**2009 Physics Report**

**Step 1: Department/Program Mission**

The Physics Department at Albion College is committed to providing intellectually rich and challenging learning experiences for students as part of their preparation for their life’s work. We are a learning-centered community of students and faculty that seeks to make relevant, qualitative, and quantitative conclusions from observations of the physical world.

Our program has several specific goals, including 1) to provide a high quality major program with sufficient depth and breadth of study in the core areas of physics to enable students to pursue advanced studies in physics or engineering or to be successful in physics-related careers, 2) to provide high quality major and minor programs for secondary education certification and the elementary integrated-science program, 3) to provide cognate courses for students in other sciences, including biology, chemistry, geology, and health sciences, 4) to provide the physics curriculum for the dual-degree program in engineering, 5) to provide high quality physics and astronomy courses for the general education requirement, and 6) to provide faculty as participants in interdisciplinary courses and programs, such as the Honors Institute, the First-Year Experience program and the Environmental ‘Category’ requirement.

**Step 2: List goals/outcomes**

Note: This is draft updated plan, submitted to Assessment Committee as a substantial improvement to the currently approved plan.

**LEARNING GOALS FOR ALL AREAS**

1. Students in our program will develop proficiency in the theory and practice of physics as appropriate to their major, minor or program of study.

2. This proficiency will prepare students well for further education or careers as physicists, educators, or any other relevant life’s work.

**DESIRED OUTCOMES**

*Assessment Area: Physics major curriculum, Mathematics/Physics major curriculum*

**OUTCOME I.** Physics graduates will have knowledge required to participate in advanced research in Physics or related areas.

**OUTCOME II.** Physics graduates will have the skills necessary to participate in advanced experimental research in Physics or related areas.

**OUTCOME III.** Physics graduates will be able to clearly articulate theoretical and experimental concepts in oral and written presentations.

**Step 3: Identify program components**

**PROGRAM COMPONENTS**

See course matrix.

**Step 4: Select methods/data sources and instruments**

**QUANTITATIVE MEASURES AND/OR QUALITATIVE INDICATORS**

**ASSESSMENT I.** Physics graduates will receive scores on the Major Field Test which are consistent with national norms. Knowledge will also be assessed in introductory courses using pre-tests and post-test that have national benchmark standards. Admission to graduate and professional schools will be used as an indirect indicator of student preparation for advanced work, as will alumni surveys.

**ASSESSMENT II.** Physics graduates will have satisfactory performance on a skills test that is administered in Phys 350, *Advanced Laboratory,* and those who participate in advanced independent research experiences will have or will develop the skills necessary to participate in those experiences. Also, external evaluation of student preparatian for off-campus research experiences will be considered when available. Admission to graduate and professional schools will be used as an indirect indicator of student preparation for advanced work, as will alumni surveys.

**ASSESSMENT III.** Physics graduates will demonstrate proficiency in writing technical reports, in critically interpreting scientific literature and in delivering a technical oral presentation on primary or secondary scientific investigations.

**Step 5: Analyze and interpret the data**

**ASSESSMENT I.**

1. The results of the Physics Major Field Test (MFT) administered to 2009 graduating seniors were added to our database of previous MFT scores, and the compendium of scores for the years 2005-2009 were analyzed for consistency with national norms and for trends. These data show that our graduates achieve receive scores that rank between the 5th percentile and the 95th percentile when compared to the nationally derived distribution of scores, and that the 2008-2009 subgroup received scores that were consistent with the national average. The highest scores received by Albion students are clearly in line with the highest scores in the national distribution, which is derived from a mixture of students from smaller colleges like ours and students whom attend highly technical physics programs at major universities. As a point of reference, GLCA schools represented in the national cohort include Albion College, Kalamazoo College, Kenyon College, and Oberlin College. The average scaled score of our student cohort is 147.8, which is commensurate with with both the individual score mean of the national cohort (149.0), and the individual score median of the national cohort (147.0). We consider that this performance to be respectable, considering that some of our students included in the Albion cohort have admitted to not taking this un-"credited" test seriously, as previously reported. Additionally, since the national cohort includes senior students from universities which offer Bachelor of Science programs, the national cohort includes scores from students at some universities that require considerably more courseswork in Physics than the eight or nine course units in Physics that Albion students typically receive.

When we consider the MFT subscores, broken into "introductory" and "advanced" coursework categories, we note that our students perform slightly below the national average in more advanced or specialized areas in physics (Quantum Mechanics/Atomic Physics, Special Topics, and Optics) -- the mean percentile of the Albion cohort is 47.1 as compared to the national average of 47.8, and above the average in the introductory classical areas of physics (Classical Mechanics/Relativity, Electromagnetism) -- the mean percentile of the Albion cohort is 48.5, as compared to the national average of 46.9. Because the number of students included in the Albion cohort (N=11) is small, this difference is not significant. The standard deviation of introductory and "advanced" percentile scores for Albion students is 28.2 and 32.5, respectively, as compared with corresponding standard deviations of 16.0 and 15.7 for the national group (N=1730). The standard deviation of the mean of "introductory" and "advanced" percentile scores for Albion students is 8.5 and 9.8, respectively, as compared with corresponding standard deviations of the mean of 0.4 and 0.4, respectively for the national cohort.

An analysis of scores received in specific content areas reveals that the mean percentile of the Albion cohort in the area of Classical Mechanics and Relativity (75.0) is higher than the national mean (47.4), the mean percentile of the Albion cohort in the area of Electromagnetism (67.5) is above the national average (46.2), the mean percentile of the Albion cohort in the area of optics, waves and thermodynamics (36.7) is below the national average (40.6), the mean percentile of Albion students in the area of quantum mechanics and tomic physics (46.8) is slightly above the national average (46.0), and the mean percentile of Albion students in the area of special topics (36.7) is slightly below the national average (38.0). Because only the average of subscores in these areas in a given year is reported mfor Albion students, it is not possible to determine deviations, and thus it's difficult to make comparisions.

Given these results, we suspect that our introductory emphasis in classical mechanics, relativity, and electromagnetism, coupled with advanced coursework in these areas which we have offered every year until this year, has resulted in the apparently improved performance of Albion students in these areas. That our students seem not to do as well in the areas of optics and "special topics" (condensed matter, nuclear, laboratory methods, and Lagrange/Hamiltonian equations) is correlated with reduced advanced course offerings in these areas in recent years.

2. In addition to the assessment of graduating seniors, assessment of the first introductory course has been conduceted. The results of a pre-semester and post-semester national mechanics assessment test in Physics 167 for Fall 2008 were analyzed (see R.R. Hake, "Interactive-engagement vs traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," Am. J. Phys. 66, 64- 74 (1998).) The "gain factor" for our students, a performance indicator that is derived from pretest/posttest data, is consistent with the national norm for a physics classes with "traditional" instruction.

3. We also note that the three four-year majors who graduated this year were all accepted into national graduate schools. These include The University of Toledo (PhD, astrophysics), Northwestern University (M.S. electrical engineering), and the University of Tennessee (M.S. Mechanical Engineering). The continued placement of students in R1 graduate programs in Physics or Engineering at either the M.S. or Ph.D. level provides additional indirect evidence that students have requisite knowledge to participate in advanced research.

Data to support the above statements and findings are filed in the Science Complex office with the Physics Department secretary.

**ASSESSMENT II.** Anecdotal results of student performance in on- and off-campus research experiences indicate students are adequately prepared and meet or exceed their advisors' expectations. Three students had off-campus research experiences (at Oak Ridge National Lab, the National Renewable Energy Laboratory, and the Tank Automotive Development Research Center) while three additional students had significant on-campus research experiments. Of the students who had off-campus research experiences, feedback from off-campus research mentors was received on only one student and that feedback, while very positive, was verbal. Of the three students who had on-campus research experiences, the students had the requisite skills to conduct the required research.

Direct evaluation of student skills is not yet available from Physics 350, which will be offered for the first time Spring 2010. The continued placement of students in R1 graduate programs in Physics or Engineering at either the M.S. or Ph.D. level provides additional indirect evidence that students have requisite knowledge to participate in advanced research.

**ASSESSMENT III.** No assessment of student writing or presentation skills was made this year. This will be an integral component to Physics 350, our new advanced laboratory experience , which will be offered for the first time in the spring 2010 semester.

**Step 6: How will the data collected be used for decision-making, strategic planning, etc.**

It is difficult to know exactly how the data will be used for program planning purposes, but our approach to program planning is as follows:

1. The five-year database of MFT scores and improvement scores on national assessment measures for introductory Physics courses (Phys 167 and 168) form "baseline" data that we will use to evaluate the revised curriculum that we implemented this year. We also implemented "TabletPCs" in Phy 167 and 168 this year, and it is unknown to us how those will affect student learning in the future.

2. We are in the process of conducting an alumni survey that will provide feedback on the efficacy of our curriculum. For many years we have informally asked alumni for feedback on our curriculum, and their feedback has been taken into account in program planning. The implementation of written feedback will allow us to provide evidence of this.

3. As resources are available, we will continue to attend national workshops which focus on new approaches to teaching introductory and advanced coursework in Physics.

The committee to review assessment findings will be the entire department because our deparment is relatively small (4 faculty) and because it encompasses all of the areas in which the faculty have expertise. It doesn't make sense to us to form a smaller committee of the faculty. Since the department has assessment as one of its charges, the department will address assessment at its weekly meetings. Formal recommendations for assessment will come from the Chair of the department.