Departmental Assessment Meeting: Report from Physics

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Summary of past decisions

Please summarize up to three departmental changes made since the last HLC visit (08-09) the impetus for those changes and any changes to information gathering about student development.

During the 2012-2013 academic year the physics department made several changes to the physics major designed to increase the major's flexibility, better accommodate increasingly varied student interests, and emphasize the hands-on nature of physics. The first change was to remove CHEM 120 General Chemistry II from the list of courses required for the major. This change seems to be common practice at comparable physics department's around the US and freed up space to institute a pool of elective courses that could be used to satisfy the major. The addition of an elective pool gives our students some freedom to tailor the major to emphasize their interests. Most of the courses added to the elective pool come from outside the department and included upper-level courses in mathematics and computer science as well as coursework in the education department. These changes allow our majors to more easily satisfy entrance requirements for engineering programs, dual-degree or otherwise; this is an area of increasing interest for our students over the last 10 years. The addition of the education coursework (EDUC 290 Science in Personal and Social Perspectives) was intended to help students with an interest in elementary or secondary education satisfy licensure requirements. (The education department no longer teaches this course so it has been removed from the elective pool.) As part of the major restructuring, we required the completion of PHYS 340 Electronics to satisfy graduation requirements. Previously students had to complete this course or PHYS 450 Directed Research to earn a physics major. The change was motivated by the desire to insure that all physics majors receive a hands-on, upper-level lab experience with scientific equipment. Research done by the broader physics community has shown that such experiences are very beneficial to students moving on to graduate work or technical work in the private or governmental sectors. Given the varied nature of faculty research interests in the department it was not possible to guarantee such an experience via completion of PHYS 450.

At planning meetings in the early 2010s the physics department committed to revising the introductory physics curriculum with a goal of incorporating modern content areas and an active learning pedagogy. In 2014-2015, Dr. Damon Spayde spent part of a year-long sabbatical (funded by the Dr. Brad P. Baltz and Rev. William B. Smith Odyssey Professorship) designing the new curriculum, generating materials, and implementing new hands-on experiences. The result was the first offering of PHYS 235/245 General Physics

I/II (Workshop) during the 2015-2016 academic year. This course is the first of its kind in the sciences at Hendrix. It meets three times a week for two hours at a time, rather than the traditional three one-hour-long lecture meetings plus three-hour-long lab. There is little to no lecturing by the instructor of record. Students work in small groups on a set of activities designed to help them discover physical principles for themselves. The activities are a mix of lab experiments, computer simulations, problem-solving, and group discussion. This active learning approach to the introductory physics curriculum has been closely studies by the physics education research (PER) community and shown to yield significantly improved learning outcomes for enrolled students. The new curriculum was piloted in 2015-2016 by Dr. Spayde who offered one section each semester of the two-semester sequence. In 2016-2017 the new curriculum supplanted the existing calculus-based sequence; each member of the department was able to teach one or more sections of the new curriculum.

As part of the preparation for the new introductory physics sequence, the department instituted a regime of pre- and post-test assessment of the introductory physics curriculum. At the beginning of each semester we administer a pair of conceptual and attitudinal surveys to every student enrolled in an introductory physics section. The same pair of surveys are administered again at the end of the semester. Analysis of survey responses provides the department with a measure of student learning that is independent of formally graded assessments. The surveys employed have been formally designed, tested, and verified by the PER community.

Looking forward

Please summarize your department's focus for student development and your evaluation methods.

Over the next academic year the department intends to assess and revise the new introductory physics course to make sure it is meeting the needs of our students. We will have access to our pre-test/post-test conceptual data to help in making decisions as well as more traditional tools of course assessment; e.g. end-of-course evaluations, performance on graded exams, etc.

Over the next few years we feel like we need to reevaluate our departmental learning goals particularly in light of the newly-articulated, college-wide Vision for Student Learning Goals. We will also be reevaluating our capstone experience.

Achieving departmental goals for students

Please explain how your departmental curriculum achieves your student learning goals, being sure to include the Capstone. Feel free to attach a curricular map or other supporting documents. Summarize the ways your department provides guidance in the effective use of research and information resources.

A few years back we mapped our departmental curriculum onto our existing learning goals. In the process of preparing this document we updated that curriculum map. The department learning goals and the curriculum map are located at the end of this document.

The physics department does not systematically provide guidance in the use of research and information resources. This is done piecemeal by certain instructors in certain courses.

Your department's role in achieving the college's shared goals for students

Please explain how your departmental learning goals contribute to the Vision for Student Learning Goals. Feel free to attach a map or other supporting documents.

Please see the attached document mapping the existing department learning goals onto the VSLG. The department's sentiment was that we could do a better job of tapping into more of the VSLG. This is part of the motivation behind revisiting department learning goals over the next few years.

Learning Goals for Physics Curriculum

1) 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.
   a) To provide all students with opportunities to understand and practice the methodology of the physical sciences.
   b) 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.
2) To provide Biology, Chemistry, Physical Chemistry, Biochemistry/Molecular Biology and Mathematics students with the background in theoretical and applied physics necessary for their chosen field of academic specialization.
   a) Biologists and Chemists need to understand the physical laws of mechanics, electrodynamics, thermodynamics, and atomic physics that are crucial to their disciplines.
   b) Mathematicians need to see how mathematics is applied to the description of natural phenomena.
3) To provide physics majors with an in-depth study in the field of physics.
   a) 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.
   b) 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.
   c) 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.

Learning Goal Matrix

	1a	1b	2a	2b	3a	3b	3c
PHYS 135 Robotics	✓	✓		✓	✓		
PHYS 160 Astronomy	✓	✓	✓		✓	✓	
PHYS 170 Earth Sciences	✓	✓					
PHYS 210 General Physics I	✓	✓	✓	✓	✓	✓	
PHYS 220 General Physics II	✓	✓	✓	✓	✓	✓	
PHYS 230 General Physics I (calc-based)	✓	✓	✓	✓	✓	✓	
PHYS 235 General Physics I (Workshop)	✓	✓	✓	✓	✓	✓	
PHYS 240 General Physics II (calc-based)	✓	✓	✓	✓	✓	✓	
PHYS 245 General Physics II (Workshop)	✓	✓	✓	✓	✓	✓	
PHYS 305 Waves & Vibrations	✓	✓	✓	✓	✓	✓	
PHYS 315 Modern Physics	✓	✓	✓	✓	✓	✓	✓
PHYS 320 Electrodynamics	✓	✓	✓	✓	✓	✓	
PHYS 330 Quantum Mechanics	✓	✓	✓	✓	✓	✓	
PHYS 340 Electronics	✓	✓			✓	✓	
PHYS 370 Thermal Physics	✓	✓	✓	✓	✓	✓	
PHYS 380 Classical Mechanics	✓	✓		✓	✓	✓	
PHYS 450 Directed Research	✓			✓	✓		✓
MATH 130 Calculus I	✓	✓		✓			
MATH 140 Calculus II	✓	✓		✓			
MATH 260 Differential Equations	✓	✓		✓	✓		
CHEM 110/150 General Chemistry I	✓	✓	✓		✓		
CHEM 120 General Chemistry II	✓	✓	✓				
CSCI 150 Foundations of Computer Science	✓	✓					
CSCI 385 Scientific Computing	✓	✓					
MATH 230 Multivariable Calculus	✓	✓		✓			
MATH 270 Linear Algebra	✓	✓		✓			
PHYS 490 Topics in Physics	✓	✓		✓	✓	✓	