INSTRUCTIONAL PROGRAM REVIEW : PHYSICS TRANSFER PROGRAM

1. Program Description and Scope:

The Physics Department at Ohlone College, in its transfer program, offers lower-division coursework in physics that satisfies in content and quality the requirements of the first two years of undergraduate study at UC, SCU and other universities. The two-semester sequence phys120/121 primarily serves the needs of biology/premedicine majors, whereas the three-semester sequence phys140/141/142 guarantees fulfillment of the lower division requirements in physics for most science/engineering programs at UC and SCU.

In conjunction with these physics courses, students are required to complete coursework in chemistry and mathematics in order to obtain Ohlone's A.S. Degree in Physics (a brochure detailing all coursework is available from the Division Office). The Physics Department maintains connections with the Chemistry and Mathematics Departments in order to synchronize or build more coordinated course content, and to discuss and agree upon academic standards. In addition, the Physics Department consults with the Engineering Department along similar lines, since the phys140/141 courses are prerequisites for some of the engineering courses.

Besides ensuring the quality of the physics transfer program, full-time faculty of the Physics Department are involved in identifying and addressing other needs and current technologies relying on physics. Survey coursework in physics is offered to meet general education requirements of students majoring in a variety of non-science disciplines or for non-degree seeking students. Starting in Fall 2007, an introductory course in nanotechnology is being taught by full-time physics faculty in collaboration with people from industry, as part of the biotechnology certificate program requirement, but also to meet general education requirements and/or stimulate general interest in this new and important technology.

2. Relationship to Ohlone College Mission and Goals:

The program is committed, in ways described below, to realize, in practice, several of the goals set forth by Ohlone College, in particular to the following:

Goal 2: Develop across the curriculum the Learning College Model, utilizing methods and technologies that hold the most promise for improving student course and program completion success rates.

and

Goal 3: Develop strategies to increase the proportion of full-time students including learning communities, cohort groups, enhanced facilities, and improved course availability.

The physics courses incorporate laboratory exercises in the coursework, to ensurethat physical concepts and theories are seen and experienced by the students in their applicability to the description and analysis of real processes. An ongoing effort exists to incorporate computer-aided data acquisition and process simulation into the program, besides more traditional methods.

The Physics Department seeks to enhance its lab facilities in collaboration with the Engineering Department (see section 5 for more details).

Lecture formats often deviate from the traditional ex-cathedra format, by integrating question-and-answer rounds, group discussions and workshops, experimental demonstrations, in-class website explorations, all of which aim at increased participation of the students.

Great efforts are made to cross-reference and link physics materials with topics in mathematics or chemistry, as well as engineering applications and new technologies. In this respect, it is worth mentioning that some of the physics full-time faculty deliberately involve themselves in the instruction of mathematics and new technologies, in order to enhance their scientific vision and to better assist their students in interdisciplinary ways of thinking.

Along similar lines, students in the physics program are expected to attend some of the brown bag seminars organized by the division, in order to broaden their scientific background and become lifelong learners.

The physics full-time faculty holds office hours in the Math Learning Center to increase students' awareness of the close connections that exist between these disciplines, to illustrate more effectively the integration of math and physics curriculum, to better reach and assist students who, often, focus on their math coursework at the expense of their science courses.

It is hoped that all of the aforementioned initiatives help the students understand and appreciate better that they are involved in completing a science program, in which each course is of fundamental importance, and that this understanding leads to better retention rates as well as completion success rates.

3. Program Student Learning Outcomes:

The students taking courses from the transfer major core programs of the physics department and the engineering department, enter these courses based on prerequisite knowledge in mathematics. The mathematics department has accumulated data during their instructional program review which clearly indicate "a disconnect between students knowing that prerequisite knowledge is important and then actually retaining that knowledge." In addition, the Transfer Level : Math/Science Subgroup reported, based on pretests administered to beginning Calculus101A as well as Calculus101C students, that "a significant percentage of Transfer Level Math/Science students are underprepared."

These conclusions come as no surprise to our faculty in the physics and engineering departments, as we observe acutely the lack of prerequisite knowledge throughout our curriculum, as well as the lack of retention of materials taught during first semester courses such as phys120 (biomed majors) and phys140 (engineering/science majors). The lack of preparedness is not just noticeable with respect to math skills, but, unfortunately, with respect to quantitative skills in general, as well as with respect to logical and verbal skills. Some of the cognitive shortcomings we notice in our classrooms pertain to:

- proper use of the English language (inability to write a sentence which is grammatically complete and correct ; frequent spelling errors ; unofficial language – coz, 4u -, ….)
- good logical insight (mixing categories - a speed cannot accelerate, an acceleration cannot speed up, energy and force are different physical entities, inertia is not a force, ….)
- correct memorization of scientific terminology and definitions
- firm grasp of orders of magnitude of physical quantities (size of atoms, distance Earth-Sun, magnitude of force needed to push a doorbell, …)
- solid understanding of numbers that can or cannot make sense in a given context (projectiles in lab experiments moving at 60 mph, speed of a wave on a string or rope equal to 300,000 km/s, …)
- sensitivity to sources of experimental error
- proficiency in solving algebraic equations and manipulating vectors
- aptitude in applying math to word problems (what are the variables, the parameters, the controls and the degrees of freedom in the word problem ; what is being solved for, and as a function of what)
- aptitude in extending calculus (in particular the theory of differential) to the calculation of physical quantities such as moment of inertia, work done by a force, electric fields due to charged objects, in which physical properties such as mass, charge are distributed over volumes rather than concentrated in points, or in which physical parameters are variable (variable force, variable mass/charge density, …)

In view of these findings, corroborated by those of the math department, our group had another look at the student learning outcomes formulated initially and reached the insight that *consolidation and integration of basic skills should be emphasized*, maybe at the cost of loftier SLO’s pertaining to the appreciation of how physics/engineering principles are at work in physical/biological/environmental reality, or pertaining to the integrated character of the scientific disciplines.

Undoubtedly, industry expects the workforce to possess solid basic skills and intellectual discipline, besides a positive work ethic. And the individual student can only become an independent learner and enjoy creativity in the possession of such skills.

To help realize these goals as educators in our respective departments, we have decided to focus on the implementation and assessment of the following SLO:

STUDENTS SHOULD RETAIN INFORMATION FROM COURSE TO COURSE

This SLO will be implemented and assessed in conjunction with the following SLO:

Students should build critical thinking and quantitative skills

This latter SLO will be - and most likely has been and is – consciously implemented by our departments on a daily basis in the following ways:

- instructors require proficiency in the correct formulation of fundamental definitions and their memorization; this knowledge could be tested at regular intervals during a given semester or across a sequence of courses
- instructors insist on precise and long-term understanding of fundamental concepts; reinforcement and deeper understanding of conceptual knowledge can be achieved by the instructor in the classroom by building up solutions to new problems from the "bottom up", thereby illustrating how these concepts allow one to deal with a wide variety of situations; such understanding could be tested for by the insertion of conceptual questions on tests as well as verbal justifications of solution procedures and quantitative steps
- instructors drill the appropriate mathematical use of and physical insight into fundamental laws and equations to solve integrated problems; once more, a "bottom up" demonstration to problem solving in lecture will instill in the student an intellectual discipline and solid basis for creative approaches; testing again should require verbal justification besides mathematical manipulation to verify the students' achievement in these skills

4. Assessment of Student Success in Reaching Program Outcomes:

ASSESSMENT OF INFORMATION RETENTION

The preferred assessment tool in our opinion is the use of combined pretest/survey.
In order to establish a baseline from which to judge the efficiency of our instruction, we propose the following:

For students entering physics120 or physics140 (starting Fall '07):

- a pretest will be administered to assess the prerequisite math knowledge; questions will focus on solving algebraic equations relating to physics word problems as they appear in textbooks of algebra, trigonometry and precalculus; also, a set of questions will address vector knowledge, using vector notations commonly encountered in trigonometry and precalculus textbooks after analysis of the results (a percentage scale indicating the level of mastery will be used for statistical purposes), the math department will be informed about possible caveats in the students' mathematical preparedness and a joint effort between the respective departments will be conducted with the aim of adjusting curriculum accordingly

- a survey (tentative version shown in Appendix, to be administered at the start of Fall '07) will be conducted in an attempt to verify the extent and quality of physical intuition that entering physics students possess in the field of mechanics; qualitative and semiquantitative answers will be sought, regarding linear and circular motion, forces, energy, fluids, as these topics connect to experience and observation to which each one of the students should in principle have been exposed in his/her lifespan

the results of this survey form the basis for comparison with a similar one conducted at the end of the first semester (at the end of phys120 or phys140);

the survey clearly serves a dual purpose: results provide indications supporting both a meaningful proactive approach that focuses on problematic areas, and a retroactive approach that allows instructors to judge the efficiency of the course

For students entering physics121 or physics141/142 (starting Spring '08):

- a survey will be conducted in an attempt to verify the extent and quality of physical intuition that these students possess with respect to electricity and the microscopic, atomic and molecular nature of matter; qualitative and semiquantitative answers will be sought regarding these topics; obviously not all of these topics connect to direct experience and observation, but questions will mainly be of such nature that students have to creatively apply their basic knowledge of mechanics -- that they hopefully retained from the previous physics course

the results of this survey will not only be compared with a similar one conducted at the end of the second semester (at the end of phys121 or phys141/142), but also with the end-of-semester survey of physics120 or physics140 students, in order to discern possible progress in physical reasoning and intuitive skills.

For students entering physics121 (starting Spring '08):

- a pretest will be administered to assess the prerequisite math and physics knowledge; questions will focus on understanding the meaning of and application of algebraic equations and vectors in applied mechanics problems;

the level of these applied problems will be the level encountered in the physics120 textbook; answers will be expected to contain a verbal as well as purely mathematical component

after analysis of the results (two percentage scales indicating the levels of mastery of physical intuition/verbal mastery and mathematical aptitude, respectively, will be used for statistical purposes), the physics department will be in a position to assess their efficiency in establishing a solid working knowledge of mechanics in physics120 and will adjust curriculum emphases accordingly; the math department will also be informed about possible caveats in the students' mathematical preparedness and a joint effort between the respective departments will be conducted with the aim of adjusting curriculum accordingly

For students entering physics141/142 (starting Spring '08):

- a pretest will be administered to assess the prerequisite math and physics knowledge; questions will focus on understanding the meaning of and application of limit, derivative and definite integral, in both purely mathematical context and applied physics problems; the level of these applied problems will be the level encountered in the calculus101A and calculus101B textbooks, as well as in the physics140 textbook; answers will be expected to contain a verbal as well as purely mathematical component

after analysis of the results (two percentage scales indicating the levels of mastery of physical intuition/verbal mastery and mathematical aptitude, respectively, will be used for statistical purposes), the physics department will be in a position to assess their efficiency in establishing a solid working knowledge of mechanics in physics140 and will adjust curriculum emphases accordingly; the math department will also be informed about possible caveats in the students' mathematical preparedness and a joint effort between the respective departments will be conducted with the aim of adjusting curriculum accordingly

5. Assessment of Program through Review of the Teaching Learning Process:

In preparation of this document, I have met and discussed with Linda Messia and Gary Mishra the need for sharing equipment for our respective laboratories. More than with the other scientific disciplines involved in the physics transfer program (chemistry, biology), physics lab equipment can be used in an engineering lab and vice versa. Of particular usefulness for a physics lab would be components from an electric circuits/ electronics lab (power supplies, electrical wiring, oscilloscopes, resistors, capacitors, inductors, devices to measure capacitance and inductance, …) or materials science lab (microscopes, materials inspection and testing equipment). An integrated physics/engineering lab space would probably be the best option to combine equipment and other resources of both departments.

In addition, the physics department is involved in developing curriculum in new technologies (nanotechnology/biotechnology). The acquisition of an atomic force microscope, and possibly, spectroscopic equipment, is a focus for future development of the program, no doubt in close collaboration with biology, chemistry and engineering, who could utilize this equipment equally well.

6. Assessment of Program Improvement since previous Program Review:

As this is the first program review document, this step will be implemented during the second program review cycle.

7. Description of Review and Dissemination Team Involvement:

The members of the Review and Dissemination Team are:

Dr. Ronald Quinta
Dean: Math, Science and Engineering Division

Yvette Niccolls
Program Coordinator: Math, Science and Engineering Division

Dr. Luc Desmedt
Professor of Physics

Dr. Jim Baxter
Professor of Biology

Linda Messia
Assistant Professor of Mathematics/Engineering

Dhaval Brahmbhatt
CEO PHYCHIP Corporation
Founder and Chairman Emeritus of IEEE San Francisco/Bay Area Nanotechnology Council

The SLOs were communicated by myself for discussion on at least two occasions which most of the science and engineering faculty, as well as dean Quinta, and program coordinator Niccolls attended.

The subsequent development of the present proposal was discussed in detail during two meetings with Linda Messia.

Written feedback was provided to Dr. Baxter and Yvette Niccolls.

Due to familial circumstances and absences thereby caused, I unfortunately was not able to create opportunities for further discussions with, in particular, Dr. Quinta and Mr. Brahmbhatt. Such state of affairs obviously does not preclude future, and much anticipated, exchanges of ideas.