

Proposal to the Science Education Initiative

Abstract

The faculty members of the Department of Physics have a long-standing commitment to provide our students with a superb education in the physical sciences. We are recognized leaders in the creation and application of innovative education techniques. We propose a 4-year program to 1) Develop learning goals and methods for evaluating student mastery of the existing physics curriculum, 2) Provide physics faculty members with financial and personnel support to develop effective ways to teach the curriculum, 3) Maintain and encourage the use of a library of course materials and associated information about the measured efficacy of physics courses. During the 4 years of the program, we will develop learning goals, assessment tools and/or teaching materials for up to 8 courses (1 to 2 courses per year) potentially covering the bulk of our undergraduate major and non-major courses. We note that such work is already being done in the department without any additional funding. (Professors Dubson and Pollock are working on the junior courses Physics 3310 (Electromagnetism 1) and Physics 3220 (Quantum Mechanics 1)) Additional funds will allow us to expand these activities.

Background

Department of Physics faculty members have a long tradition of innovative teaching, exemplified by faculty-authored textbooks, our undergraduate teaching laboratories, our extensive lecture demonstration capabilities, locally developed course materials, and many campus and national teaching awards. Over the last few years, our department has been active in developing lecture techniques based on in-class conceptual questions, real-time audience response systems, online homework systems, online student feedback, online simulation and demonstration, and the development and use of tools to evaluate student performance and attitudes. We have developed extensive libraries of course materials (particularly conceptual questions) for the large introductory physics courses. We are in a strong position to implement and test course improvement strategies.

General principles

The faculty members of the Department of Physics are interested in providing students with the very best instruction in all our courses. Over the next four years, we propose to expend the initiative funds subject to the following general guidelines:

- Emphasis will be placed on determining the learning goals for existing courses. Learning goals are a prerequisite for course and teaching technique evaluation.
- Emphasis will be placed on developing course evaluation tools for existing courses. Measuring whether material has been successfully transmitted to students is a difficult task, particularly for evaluating levels of expert knowledge. However, it is valuable to attempt to measure student learning as a first step to assessing teaching techniques.
- Funding for any specific course project, whether for pure evaluation or for course modification, will be initiated by a faculty proposal. Proposals will be evaluated for funding by a faculty committee appointed by the Chair of the Department of Physics. Successful proposals should include a plan to develop a list of key learning goals reflecting broad faculty input/feedback and explain the type of evaluations and/or innovations that are planned, specific goals for student learning, and the tools to be used or developed to evaluate their utility and efficacy. One of the criteria will be that the proposal fit in with the sequence of courses that have already been worked on. In addition, as part of the work on improving our teaching of Physics 3310 (Electromagnetism 1) and Physics 3220 (Quantum Mechanics 1), both upper-division courses, Professors Dubson and Pollock have already surveyed the department faculty on

what material should be taught in these courses and what we expect that students will learn in these courses. Such surveys will be a part of any future proposals.

- The Department of Physics will act as a repository for syllabi, course materials, associated evaluation tools, and the results of course and student learning evaluations. The Department of Physics will form a Teaching Innovations Committee to keep the faculty apprised of progress on defining learning goals, on new evaluation tools, and new teaching techniques. Committee activities will include the organization of seminars and other activities to inform the faculty and encourage the use of successful tools and innovations. The departmental feedback to the faculty and storage of materials and results is part of long-term evaluation and smooth transfer of successful courses.
- The Department of Physics will participate in the creation and distribution of technical and attitude surveys to our students, to attempt to evaluate the value of our curriculum and teaching techniques. The present Senior exit survey will be generalized and administered to all majors and a random selection of non-majors. Questionnaires will be mailed to our graduates in an effort to evaluate the longer term impact and value of our courses.
- We expect that courses that are early in the curriculum and/or courses that enroll large numbers of students should receive attention first.

Possible project components

Teaching innovation in our department has historically been and will continue to be a grass-roots effort, driven by individual faculty and faculty groups, and motivated by our shared desire to teach well. We will rely on the individual faculty members and faculty groups to generate proposals for course evaluation and course development. Such proposal activities assure the freest flow of ideas and the fastest path to constructive change. We anticipate two major project types: 1) Straight evaluation of existing courses at the request of the instructor. 2) Course innovation proposals that would involve modification followed by evaluation. While we anticipate that each course project will be unique, our general expectations suggest the following broad outline:

1. Substantial effort will be expended to building methods for evaluating student mastery of the course materials. We will concentrate on creating ways to measure what the students have learned, so that teaching strategies can be evaluated against faculty-determined expectations.
2. Project staff will work with the Department of Physics to document course materials and evaluation tools/results.
3. For projects that plan on course modification, the teaching goals and detailed syllabi will be passed through the Department of Physics Curriculum Committee for comment and approval to assure that the innovations remain consistent with faculty-approved program goals.

Faculty members are encouraged to draw on the extensive expertise within the department or from outside to develop evaluation and/or innovative teaching techniques. Additional components, depending on the scope of the proposal, might include:

- Course projects might span three semesters, possibly four, to allow a full cycle of evaluation, modification, and reevaluation.
- Two regular faculty members might be involved, with the course project constituting their primary teaching assignment (buyout funds are budgeted to allow such joint teaching of small classes). Over the time of the project, different faculty members might take the primary lecturing role, to assess the transportability of course materials.

- Ph.D.-level teaching fellows may be requested to assist the faculty in developing course evaluation tools and/or course materials.
- Additional teaching assistant or learning assistant staff may be requested as needed.
- Expert help external to the Department of Physics or external to CU may be requested.

Budget

We suggest four years of funding at \$70K per year, broken out as \$50K for a Ph.D. teaching fellow, \$10K for faculty summer salaries and team teaching support, \$10K for additional learning assistant support.