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A New Course Promoting Science as a Way of Knowing

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Organization: University of Maine

A New Course Promoting Science as a Way of Knowing

Project Participants

Senior Personnel

Name: Dowse, Harold
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

Organizational Partners

Other Collaborators or Contacts

Dr. Eleanor Groden, Assoc. Prof., Co-taught the course for two years
Mr. Kevin Tracewski, Instructor, ran the laboratories
Ms. Nancy Curtis, Instructor, helped develop the laboratories
Dr. Becky Talyn, TA, helped develop laboratories

Activities and Findings

Project Activities and Findings:
The new course was designed from the ground up to demonstrate in a convincing way that the scientific method is the most objective, self-correcting way of knowing. This funding was used to establish the laboratory portion of the course. The core is biology, but other disciplines are introduced, providing a focused introduction to the scientific method. A select set of connected subjects were chosen for general interest, potential for exciting laboratories, and social relevance. We demonstrate the practical utility of critical thinking, experimental design, careful data collection, and objective analysis. A high degree of showmanship in laboratory is necessary and appropriate. Labs were proposed, blocked out, revised, and written up. The primary task then was to offer the course the first year, collect feedback on the laboratories, and then revise them, supporting those that worked best, improving those that were promising but not quite on the money, and eliminating those that were inappropriate for our clientele. Improving the way the labs are offered is a constant work in progress.

Project Training and Development:
The course was offered the first year to freshmen with the idea that it would draw off those students who normally would take our BIO100 course, which is an introduction to biology for those going on in science, or at least who need this course as a prerequisite for a program or further courses like Anatomy and Physiology. The premise is that these students will need a different approach to understanding science in general and biology in particular. The course was developed by the PI, Dr. Harold Dowse and another Associate Professor in the Biology Department, Dr. Eleanor Groden. In addition, the department assigned considerable resources to the project, including a full-time Instructor, Mr. Kevin Traceski, who is responsible for the laboratories in all our introductory courses, a part time Instructor, Ms. Nancy Curtis, who worked exclusively on this project for half a year, and a graduate student, Ms. (now Dr.) Becky Talyn, who worked with us on development of the labs.

We started with the laboratories initially proposed in the application, and developed them in detail, focusing on practical matters of

implementation, a lab book, and a set of notes for the TAs to use when teaching. Mr. Tracewski developed a coordinated plan to get materials, etc. in place in time for the course to begin in the spring of 1999. Because of the perceived niche the course was to fill in the curriculum, it was heavily enrolled the first year, nearly 300 students. Five TAs were assigned to the course that spring, and the course was coordinated by the PI, with Mr. Traceski coordinating the laboratories and supervising the TAs.

The textbook consisted of a custom published collection of book chapters and writings from the literature, including such classics as 'The tragedy of the commons' by Hardin. This allowed us to pick and choose the non biological subjects carefully, and emphasize topics from other disciplines relevant to the biology portion, which predominated. An example is our coverage of the age of the earth, one of the hot button topics of pseudoscience. We presented enough basic geology and nuclear physics to talk about relative and absolute dating methods, and did an experiment on the half life of an isotope in laboratory. This was one of the most popular lab exercises.

The course went well the first year, but there were a number of problems with laboratories that stemmed partly from the fact that it was being offered for the first time. There are matters of scale that are hard to assess. For example, in the bacterial transformation lab, over a thousand agar plates had to be poured. Not all the labs proposed could be run as originally conceived, and were altered before being offered as feedback from the students and TAs began to return. TAs were asked to keep careful notes on how there labs went, noting strong points, weak points, and general student interest and reaction to the exercises. Even during the first year, this was useful in revising upcoming labs. The laboratory handouts for the second half of the semester were withheld until adequate alterations could be made.

A number of important lessons were learned in the first year, and during the summer the lab exercise book was rewritten, the suggestions of the TAs and Mr. Tracewski being used to their full advantage. Several laboratories were totally scrapped, and adjustments were made to use remaining funding to support fully those that worked best, and strengthen those with possibilities. Fortunately, owing to conservative spending the first year, no equipment was purchased for laboratories that were subsequently abandoned as unworkable. A complete set of revised laboratory exercises, as used in the spring of 2000, will be sent under separate cover to the appropriate parties.

One other finding was critical to the excellent student ratings the course achieved in its second year was our decision to target a more mature clientele. We renumbered the course BIO222, from BIO110, to reflect the rigor involved. This was never meant to be a course devoid of hard work. This targeted second-year and above students. The material is somewhat less taxing than is found in the sister course, BIO100 for mainstream science students. This is normally taken in the first semester by these students, but non science majors found the material too difficult for their first year. After a year of seasoning, they seemed better able to follow the material. This lowered the numbers of students enrolling considerably, as we had exhausted the pool the first year, and asked that academic advisors not recommend the course to first year students. We expect a dramatic increase in enrollment in the spring of 2001 as the next pool of students enters their second year.

Development of the laboratories will continue, and lectures will be revised, but the course is essentially a success, with satisfied students.

Laboratories offered in the second year (substantially revised from the initial offering):

'Critical Thinking' We introduced the use of the computer for data analysis, covered basic statisics, and did a series of experiments testing whether extra sensory perception could alter the outcomes of random processes.

'Time out of mind' The age of the earth, and radiometric dating.

'Biochemistry' Experiments with enzymatic reactions

'Cell biology' Introduction to cells and tissues

'Molecular biology' Transformation of E.coli.

'Reproduction' Embryology of the sea urchin

'Respiration'

'Bacteria and disease transmission'

'Photosynthesis'

'Transgenic plants and insect behavior'

'Ecology. parts I and II'

'Field trip' Botany, Zoology, and natural history of the Maine forest

Research Training:

The course developed with these funds provided substantial opportunity for the development of teaching skills among faculty and graduate student Teaching Assistants. The PI had considerable experience with teaching large introductory courses prior to developing this course, but this was the first time he worked with large numbers of non-science majors, and reaching them required careful review of known practice before the course could be developed. His colleague in the course, Dr. Groden had taught a course for non-majors, but the numbers were much smaller. Thus she developed skill in lecturing to large classes. Developing the laboratories was the only assignment for a half-time Instructor, Ms. Nancy Bray, when she was first hired. She expended considerable effort on the project, and developed a number of skills in managing laboratories. A graduate TA helped Ms. Curtis, and also learned a lot about course development, a skill she will need in her academic career which she is just now beginning after completing her Doctorate this past spring.

Outreach Activities:

Given that the entire clientele of the course consists of non science majors, their participation serves to spread information about science as it is practiced, as opposed to seen in sensational movies and television. When Richard Dawkins came to speak here, at the invitation of the graduate student who had been instrumental in helping to develop the laboratories, we offered extra credit to the students for their attendance.

We have made our computer cluster available for summer Upward Bound students doing a summer with science.

Journal Publications

Books or Other One-time Publications

Dowse, H., E. Groden (Eds.), "Biology, the Living Science", (1999). *Book*, Published
Editor(s): Dowse, H.B and Groden, E.
Bibliography: Simon and Schuster Custom Publications

Curtis, N., K. Tracewski, E. Groden, and H. Dowse, "Biology: The Living Science. Laboratory Manual", (2000). *Laboratory Manual*, In-House publication
Bibliography: Produced in-house by the University of Maine press

Web/Internet Sites

URL(s):

Description:

Other Specific Products

Contributions

Contributions within Discipline:
This course is our contribution to development of a curriculum for non-science majors which would allow the presentation of science as not only an objective tool for describing the natural world, but as an inherently interesting subject worthy of study for its own value. Our successes and failures in this endeavor should be of use to others in their own attempts. We intend to summarize our experiences, note our problems and their solutions, and make all of this available in an article in a suitable education methodology journal. We expect that it will take a few more years for enrollment to stabilize, and for the laboratories to achieve the sort level of polish needed to make the findings relevant.

Contributions to Other Disciplines:
We chose a multidisciplinary approach to the course, starting with the Copernicus/Galileo/Newton revolution, and Newton's 'rules of reasoning'. We progress then to elementary geology, and the age of the earth, with enough nuclear physics to make radiometric dating understandable. The laboratory exercise includes measuring the half-life of an isotope. Thus, we show the inter-relateness of disciplines. One cannot speak of photosynthsis without the physics of light as a partner. Biological molecules must be understood in the context of elements and inorganic molecules. The scientific disciplines are shown to be linked in another critical way, namely the commonality of the scientific method.

Contributions to Human Resource Development:
Many of the students passing through this course are from our College of Education, and are on their way to becoming teachers in the Maine school system. By demonstrating the power of science to them, and capturing their interest, we feel we are likely to have a very positive impact on their future careers. Even though they will not teach science classes, the anti-science bias so common in our society needs to be fought most critically by non-scientists who have a real working knowledge of how it works.

Additionally, the networked computer cluster purchased for this course by this grant is maintained throughout the year, and Upward Bound students, working on science projects, have benefited directly from the use of these fine machines.

Contributions to Science and Technology Infrastructure:
As noted earlier, the computer cluster set up for this course is used at other times of the year. It is on the Net, and has browsers installed. It has been used for a graduate-level course in computer modeling of evolutionary genetics, biometry, and a graduate population genetics course offered by the School of Marine Sciences.

Beyond Science and Engineering:
It is exptected that non-scientists will decide with their votes on such issues as genetically engineered agricultural products. We conduct a lab on genetic engineering. The students do a bacterial transformation, producing an ampicillin-resistant strain by inserting a plasmid. Later, they look at the resistance of potato plants engineered to produce the insecticide Bt to the Colorado potato beetle. This is just one immediately relevant example. One hopes that their understanding of the process along with its pros and cons will increase the likelihood that they will vote based on something other than the politician who can shout the loudest.

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