Department of Physics and Astronomy
Assessment Report 2011

This assessment report was prepared on June 25, 2011, by Chris Taylor, on behalf of the Assessment Committee of the Department of Physics and Astronomy. The Committee membership is: Gary Shoemaker, Vassili Sergan, Chris Taylor, and Hossein Partovi.

Background

First, some background information to provide context for the assessment report. The number of majors in the Physics program is small for departments on this campus, but is in fact large for similar departments at other universities across the United States. The American Institute of Physics (AIP) conducted a survey of the size of Physics departments for departments whose highest degree granted were either bachelor's, master's or Ph.D. Among Physics departments whose highest degree was a bachelor's, in 2008, the year of the survey, 59% granted between 0 to 4 degrees, 30% granted between 5 to 9 degrees, and 11% granted 10 or more. Our department granted 4 degrees that year, and our average from 2005 – 2010 is 5 per year. Furthermore, we had 7 graduates in AY 09/10, 5 in AY 10/11, and expect higher numbers in the future as a result of actively recruiting new Physics majors. Although we are currently graduating Physics majors in greater numbers than 70% of all similar departments in the nation, having numbers in single digits makes a statistical analysis of learning outcomes difficult. The Assessment Committee has made an effort to use rigorous statistical measures when the population size warrants such an approach, but where numbers are insufficient for that kind of analysis, a qualitative study of course curricula and examples of student work in combination with results of surveys and interviews was conducted to assess student learning outcomes.

Learning Outcomes and Methods of Assessment

**Physics Knowledge** – Students should develop a broad understanding of basic principles of physics and mathematics and the foundation for acquiring new knowledge and applying it in a variety of situations.

The Physics Knowledge outcome is directly assessed in two ways, 1) analyzing exams and final course scores in upper division physics courses on a rotating basis, and 2) analyzing examples of student work such as lab reports and journals, computational physics projects, faculty/student research projects, and work on the capstone senior project.

1) The Assessment Committee obtained copies of final and mid-term examinations from the instructors of four upper division courses that were taught in AY 09/10: Phys 110, Phys 145, Phys 162, and Phys 163. Phys 110 and 145 are “core” courses in our major program, while Phys 162 and 163 cover computational modeling in physics and are part of the Department’s new certificate program in scientific computation. Phys 162 and 163 also count as electives for both the B.S. and B.A. degrees in Physics. Phys 145, in addition to being a core theory course, also has a major, intensive laboratory component.
For the first time a lower division major course, Phys 11A, was included in the yearly assessment cycle. Phys 11A is a calculus based introductory physics course, taken primarily by engineering and science students. It is normally the first physics course that first-year physics majors take in the major.

Phys 162 is being assessed for the first time after a recent total revision in the course description to update the curriculum to cover contemporary methods in computational physics. Physics 163 is a new course and is being assessed for the first time. Both Phys 162 and 163 include a significant number of non-Physics majors in their enrollments. All instructors removed student names from the exams, and submitted three exams from each course, representing excellent, satisfactory, and poor (failing) performance (when possible).

The Committee reviewed each of the exams to ensure that they properly reflected the required course content, and that the exams were neither too simple nor too difficult for the level of the course. The Committee looked at the scores assigned to the students of the three examples to ensure that grading was fair and represented a real evaluation of the abilities of the students. The Committee was satisfied in both regards (level of the exam and level of the grading) and established that the exams provided useful information on the students’ levels of physics knowledge. Since final course grades are largely based on exam performance and homework scores, the course grade distributions will accurately reflect the students learning in each of the reviewed courses.

Analytical Reasoning – In addition to Physics content, students should develop problem solving, critical thinking, and analytical skills and be able to learn new skills as needed.

The Analytical Reasoning outcome is assessed through 1) the analysis of final exams as previously described; and 2) analysis of student work, also described above.

1) The sample student exams were studied by the Committee for evidence of mathematical reasoning and critical thinking. The exams are an excellent opportunity for this because the students are required to show their work, giving the Committee insight into their problem solving processes.

2) Examples of student work were studied for evidence of computational and experimental reasoning. For this year, computational projects from Phys 163 represented examples of student work.

Technical Skills – Physics students must be exposed to a broad range of technical skills and should become proficient in many.

The Technical Skills outcome is assessed primarily through analysis of student work. The only laboratory course in the rotation for assessment in AY 2010-2011 was Phys 145, which is a combination of theory and laboratory components. No examples of student laboratory projects were submitted from Phys 145.
**Communication Skills** – Students should develop the ability to clearly express their thinking in both oral and written form and to efficiently acquire new information from many sources.

The Communication Skills outcome is also primarily assessed through analysis of student work, including exams and senior project reports, both oral and written. While solving physics problems students must learn to communicate effectively using mathematical symbolism, and equally as important, learn to communicate in a narrative fashion the relationship between the mathematical and physical concepts the underlying mathematics is describing.

**Programmatic Assessment**

In addition to assessing particular student outcomes, the Assessment Committee also continued its broad look at the entire Physics program, to determine if the structure of the program facilitated student learning, and to determine if the students were achieving their own goals in Physics, be that admission to a graduate program, or entrance into a satisfying career path outside of academia. This year the Committee conducted exit interviews conducted with seniors who graduated either Fall 2010 or Spring 2011.

**Results and Discussion**

**Physics Knowledge**

The results from both assessments of Physics Knowledge indicate that Physics majors are meeting this learning goal.

1) Student final exam scores and course grades for the upper division courses Phys 110, 145, 162 and 163 show that nearly all physics majors demonstrated satisfactory levels of physics knowledge by achieving passing grades. Many students demonstrated excellent levels of physics knowledge by earning grades of B- or higher in these courses. Overall, about 70% of students earned grades of B- or higher. Only one student earned a grade of F in all of the courses being assessed this cycle, out of a total of 48 students enrolled in the four courses.

In the lower division course Phys 11A, the performance level was lower than in the upper division courses, but consistent with expectations and historical data, both at CSUS and nationally.

The calculus based physics series, of which 11A is the entry course, is to a large measure the testing and proving grounds for students of science and engineering. It is here that students with insufficient preparation in analytical reasoning or inadequate mathematics preparation fall short of expectations and often change majors. It is for this reason that much effort has been channeled into improving student learning and performance in this series, nationally and here at CSUS.

Overall, 92% of students enrolled at census date obtained grades of D- or better, and 82% C- or better. The latter is considered the more realistic "passing grade," so we have a "satisfactory
completion rate" of 82% in Physics 11A for AY 2010-11. As stated above, while not ideal, this rate is consistent with our expectations and well within the National range.

**Analytical Reasoning**

The results from both assessment measures of Analytical Reasoning indicate that Physics majors are meeting this learning goal.

1) Student exam scores and course grades for Phys 110, 145, 162 and 163 show that students have demonstrated Analytical Reasoning at the satisfactory level or higher. These grades reflect a combination of Physics Knowledge and Analytical Reasoning, which go hand in hand in the Physics major.
2) Examples of student computational projects from Phys 163 demonstrate that students have achieved high levels of Analytical Reasoning in the writing of the computer code to meet the goals of their individual projects. Analytical Reasoning is required in the writing of effective solutions to computational problems, as well as careful organization of the elements of logic, numerical calculations, and visualization.

**Technical Skills**

No examples of student laboratory work were submitted to the committee from the only lab course in the assessment cycle this year, Phys 145.

**Communication Skills**

The results of assessing Communications Skills through exams as well as written and oral project reports demonstrate good levels of communication through mathematical symbolism and technical writing (the latter demonstrated primarily in the written descriptions of computational projects in Phys 163).

**Programmatic Assessment**

**Senior Exit Interviews:**

The results of Programmatic Assessment through the senior exit interviews lend support to our previous results from the last three years that overall the Physics major is well structured and does facilitate student achievement in Physics.

The senior exit interviews of the graduating students resulted in wide ranging discussions using the pre-scripted interview questions as a starting point. The Committee reviewed audio recordings of each face-to-face interview to pull together a set of common themes, given here in no particular order:

- Students continue to be pleased with the very high level of accessibility of the faculty members. In particular, students who transferred from other institutions commented on
the very high level of interaction between faculty and students in the Physics program here.

- The AY10/11 graduates are the first to have been advised under the new departmental advising system. They all indicated that the advising was much improved over several years ago, and that the advice they received helped them in planning their undergraduate physics educations.
- All students expressed frustration with the lack of regularity in timing of upper division physics courses, both required courses and electives. They also commented that a wider variety of physics elective offerings would be highly desirable. They often also remarked that they understood resource limitations to be the cause of these circumstances.
- Students uniformly praised the laboratory courses (Phys 115, 116, 145, 175). Some of the graduates stated that the hands-on skills gained in lab courses would be a valuable asset in the workforce.
- Students found the senior project to be a valuable experience.

Closing the Loop

Last year the Assessment Committee made the following recommendations to the Department:

1) Examine the teaching of error analysis within the upper division curriculum to determine the best courses in which to strengthen this key scientific concept. No steps were taken by the department in AY 10/11 – this remains an on-going concern.

2) Revise the document given to students enrolled in Phys 191 (Senior Project) to emphasize the requirement that their work must be placed into the context of the underlying physics. The student handbook for the Senior Project was substantially revised during AY 10/11 and these new guidelines were incorporated.

Recommendations

Based on the analysis described above, the Committee makes the following recommendations to the Department for AY 11/12:

- Examine the teaching of error analysis within the upper division curriculum to determine the best courses in which to strengthen this key scientific concept.
- Continue and expand the practice of optimizing upper-division course rotations using student readiness data so as to afford the most timely offering pattern possible given the prevailing resources constraints.
- Initiate, as appropriate, an examination of our degree programs as well as assessment practices in response to the recommendations of the Program Review Team, expected in Fall 2011.

All members of the Assessment Committee felt that the review and analysis of the assessment data was a very helpful process and that it has provided a valuable look at the goals and
procedures of the Department. Following the recommendations outlined above will result in immediate and long-term improvements in the quality of our Physics programs. With the current report, all upper division courses in the Physics major have been assessed at least once.

Important assessment activities for the upcoming year include:

- The assessment cycle is now complete — all regularly offered upper division Physics courses have now been covered in an assessment report. Beginning next year we will start to have second assessments on some courses and can now examine the data for trends over time.
- Analyzing final examination and the course grade distribution for the following lower division Physics course: Phys 11C (an entry course for our majors).
- Empanelling the Student Assessment Committee in the Fall 2011 semester to make their biannual report to the Department.
- Continuing to collect and analyze senior project reports and the feedback forms from the oral presentations. This will be done in the spring semester for reports covering the entire academic year.
- The Department completed its program review in AY 10/11. Any feedback from the review team regarding assessment will be considered, and appropriate changes will be made to the Department’s assessment plan, as recommended above.

Assessment Materials on File

The following assessment materials used in the preparation of the 2010 report are kept on file in the Department of Physics and Astronomy office:

1) Audio recordings and transcripts of senior exit interviews.
2) List of questions used during senior exit interviews.
3) Examples of excellent, satisfactory and poor student work on final and mid-term examinations for Phys 11A, Phys 110, Phys 145, Phys 162, and Phys 163, for the academic year 10/11.
4) Syllabi for the same courses listed in (3) above.
5) Grade distributions for the same courses listed in (3) above.
6) Examples of excellent, satisfactory and poor student work in the computational projects assigned in Phys 163.