

Department of Physics 2008 Program Review Self-Study

QUESTION 13: Assessment Describe your unit's undergraduate and graduate outcomes assessment procedures.

During the last review period, how has the department/program assessed how well it has accomplished its curriculum goals? What has the department/program concluded with respect to the outcomes of its undergraduate and (and if applicable, graduate) curriculum? What changes in the curriculum or in major requirements have occurred as a result of your assessment of undergraduate program.

The Department has standing committee for departmental, peer evaluation of teaching. All junior faculty are evaluated by 1- 2 external reviewers each term. Evaluation criteria have been revised since 2001 to help align teaching practices with departmental goals for student learning and employ the findings from research on student learning. In addition many courses have been evaluated over time with research-based conceptual learning instruments.

Introductory Physics sequences:

The department employs research-based measures of student conceptual learning, and students beliefs about the nature of science.

In the calculus based sequence we use the Force and Motion Concept Evaluation, the Brief Electricity and Magnetism Assessment, and the Colorado Learning Attitudes about Science Survey. All courses are issued pre- and post evaluations and every term, and the results are made available to faculty teaching courses. These assessments demonstrate student learning gains as much as three times the national average.[Can insert figure as needed].

In the algebra based sequence faculty use the Force Concept Inventory, the Conceptual Survey of Electricity and Magnetism and the Colorado Learning Attitudes about Science Survey.

The courses have additionally issued the Student Assessment of Learning Gains survey to identify student perceptions of effective educational practices.

Our courses have documented impacts on improved student learning and the development and support of students' positive attitudes about he nature of science and learning science. These evaluations have led to feedback for faculty, mentoring / partnering of faculty in team teaching scenarios and revisions of courses. The external review of the physics sequence that serves the College of Engineering and Applied Science found our courses to be effective and impressive.

At the upper-division, efforts from the Science Education Initiative, and the Physics Education Research group have supported the development, validation, and

implementation of assessment instruments to evaluate student learning (educational effectiveness) in:

- Modern Physics: (Phys 2130 / 2170): quantum mechanics conceptual survey
- Electricity and Magnetism (3310): Colorado Upper division Electrostatics survey (CUE)
- Quantum Mechanics: Quantum Mechanics Assessment Tool (QMAT)

The Colorado Attitudes about Science Survey is also issued in these courses. The three learning assessment tests have been tested at CU and universities around the country.

These instruments and associated course reforms are based on a consensus learning goals established by 10-12 physics faculty during a series brown-bag lunch meetings.

Additional studies on impact have:

- examined longitudinal impacts on student interest and attitudes about physics through the major (Perkins, 2007).
- Detailed the use of clickers across the curriculum and penetration into upper division and graduate courses.

Graduate Survey

In 2008, the Department of Physics in collaboration with the Science Education Initiative conducted a survey of 267 B.A. Physics graduates who completed their bachelors degree between 1997 and 2007. The purpose of the survey was to determine career paths of our graduates and survey their opinions about two upper division courses that SEI was about to transform, PHYS 3310 (electricity and magnetism 1) and PHYS 3220 (quantum mechanics 1). Sixty-seven alumni responded, a 25% response rate. The results were very interesting and led us to consider how to better meet the needs of the range of students who major in physics. The results also informed our course transformation efforts in electricity and magnetism and quantum mechanics. The results were interesting enough to prompt us to also conduct a survey of the Engineering Physics alumni. The results of that survey have not yet been analyzed.

Here are some of the findings. The complete survey is an appendix to the self study report.

About half (51.4%) took the GRE. The average GRE score reported (N=7) was 637.

Immediately after graduation, about half applied for employment (45.3%; compare to 38% nationwide) and half applied for admission to a graduate program (52%; compare to 57% nationwide)

At the time of the survey, about two-thirds (66%) had enrolled in a graduate program at some point in time.

On average, about half (52%) of students' applications to graduate school or employment were accepted, and they submitted an average of 17 applications each (though many

submitted far fewer). Most saw the success of their applications as being due to recommendations (26.5%) and research experience (25.2%). Most saw the rejection of their applications as being due to low GRE scores (30.1%) and GPA (26%).

Over half obtained a BA or BS as their highest degree to date (62%), followed by MS (33%) and PhD (5%). Slightly under half (40%) were currently in MS or PhD programs.

A majority (65%) had enrolled in a graduate program (40% were still currently enrolled), but a substantial fraction (35%) had never attended graduate school.

A majority (66%) indicated that their current jobs/school were related to physics.

Alumni not in graduate school held a wide variety of jobs, especially in industry and finance.

More graduates included industry in their past experience or future plans (52%) than any other single job type, including a PhD program (46%).

Those respondents who went on to non-physics related jobs, but did NOT attend graduate school were highly successful professionals with excellent grades at CU.

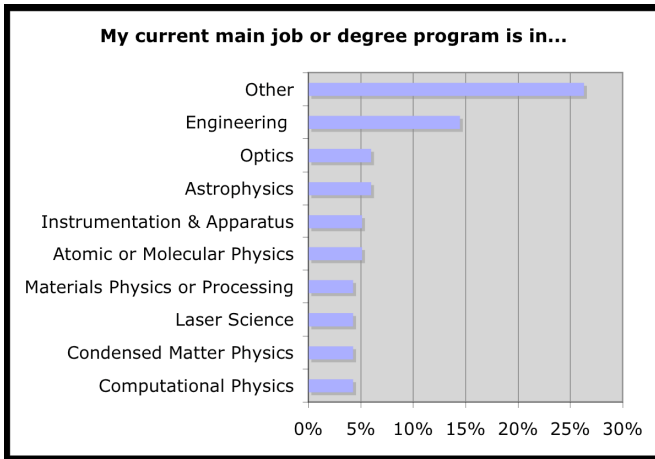
Students appreciated homework help sessions, an instructor who genuinely cared about their learning, challenging homework, a connection between math and physics, and real world applications.

Students felt they matured in E&M I and Quantum I by learning to take control of their own learning and improving problem-solving skills. Students were less sure that they had matured as physicists in Quantum I, which was seen as a “weeder” class.

E&M I was seen as more relevant, memorable, and understandable than Quantum I. In Quantum I, many complained about mathematical focus at the expense of understanding and the disconnection from real-world examples.

Those who went on to graduate school found the material in these courses more relevant to their career than those who did not.

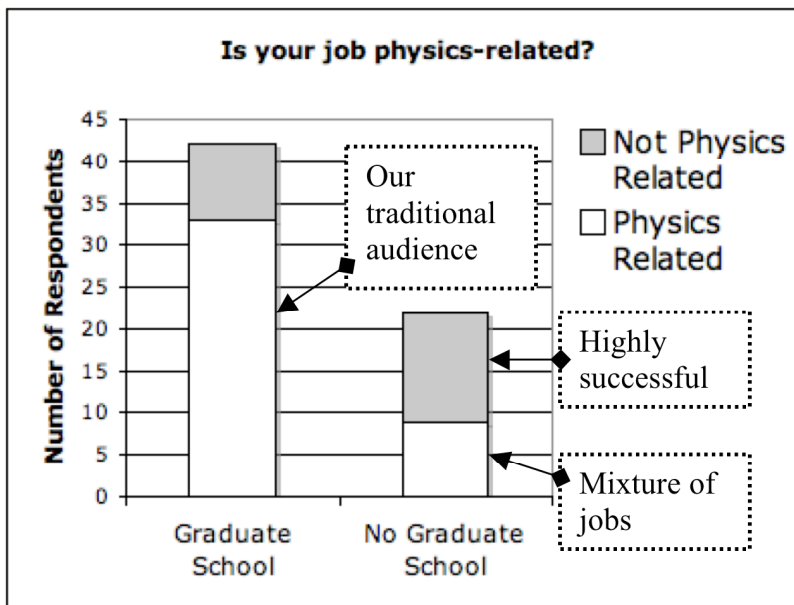
About two-thirds (66.1%) indicated that their current job was physics related. Most jobs did not fall into a standard physics categorization (such as optics or astrophysics). The most common categorization was Engineering (14.4%), with all others being roughly equally weighted. Statistics below are for those categories selected by at least 4% of respondents.



What are their jobs?

Some of the jobs listed, other than graduate programs, were:

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|--------------------------------|-----------------------------|
| Strategic consulting | Sales engineer |
| Staff engineer | Foreign service officer |
| Financial advisor | Paramedic |
| Financial analyst | Research analyst |
| Actuary | Patent examiner |
| Stress analyst | Pastor |
| Laboratory manager | Associate scientist |
| Data analyst | Manufacturing lead |
| Science Discovery | Solar electric installation |
| VP of finance | Project manager |
| Satellite integration engineer | NASA educator |
| Aerospace system engineer | Production coordinator |
| Technical writer | Naturopathic medicine |
| Religious studies | |



Physics and Non-Physics Related Jobs

Not all respondents were employed in physics-related jobs or in graduate school related to physics. Below are the percent of respondents who are in physics-related jobs, broken down by whether they went to graduate school. Not surprisingly, those who go on to non-physics jobs felt less prepared for their jobs by these upper division courses than did those who went on to physics related jobs. Most alumni who enrolled in graduate school are in physics-related jobs or graduate programs.

Those who are not in physics related jobs are still in high functioning positions (VP of Finance, dental school, financial engineering, staff engineer, actuary, software engineer, etc.)

But what about those who did NOT go on to graduate school? We find some interesting differences when we examine this group. Those who went on to physics related jobs without a graduate degree have a variety of positions (electronics, lab and safety manager, scientist, aerospace engineer, optical engineer, manufacturing lead, sales engineer, data analyst). However, when examining those with NON physics related jobs we find a group with highly functioning and highly satisfying jobs, across the board: Foreign service officer, financial advisor, product manager for PayPal, systems engineer at Microsoft Virtual Earth, computer engineer, financial analyst, paramedic, and research analyst. These alumni got similarly high grades in upper division courses as did those who went on to graduate degrees. Thus, our graduates can be highly successful professionals even if they leave physics and do not receive a graduate degree.