Student Achievement Assessment Plan

Physics Department
Hendrix College

June 8, 1998
I. Aims of Hendrix Physics Program

The discipline of physics has been a major influence on western culture since the seventeenth century, and it has influenced the cultures of the entire world during the twentieth century. The successes of the methodologies of the physical sciences have led to the assimilation of those techniques into many other areas of intellectual endeavor. The ways that physicists model the natural world has had a noticeable effect on the philosophical outlook of the entire world.

A major goal of the Hendrix Physics Department is to provide science and non-science students with an introduction to both the methodology of the physical sciences and the major models of reality developed in the physical sciences. We strive to provide all students with opportunities to understand and practice the methodology of the physical sciences. We also strive to provide students with a grasp of the historical development of models of the physical world, the experimental basis of these models, and how these models have impacted how humanity views reality.

A second major goal of the Physics Department is to provide Biology, Chemistry, and Mathematics students with the background in theoretical and applied physics necessary for their chosen field of academic specialization. Biologists and Chemists need to understand the physical laws of mechanics, electrodynamics, thermodynamics, and atomic physics that are crucial to their disciplines. Mathematicians need to see how mathematics is applied to the description of natural phenomena.

The third major goal of the physics department is to provide physics majors with an in-depth study in the field of physics. Our physics graduates should have a clear understanding of the experimental basis of all fundamental physical theories. They should understand the major theories and be able to explain how they follow from experimental results. We provide them with a panoramic view of the field of physics with enough detail to enable them to easily make connections with new information in physics, and thereby more readily assimilate new information. We expect that our students will understand the interrelatedness among different areas of physics. One of the most important aspects of our program for
majors is undergraduate research. We feel that students don't really understand the nature of the field of physics until they have practiced it, reported their results at a meeting involving students from other institutions, and compared the quality of their work with that of students at other institutions. Since we consider ourselves a national liberal arts college, this comparison should be at the national level.

II Assessment of Student Achievement

Assessment of student academic achievement in physics employs the following seven evaluation tools:

1.) course syllabi are maintained for all courses offered,

2.) samples of final examinations, laboratory reports, and student papers are maintained,

3.) grades assigned to students,

4.) student evaluations of course content and value,

5.) senior comprehensive examination,

6.) student presentations at national meetings,

7.) student focus groups and,

8.) success of graduates in obtaining graduate school acceptances, assistantships, or employment.

The department retains a copy of the syllabus for every regular course offered. Examination of these records reveals the material covered and the experiences provided in each course. Samples of final examinations and laboratory reports are retained for most courses. These provide insight into both the level of expectations and student achievement in the course. The grades assigned to all students in all courses are kept by the college registrar. At the end of most courses, students complete an
evaluation of how the course has contributed to their intellectual development. Syllabi, final examinations, laboratory reports, grades, and student evaluations are especially useful in courses for non-majors where other assessment tools are not so readily available.

The senior comprehensive examination is an excellent method of evaluating our majors' mastery of the concepts of physics. Two options are available to students for the senior comprehensive examination: they can either use the Advanced Graduate Record Examination Field Test in Physics (GRE), or take an exam prepared and administered by the department. We encourage students to take the GRE first (the school pays for it). If they are not satisfied with that score, they can take the department exam and use the higher of the two scores. About 75% of our seniors take the GRE. The advantage of encouraging seniors to take the GRE is that it provides us with a national comparison of our students' preparation.

Nearly all of our majors participate in undergraduate research while at Hendrix. All of these students present their results at national meetings of the American Physical Society or the National Conference on Undergraduate Research. In 1997 and 1998, 9 out of 10 graduates have presented results at one of these two meetings. Undergraduate research is a real test of students' understanding of physical concepts, their mastery of the methodology of the discipline, and their ability to communicate their ideas. Comparison of our students' presentations with those of students from other institutions provides an excellent evaluation of the Hendrix program for physics majors.

Every year, the department selects a faculty member outside the natural sciences to conduct a focus group with our graduating seniors to determine their impressions about our department. This evaluation tool provides useful insights into strengths and weaknesses of the program.

Finally, we keep records of what all our graduates do immediately after graduation. Although we are not dedicated to placing every graduate in graduate school, the success of those wishing to attend graduate school is another national comparison for our program.
Suggested Questions for Focus Group

1.) Some of the areas typically covered in undergraduate physics programs are listed below. How do you feel about your preparation in each of these areas?

   atomic physics (experimental foundations of quantum mechanics)
   condensed matter
   electricity and magnetism
   electronics
   general relativity
   mathematical methods
   mechanics
   nuclear physics
   nonlinear dynamics
   optics
   particle physics
   physics of waves
   plasma physics
   quantum mechanics
   special relativity
   statistical mechanics
   thermal physics

2.) Do you feel that you have a good view of how the different areas of physics connect to each other?

3.) To what degree did your study of physics at Hendrix develop or improve your analytical thinking and problem solving skills?

4.) Does the department provide an atmosphere conducive to cooperative learning? Did your participation in departmental activities help you feel that you were a member of a community of scholars?

5.) Were you provided with adequate hands-on laboratory experiences.

6.) Did your experience at Hendrix improve your ability to communicate your ideas about science?

7.) If you did research, in what ways was that experience useful?

8.) Do you have any suggestions for how we might improve our program?

9.) Are there things that we are doing that are especially effective? If there are, should we focus more energy on these things?

10.) Are there things that we are doing that we should change or discontinue?
RESPONSES TO FOCUS GROUP QUESTIONS

1) **Atomic Physics**: The students interviewed felt like the Modern Physics class was a good introduction to atomic physics. They particularly cited the appropriateness and quality of the experiments conducted in the class. Students also indicated that the class established good foundations for related sections of the GRE. Additionally the students felt that the course provided a good background for elementary quantum mechanics.

**Condensed Matter**: Not covered in curriculum.

**Electricity and Magnetism**: The students interviewed felt like they received a solid foundation in electricity and magnetism as part of their general curriculum.

**Electronics**: The students interviewed all indicated that the Electronics course was a “very special” course. They felt that the instructor and course content provided an excellent foundation in electronics. They also indicated that they gained some exposure in the Fundamental Physics II class.

**General Relativity**: Not covered in curriculum.

**Mathematical Methods**: The students interviewed felt that the math requirements and physics classes provided good exposure in this area. They indicated that Linear Algebra might be added to the list of required or at least “highly recommended” math courses. The students indicated that an independent study offered in Mathematical Methods was “great” and particularly cited the appropriateness of books and handouts.

**Mechanics**: The students interviewed felt that the Mechanics course offered by the physics department was exceptional. They felt that the course provided a basis for the entire discipline. They indicated that the course provided an excellent foundation for the GRE and actually took them to a level beyond that covered on the GRE questions. They also felt that the course would provide an excellent foundation for graduate work in physics.

**Nonlinear Dynamics**: Not covered in curriculum.

**Optics**: The students felt like they got some exposure in Fundamental Physics III but that this topic was not covered at a level consistent with the other areas in the discipline. Some students indicated that they would have taken a course if offered.

**Particle Physics**: The students interviewed indicated that they received no exposure in their physics classes. They indicated that they did receive minimal exposure in General Chemistry II.

**Physics of Waves**: The students interviewed indicated that they received good exposure to this topic in the Fundamental Physics II class. Additional exposure occurred in the Modern Physics and Quantum Mechanics courses.

**Plasma Physics**: Not covered in curriculum. The students were not even aware of this part of the discipline.

**Quantum Mechanics**: The students interviewed indicated good exposure to this topic in several courses including Quantum Physics I and II and Modern Physics. They indicated that they were well prepared for the GRE questions on this topic.
Special Relativity: The students interviewed indicated that the received some exposure in Fundamental Physics III and Electricity and Magnetism. They felt that this topic was not covered in the same depth as other parts of the discipline. They nevertheless indicated that they considered their exposure to be appropriate.

Statistical Mechanics: The students interviewed indicated some dissatisfaction with their exposure to this field. They felt that they needed more extensive exposure to be prepared for graduate study. They indicated that they would like to see a course offered.

2) It is my impression that the students interviewed were somewhat dissatisfied with the manner in which the different areas of physics were connected together in their curriculum. They indicated that they felt like they had excellent exposure to the core of the discipline but were unsure how well the different areas, particularly tangential areas, had been synthesized. They all considered the synthesis courses that were taught to be ineffective. They felt that the dual teachers were not organized and that some time was wasted. They all indicated that these courses would have been better if taught by a single instructor. All students felt that the approach adopted by Professor Barciaga was well suited for this type of material.

3) The students interviewed felt like the physics program at Hendix was extremely rigorous and did an excellent job in developing analytical thinking and problem solving skills. They felt that the program was totally adequate in this regard.

4) The students interviewed overwhelmingly answered this question in the affirmative. They felt that the professors in the department were well educated and extremely knowledgeable in their discipline. They considered their professors to be well prepared and genuinely interested in their students both academically and personally. They all cited the accessibility of faculty members and emphasized the importance of faculty/student interaction. I was particularly impressed by the camaraderie of the group and their pride in being physics majors. They indicated that in addition to receiving an excellent education they had a lot of fun during their tenure at Hendrix as physics majors. The group that I interviewed exuded a level of confidence, satisfaction with their academic attainments, and sense of belonging to a group of scholars that was truly remarkable. Congratulations on your accomplishments as a department in this area.

5) The students interviewed were satisfied with their laboratory experiences but indicated that they would like to see an expanded role for this part of their education. They felt that this was a very important part of the learning process.

6) The students all answered this question in the affirmative. They all appreciated the fact that they were strongly encouraged to make presentations at NCUR. They also cited other talks and classroom presentations that they had given. They also indicated that they profited from oral comps. I was particularly was surprised about this as our
students usually complain about our oral comps. Again, I complement you on the confidence, poise, and sense of achievement that you have instilled in your group.

7) The students interviewed all felt that they had profited significantly from their research experiences. They indicated that their research work was the “best” part of their Hendrix experience. They further indicated that they learned more from their research than from any other aspect of their education. They indicated that their research experiences stimulated their interest and gave them exposure to “real science”. They felt that they all profited from independent study courses that were outgrowths or extensions of their summer research. Additionally they felt that the research they did at Hendrix gave them exposure to special fields within the discipline. The students who are continuing their education with graduate study all indicated the importance of their research experiences as a motivational factor. All of they students displayed an attitude of confidence in their ability to do research. As noted above, they profited from their NCUR participation which was largely an outgrowth of their research experiences, Again, congratulations on the excellent job you are doing in this area.

8) The students interviewed felt that they derived no benefit from the required chemistry courses. With their level of arrogance and confidence noted above they felt that the intro chemistry courses were not up to the rigor of their physics curriculum. (I love the attitude of this group!) They suggested that the department might benefit from the implementation of statistical mechanics, biophysics and nuclear physics courses. No other suggestions.

9) Research, teaching, and quality of educators. See comments above.

10) Delete chemistry requirement. See comments above. The students also indicated that they would like to see better communication among faculty members in the department. They indicated that they sensed departmental tension in a recent departmental search.