached a point of diminishing returns when trying to brainstorm new activities. In hindsight, I wish I had attempted to engage a couple other faculty for fresh ideas (but I'm not confident they would have been willing to offer time and I'm worried it might have been too difficult to bring them up to speed).

  I'm concerned that faculty assigned to teach the course after Heather might not like the new course, but I'm not sure what more we could do to address this concern (I think we've already been proactive about this).

  Bolton will be creating Studio Physics course in the department and will draw on this process from 1140 to guide that transformation.

5. Future Plans

- What future plans do you have related to the work, other than work on a specific course?
  Present at 2018 AAPT and write up several papers about the work.