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Psych 440 / Honors 440: Psychology of Science (Spring, 2005)

Required Text:

Gorman, Michael E., Tweney, Ryan D., Gooding, David C., & Kincannon, Alexandra P. (Eds.) (2005). Scientific and technological thinking, Mahwah, NJ: Lawrence Erlbaum Associates.

Recommended Texts (At least one from the following list):

Sacks, Oliver (2001). Uncle Tungsten: Memories of a chemical boyhood. New York: Knopf.

Sobel, Dava (1996). Longitude: The true story of a lone genius who solved the greatest scientific problem of his time. New York: Penguin.

Feynman, Richard P. (as told to Ralph Leighton) (1985). "Surely you're joking, Mr. Feynman": Adventures of a curious character. New York: W.W. Norton.

Hickam, Homer (1999). Rocket boys: A memoir. New York: Dell Publishing Co.

Course Goals:

This course will be an introduction to the scientific study of scientific thinking, using methods derived from recent cognitive science. Laboratory and field procedures for studying selected components of scientific thought (e.g., hypothesis testing, anomaly resolution, model-based reasoning) will be introduced and applied. The course fulfills the psychology laboratory requirement for psychology majors, and has a prerequisite of Psychology 270 (Quantitative Methods) and Psychology 290 (Research Methods) for majors. For non-psychology majors, laboratory experience in one or more of the sciences is required, along with permission of the instructor.

Because the class varies in knowledge about science, we will necessarily have to follow somewhat different paths in exploring these issues. Those who have had a series of biology courses, for example, may be called upon to help those of us without such background to understand what the discovery of DNA is really all about. Everyone, regardless of background, will be expected to bring aspects of their own thinking to the discussions! This follows from the fact that, for all of us, the meaning of science is important.

Course Requirements:

The primary requirement is your own critical reading of the assigned material, the synthesis of your own reasoned and knowledgeable views about the meanings of science and scientific thinking, and the communication of those views to others. All students will be expected to take reading notes, which may be used during quizzes, and which will be collected from time to time.

In-Class Quizzes (& occasional homework assignments) will be given from time to time and will take two forms; reading checks, given at the beginning of a class (to ensure everyone is keeping up with the readings) and discussion checks (given at the end of a class, to ensure everyone is actively participating in class discussion).

A term paper, based upon a scientific episode of your choosing, will be required.

Reading Assignments

What is science? From Observation to Explanation

Thagard, P. (2005). How to be a successful scientist. In GTGK, pp. 159-172.
Feynman, Richard P. (1985). Cargo cult science. (Adapted from the 1974 Cal Tech Commencement Address). In Richard P. Feynman (as told to Ralph Leighton), “Surely you’re joking, Mr. Feynman!” Adventures of a curious character. (pp. 338-346). New York: W.W. Norton & Co.

I. Seeing the World

“Noticing”

Shrager, J. (2005). On being and becoming a molecular biologist: Notes from the diary of an insane cell mechanic. In GTGK, pp. 119-136.
Tweney, R. D. (1985). Faraday's discovery of induction: A cognitive approach. In D. Gooding & F. A. J. L. James (Eds.), Faraday rediscovered: Essays on the life and work of Michael Faraday, 1791-1867. (pp.189-210). New York: Stockton Press/London: Macmillan.

Observations & Data

Fleck, L. (1935/1979). Genesis and development of a scientific fact. (trans. by F. Bradley & T.J. Trenn). Chicago: University of Chicago Press. Prologue & Ch. 1 (pp. xxvii-xxviii & 1-19).
Popper, K.R. (1962/1981)). Conjectures and refutations. London: Routledge & Kegan Paul. Selection: The myth of inductive hypothesis generation, in R.D. Tweney, M.E. Doherty, & C.R. Mynatt (Eds.), On scientific thinking. New York: Columbia University Press, pp. 72-76.

Mynatt, C. R., Doherty, M. E., & Tweney, R. D. (1978). Consequences of confirmation and disconfirmation in a simulated research environment. Quarterly Journal of Experimental Psychology, 30, 395-406.

II. Intervening in the World

From Trial & Error to Experimentation

Klahr, D. (2005). A framework for cognitive studies of science and technology. In GTGK, pp. 81-95.

From Experimentation to Simulation

Simon, On the logic of simulation. [Selections from *Models of my life*]

Scientific Artifacts

Tweney, R.D., Mears, R.P., & Spitzmüller (2005). Replicating the practices of discovery: Michael Faraday and the interaction of gold and light. In GTGK, pp. 137-158.

III. Representing the World

Graphs & Diagrams

Gooding, D.C. (2005). Seeing the forest for the trees: Visualization, Cognition, and Scientific inference. In GTGK, pp. 173-218.

Equations & Mathematics

Tweney (unpublished), Chapter on Math

Kurz, E.M. (1998). Representation, agency, and disciplinarity: Calculus experts at work. In M.A. Gernsbacher & S.J. Derry (Eds.), Proceedings of the twentieth annual conference of the Cognitive Science Society. (pp. 585-590). Mahwah, NJ: Lawrence Erlbaum Associates.

IV. Explaining the World

Perception, Analogy

Trickett, S.B., Schunn, C.D., & Trafton, J.G. (2005). Puzzles and peculiarities: How scientists attend to and process anomalies during data analysis. In GTGK, pp. 97-118.

Causation

Dunbar, K. N. & Fugelsang, J.A. (2005). Causal thinking in science: How scientists and students interpret the unexpected. In GTGK, pp. 57-79.

Model Based Reasoning

Bradshaw, G. (2005). What's so hard about rocket science? Secrets the rocket boys knew. In GTGK, pp. 259-276.

Ippolito, M.F. (2005). Problem representation in Virginia Woolf's invention of a novelistic form. In GTGK, pp. 219-258.

VI. Science in Culture and Society

Scientific Communities: "On the Shoulders of Giants"

Nersessian, N.J. (2005). Interpreting scientific and engineering practices: Integrating the cognitive, social, and cultural dimensions. In GTGK, pp. 17-56.

McCauley, R.N. (2000). The naturalness of religion and the unnaturalness of science. In F.C. Keil & R.A. Wilson (Eds.), Explanation and cognition (pp. 61-86). Cambridge, MA: MIT Press.