ENTOMOL 7910: The Nature and Practice of Science

Course Description and Syllabus: Spring 2014

Section: 29727

Credits: 2

Time: Thursdays, 2:20-4:10 pm

Location: 244 Kottman Hall, Columbus video-linked to 121 Fisher Auditorium, Wooster Campus

Instructor:

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Course Description: The course explores the analysis and application of logic underlying scientific reasoning and science as a human endeavor. The application of concepts to the participant's own graduate research is emphasized.

The first half of the course provides in-depth structural and functional analysis of the scientific method, including contrasting philosophical views, interrelationships of functional components (discovery, empirical observation and pattern detection, theoretical explanation, prediction, and tests), role of inductive and deductive logic in hypothesis testing, and integration of logic with experimental design and statistics.

The second half of the course focuses on science as a human endeavor including creativity, evaluation of scientific productivity including attribution of credit and reward, ethical issues in research and scholarship, and social issues such as women in science. The goal is to engage participants in critical examination of what science is, how science should be done, and the contribution of their research to the larger picture of accumulation of knowledge and ethical obligations of scientists. The course is structured around discussion of carefully chosen readings. Evaluation is based on class participation in these discussions, as well as written assignments that require students to apply subject matter to analyses of primary literature and their own research. The course is targeted towards graduate students conducting independent research, and experience has shown that the course is as beneficial for students beginning their M.S. program as it is for senior Ph.D. students.

Abbreviated Description: Analysis and application of logic underlying scientific reasoning, theory, hypothesis, and their integration with experimental design, discovery, ethics, and science as a human endeavor. Recommended for graduate students conducting independent research.

Evaluation: Course evaluation is based on participation in discussion of the assigned readings, and written exercises that apply readings and discussion topics to the primary literature and participant's own research. Your contributions to discussions should (1) demonstrate that you have completed assigned readings, (2) share original thoughts about the reading, (3) advance rather than stifle open discussion.

Course objectives:

- Engage participants in critical examination of what science is, how science should be done, the contribution of their research to the larger picture of knowledge accumulation, and ethical obligations of scientists.
- Provide in-depth structural and functional analysis of the scientific method, including contrasting philosophical views, and interrelationships of functional components (discovery, empirical observation and pattern detection, theoretical explanation, prediction, and tests).
- Understand the role of inductive and deductive logic in hypothesis testing, and integration of logic with experimental design and statistics.
- Focus on science as a human endeavor including motivations of scientists, creativity, evaluation of scientific productivity including attribution of credit and reward.
- Examine ethical issues in research, scholarship, and application of scientific knowledge.

Course content:

- Address the question of what is science; philosophical views of accumulation of scientific knowledge; role of inductive and deductive logic in scientific reasoning.
- Integrating scientific logic with experimental design and statistical analysis; role of theory in accumulation of scientific knowledge.
- Issues of scientific discovery, creativity, and innovation and their intersections with evaluation of scientific productivity, including scientific metrics.
- In-depth case study of a contemporary scientific issue as a focal point for an examination of ethical issues in scientists' motivations and actions in regard to research, scholarship, and extension of knowledge into society.
- Introduction to and applications of tools for inquiry in the "grey area" where science meets society.

Schedule and Reading List

Jan 9: What is science (or, does motorcycle maintenance count)?

readings: Pirsig, R.M. 1974. *Zen and the Art of Motorcycle Maintenance*, pp. 92-96. Bantam Books, Toronto.

Assign Exercise 1: Develop and write a metaphor for science

Jan 16: Philosophical Views of Accumulation of Scientific Knowledge

readings: Kuhn, T.S. 1982. Logic of discovery or psychology of research. **In** P. Grime, ed. *Philosophy of Science and the Occult.* SUNY Press, Albany, New York.

Popper, K.R. 1982. Science: conjectures and refutations. **In** P. Grime, ed. *Philosophy of Science and the Occult.* SUNY Press, Albany, New York.

Jan 23: Role of Inductive and Deductive Logic in Scientific Reasoning

reading: Giere, R.N. 1981. Justifying Scientific Theories. **In** *Understanding Scientific Reasoning*, 2nd ed (chapter 6, pp. 96-136, Holt, Rinehart, & Winston. New York.

Assign Exercise 2: Compose an essay that integrates vocabulary of philosophy of science

Jan 30: Integrating Scientific Logic with Experimental Design and Statistical Analysis

reading: Underwood, A.J. 1990. Experiments in ecology and management: their logics, functions and interpretations. *Aust. J. Ecol*. 15:365-389.

Feb 6: The Concept and Value of Falsification: class participation exercise

readings: Platt, J.R. 1964. Strong Inference. *Science* 146:347-353.

Feb 13: Role of Theory in Accumulation of Scientific Knowledge

readings: Lewis, R. 1990. Theories, speculation, and the structure of knowledge. *Speculations in Science and Technology* 13:13-17.

Lewis, R. 1994. Organizing the rules of nature. unpublished manuscript.

Loehle, C. 1987. Hypothesis testing in ecology: psychological aspects and the importance of theory maturation. *Quart. Rev. Biol*. 62:397-409.

Feb 20: Logical analysis of the primary literature: examples

Assign exercise 3: Analyze logical structure of two journal articles of your choosing

Feb 27: Discovery, Innovation, and Social Aspects of Science

Case study: NOVA video "Penicillin: Rise of a Wonder Drug."

readings: Fleming, A. 1929. On the antibacterial action of cultures of a penicillium, with special reference to their use in the isolation of *B. influenze*. *British Journal of Experimental Pathology* 10:226-236.

Root-Bernstein, R.S. 1989. How scientists really think. *Perspectives in Biology and Medicine* 32:472-488.

Loehle, C. 1990. A guide to increased creativity in research - inspiration or perspiration? BioScience 40:123-129.

Mar 6: Evaluating Scientific Productivity: Count or Weigh?

readings: Leary, R.A. 1985. A framework for assessing and rewarding a scientist's research productivity. *Scientometrics* 7:29-38.

Kuyper, B.J. 1991. Bringing up scientists in the art of critiquing research. *BioScience* 41:248-250.

Rosenzweig, M.L., J.I. Davis, & J.H. Brown. 1988. How to write an influential review. *Bull. Ecol. Soc. Am.* 69:152-155.

Waser, N.M., M.V. Price, & R.K. Grosberg. 1992. Writing an effective manuscript review. *BioScience* 42:621-623.

Assign exercise 4: Analyze logical structure of your research program

Mar 13: Spring Break

Mar 20: Women in Science: Panel Discussion

Mar 27: Scientific Ethics: Ethics in Research

readings: Sigma Xi. 1986. *Honor in Science.* Sigma Xi, The Scientific Research Society. New Haven, CT.

Gifford, F. 1994. Teaching scientific integrity. *The Centennial Review* 38:297-314.

Apr 3: Scientific Ethics: Ethics in Scholarship Including Authorship

Apr 10: Scientific Ethics: Case Study

Apr 17: Scientific Ethics: Ethics in Application of Scientific Knowledge and the Role of Scientists

readings: TBD: topical subject focused on interactions between science and society