Physics 180 / TEP 105: Teaching and Learning Physics

A course on how people learn and understand key concepts in electricity and magnetism. Readings in physics and cognitive science plus fieldwork teaching and evaluating K-12 students. Useful for students interested in teaching. Prerequisites: Physics 1A, 2A, 4A, or permission, May substitute for TEP 118. 4 Units.

The following document describes a one quarter, undergraduate course examining both key concepts physics and methods used for learning these concepts. This experimental course is designed to promote student interest in physics and education. Furthermore, it will address UCSD commitment to community outreach, and thirdly, it will develop research sites for an NSF sponsored study of undergraduate and pre-college student physics education.

Research studies increasingly demonstrate that while students master the mathematical formalism of introductory physics courses, many of them do not achieve a rigorous understanding of the concepts behind the formalism. Along with studies that measure students' conceptual grasp of physics, a growing body of literature now explores student learning in physics, their use of various cognitive strategies, and the contextual factors which enhance learning. This course will incorporate, address, and respond to these research studies.

Course Content:
This course will examine the key aspects of electricity and magnetism coupled with a study of research on learning physics. In- class readings and discussion will focus on learning physics concepts and educational research which informs such learning. Students will follow the structure of Halliday, Resnick, and Walker (or Hecht) and work problem sets similar to the pre-requisite introductory course. However, students will simultaneously be expected to analyze and critique the physics activities from a conceptual / pedagogical viewpoint, discerning the key physics concepts embedded in the problems and the cognitive strategies one uses to solve such problems.

During a laboratory component, students will be required to participate in fieldwork at a junior or senior high school-based science program where they will develop, test, and apply theories developed within the course. The explicit goal of undergraduate — pre-college student partnership is to bolster undergraduate conceptual understanding while introducing physics concepts to the younger students in informal, project oriented activities. Undergraduates will be expected to develop projects suitable, accessible, and informative for the pre-college students.

Course Structure:
A seminar style course will run 3 hours in two 1.5 hour sessions
The fieldwork will require 20 hrs at site, and will be arranged in coordination with student and site schedules. For students who wish to spend more time on the field component, funding is available to support extra student time at site. It is expected that the fieldwork will take place in the afternoon, during after-school hours.
Lab Sites: Earl Warren Jr., National City Middle School, Torrey Pines High, and UCSD labs
Student grades will be determined by an evaluation of class participation, homework, project development, and final papers.
Course Pre-requisites: Physics 1B,2B,or 4B, possibly Physics 11

Noah Finkelstein: nfinkels@ucsd.edu

NSF Research Study:
This course (in-class and laboratory) will form the basis of a research study to evaluate theories in cognitive development and learning strategies of both undergraduates and pre-college students. I hypothesize that by focussing on conceptual approach to physics, by studying and reflecting on cognitive strategies for learning physics, and by teaching these concepts to pre-college students, undergraduates will master and retain deep-seated concepts within this content area of physics. For instance, students often arrive to a basics physics course with only an intuitive or experientially based theory of physics. Through a study of electricity and magnetism and cognitive strategies which build on prior knowledge, this course will formalize student concepts in physics. Undergraduates' mastery of conceptual understanding in physics will be assessed before, during and following this course. Monitoring this group (and a control group of students with similar background in physics) will provide data to confirm or refute claims of student ability to grasp of physics concepts and mathematical acuity, and to study overall retention of both the mathematical formalism and the physics concepts.

Furthermore, the undergraduate participation in school-based, informal science programs will allow evaluation of theories of ability, interest, and strategies of junior and senior high-school students. Jointly, undergraduate and pre-college participants will be expected to develop and direct pre-college student projects in physics (with such overt goals as science fair participation). Less formal assessments, such as project and portfolio evaluation, will provide a direct measure of pre-college student ability and interest in physics. Undergraduate ethnographic fieldnotes and project development will comprise data for a formative evaluation of the project.

Physics Education Major:
The course is designed to be jointly offered by the Physics Department and Teacher Education Preparation program. Such a course is designed to foster student interest in majoring in physics, particularly the secondary school BA program. This course will serve two segments of the undergraduate physics student population - those interested jointly in physics and education, and those students who might benefit from additional work in introductory physics. However, there is broader potential for student participation including graduate students interested in education and teaching, and students in other scientific disciplines, such as chemistry and biology. The course will bridge traditional studies of physics with cognitive studies and education. It is designed to be offered as a specialized elective within the Physics Department and as a substitute for the TEP 118 cognitive development class.

more information at: http://communication.ucsd.edu/LCHC/nfinkels/Physics180.html