EDC&I 571U: Exploring the Gap Between Science Education and the Practice of Science

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Spring 2004 Thursdays 4:30 to 6:50pm Miller 112A

Prof. Philip Bell
312F Miller Hall
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OH: Tues, 3:30 to 5:30 (sign-up on the door)

COURSE OVERVIEW

Every one of us is regularly bombarded with a variety of discrepant images of science, ranging from highly structured and hyper-logical investigations found in classrooms and curricula to whirlwind and immaculate accounts of brilliance associated with scientific breakthroughs as found in movies and books to tales of perseverance, serendipity, and adventure in documentaries of scientific discovery. How do individuals piece together an understanding of the complex nature of science from all of these discrepant images? How have scholars from different intellectual traditions come to understand the complex nature of science? Specific educational questions follow. What are the latent and the desired gaps between science education and our understanding of the nature of science at the beginning of the 21st century? What are the points of confluence we might wish to promote for specific reasons, and how might that be achieved? Specifically, what images of science *should* we be providing to students in instruction and in their everyday cultural experiences in order to deepen their understanding of the purposes and practices of science given its complex role in our society?

In this seminar we will inquire as a group into the relationship between the purposes and forms of science education and the nature of science. In addition to hearing from natural scientists, we will review a range of conceptual frameworks and perspectives from cognitive psychology, philosophy, anthropology, history, sociology, and linguistics that present specific images of scientific practice, thinking, and influence. We will leverage our collective experience and interests to delve into the educational implications and manifestations of these different images of science — or try to understand their absence from the typical school day (e.g., why is scientific controversy typically absent from the science curriculum?). We will also concern ourselves with issues of epistemology—what images of science are embedded in the range of people's everyday life experiences and how do they make sense of those discrepant images of science? We will foreground the public's understanding of the nature and purposes of science in contemporary society and highlight specific research agendas for science education.

CLASS ASSIGNMENTS

1. Class Participation. All class members are expected to read the assigned readings and actively participate in the discussions each week.

2. Volunteer Reading: You will be asked to read, summarize and lead a brief discussion on any *one* of the readings listed in the syllabus as "volunteer readings." In consultation with the instructor, you can also arrange to select a different reading for this purpose.

3. Small Weekly Assignments: In addition to our discussions, we'll spend a bit of time each week actively exploring the gap between science education and the nature of science through small, specific assignments. I've listed a number of possible assignments below, but these are things we can map out together as a group in order to best leverage our collective intelligence and to explore to issues that emerge from our discussions. Some potential assignment ideas include:
    a. *Systematic observation of disciplinary scientific activity:* You might attend a departmental lecture somewhere on campus, hang out in online science community, or arrange to visit an active research group. Your role is to carefully observe and describe the activity that takes place in the setting— what is being accomplished, the nature and purpose of epistemic practices, the focus of discussions or individual work, the norms for interaction or data analysis, the interpretation of specific scientific work, etc.).
    b. Survey the presence and representation of science in cultural media products: Here we would document where "science" shows up in the world for specific groups or the citizenry at large by carefully analyzing specific print, video, multimedia, or Internet resources. The focus is on understanding the representation of science in dominant cultural products.
    c. *Adopt and describe a scientific controversy:* These contentious topics might be historical or contemporary, occurring on the public stage or within specific scientific communities, enduring moral questions related to scientific inquiry or tractable problems that will ultimately be settled, or disciplinary or interdisciplinary.
    d. *Journal and Bibliography Search:* What existing publications or collections exist that intersect with the themes of the course? These resources will be added to our community blog.
    e. *Bibliography for Final Paper or Proposal:* Each of you will be asked to compose a final research paper or proposal. This bibliography would be specifically associated with your culminating project.
    f. *Self-document personal, everyday encounters with "science" over a brief period of time:* How many discrete images of science do we each encounter in our everyday activities? How do we interpret these different images? Such recordings could be interpreted from the perspective of understanding our folk epistemologies. We could each engage in self-documentation and perhaps we can locate and train volunteers to self-document their "science encounters" as well.

4. Final Research Paper or Proposal (8-12 pages, double-spaced) **DUE: 6/7 at noon**
The final product for this course will be an elaboration (or "fleshing out") of one of the assignments from this course. You will work with me on the selection and framing this final assignment. You may also elect to draft a research proposal for a specific professional purpose (e.g., scholarship application, dissertation proposal); the proposal must be *directly* related to the themes of the course. Final course papers are due in my physical mailbox in Miller 312 *by June 7th at noon*.

GRADING POLICY

I expect all assignments to be completed in a timely fashion. All written work will be held to high standards and should conform to rules of proper grammar, usage, punctuation, and

spelling. You should conform to standard APA format unless you have a good argument to do otherwise. Because of time pressures, *late papers will not be accepted unless prior written confirmation has been given by the instructor.* Assignments will be weighed according to this scheme:

Class & Blog Participation	30%
Small Weekly Assignments	30%
Volunteer Reading	10%
Final Paper or Proposal	30%

Please double-space all written work to be turned in and use a 12-pt. font. I would rather not receive email attachments or faxes unless prior arrangements have been made.

REQUIRED COURSE TEXTS (available at the UW Bookstore; also on reserve)

Kuhn, T. S. (1996). *The structure of scientific revolutions* (3rd ed.). Chicago: University of Chicago Press.

Biagioli, M. (Ed.). (1999). *The science studies reader*. New York: Routledge.

OPTIONAL COURSE TEXTS (available at the UW Bookstore; also on reserve)

Godfrey-Smith, P. (2003). *Theory and reality: An introduction to the philosophy of science*. Chicago: The University of Chicago Press.

Hess, D. J. (1997). *Science studies: An advanced introduction*. New York: New York University Press.

Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.

SCHEDULE OF ACTIVITIES, MILESTONES & READINGS

Week 1, 4/1	**Introduction**

This session will provide an introduction to the goals and purposes of this course. In this class we will:

- Preview the main themes and activities of this course.
- Discuss Dewey's *My Pedagogic Creed*

Week 2, 4/8	**Framing the gap between science education and the practice of science**

REQUIRED READINGS

DeBoer, G. E. (1991). What we have learned and where we are headed, *A history of ideas in science education: Implications for practice* (pp. 215-241). New York: Teacher's College Press.

Dewey, J. (1910). Science as subject-matter and as method. *Science, 31*(787), 121-127.

Lemke, J. L. (1992). *The missing context in science education: Science.* Paper presented at the Annual Meeting of the American Education Research Association (AERA) Conference, San Francisco.

Duschl, R. (2001). Making the nature of science explicit. In R. Millar, J. Osborne & J. Leach (Eds.). Improving Science Education: The contribution of research. Philadelphia, PA: Open University Press, 185-206.

Osborne, J., Collins, S., Ratcliffe, M., Millar, R., & Duschl, R. (2003). What "Ideas-about-science" should be taught in school science? A delphi study of the expert community. *Journal of Research in Science Teaching, 40*(7), 692-720.

VOLUNTEER READING

Feynman, R. (1969). What is science? *Physics Teacher*(September), 313-320.

Week 3, 4/15	**Portraying epistemology in the classroom (AERA — NO CLASS)**

REQUIRED READINGS

Schwab, J. (1962). The teaching of science as enquiry, *The teaching of science* (pp. 3-103). Cambridge, MA: Harvard University Press.

Rudolph, J. L. (2002). Portraying epistemology: School science in historical context. *Science Education, 87*, 64-79.

Burbules, N. C., & Linn, M. C. (1991). Science education and the philosophy of science: Congruence or contradiction? *International Journal of Science Education, 13*(3), 227–241.

VOLUNTEER READING

Sullenger, K., Turner, S., Caplan, H., Crummey, J., Cuming, R., Charron, C., & Corey, B. (2000). Culture wars in the classroom: Prospective teachers question science. *Journal of Research in Science Teaching, 37*(9), 895-915.

Week 4, 4/22 **Historical and philosophical perspectives**

REQUIRED READINGS

Kuhn, T. S. (1996). *The structure of scientific revolutions* (3rd ed.). Chicago: University of Chicago Press.

Turner, S., & Sullenger, K. (1999). Kuhn in the classroom, Lakatos in the lab: Science educators confront the nature-of-science debate. *Science, Technology & Human Values, 24*(1), 5-30.

VOLUNTEER READINGS

Popper, K. (1963/1999). Falsification. In R. Klee (Ed.), *Scientific inquiry: Readings in the philosophy of science* (pp. 65-75). Oxford: Oxford University Press.

Feyerabend, P. (1978/1999). An argument against method. In R. Klee (Ed.), *Scientific inquiry: Readings in the philosophy of science* (pp. 228-235). Oxford: Oxford University Press.

Week 5, 4/29 **Sociological perspectives & The disunity of science**

REQUIRED READINGS

Bourdieu, P. (1975, abridged 1998). The specificity of the scientific field and the social conditions of the progress of reason. In M. Biagioli (Ed.), *The science studies reader* (pp. 31-50). New York: Routledge.

Gieryn, T. F. (1995). Boundaries of science. In S. Jasanoff & G. E. Markle & J. C. Peterson & T. Pinch (Eds.), *Handbook of science and technology studies* (pp. 393-443). London: Sage Publications.

Hacking, I. (1996). The disunities of the sciences. In P. Galison & D. J. Stump (Eds.), *The disunity of science: Boundaries, contexts, and power* (pp. 37-74). Stanford: Stanford University Press.

Week 6, 5/6 **Understanding the cultural practices of scientists in labs**

REQUIRED READINGS

Latour, B., & Woolgar, S. (1979/1986). An anthropologist visits the laboratory, *Laboratory life: The construction of scientific facts* (pp. 43-90). Princeton, NJ: Princeton University Press.

Latour, B. (1987). Laboratories, *Science in action: How to follow scientists and engineers through society* (pp. 63-100). Cambridge, MA: Harvard University Press.

Latour, B. (1983, abridged 1998). Give me a laboratory and I will raise the world. In M. Biagioli (Ed.), *The science studies reader* (pp. 258-275). New York: Routledge.

Latour, B. (2003, June). The world wide lab / Research space: Experimentation without representation is tyranny. *Wired*, *11*(6).

VOLUNTEER READINGS

Knorr Cetina, K. (1995). Laboratory studies: The cultural approach to the study of science. In S. Jasanoff & G. E. Markle & J. C. Peterson & T. Pinch (Eds.), *Handbook of science and technology studies* (pp. 140-166). London: Sage Publications.

Galison, P. (1997/1999). Trading zone: Coordinating action and belief. In M. Biagioli (Ed.), *The science studies reader* (pp. 137-160). New York: Routledge.

Nersessian, N. J., Kurz-Milcke, E., Newstetter, W. C., & Davies, J. (2003). Research laboratories as evolving distributed cognitive systems. *Proceedings of The 25th Annual Conference of the Cognitive Science Society* (pp. 857-862).

Week 7, 5/13 **Images of scientific controversy**

REQUIRED READINGS

Collins, H. M., & Shapin, S. (1986). Uncovering the nature of science. In J. Brown & A. Cooper & T. Horton & F. Toates & D. Zeldin (Eds.), *Science in Schools* (pp. 71-79). Milton Keynes: Open University Press.

Brante, T. (1993). Reasons for studying scientific and science-based controversies. In T. Brante & S. Fuller & W. Lynch (Eds.), *Controversial science: From content to contention*. Albany, NY: State University of New York Press.

Latour, B., & Woolgar, S. (1979/1986). An anthropologist visits the laboratory, *Laboratory life: The construction of scientific facts* (pp. 43-90). Princeton, NJ: Princeton University Press.

Nelkin, D. (1995). Science controversies: The dynamics of public disputes in the United States. In S. Jasanoff & G. E. Markle & J. C. Peterson & T. Pinch (Eds.), *Handbook of science and technology studies* (pp. 444-456). London: Sage Publications.

Hines, P. J. (2001). Why Controversy Belongs in the Science Classroom. *Harvard Education Letter, 17*(5), 7-8.

Bell, P. (in press). The educational opportunities of contemporary controversies in science. In M. C. Linn & E. A. Davis & P. Bell (Eds.), *Internet environments for science education*. Mahwah, NJ: Erlbaum.

VOLUNTEER READINGS

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*, 287-312.

Cross, R. T., & Price, R. F. (1996). Science teacher's social conscience and the role of controversial issues in the teaching of science. *Journal of Research in Science Teaching, 33*(3), 319-333.

Week 8, 5/20 **Understanding the images of science held by the public**

REQUIRED READINGS

Mead, M., & Métraux, R. (1957). Image of the scientist among high-school students. *Science, 126*(3270), 384-390.

Driver, R., Leach, J., Millar, R., & Scott, P. (1996). *Young People's Images of Science* (selections). Buckingham, UK: Open University Press.

Collins, H. M. (1987). Certainty and the Public Understanding of Science: Science on Television, *Social Studies of Science*, *17*, 689-713.

VOLUNTEER READINGS

Bell, P., & Linn, M. C. (2002). Beliefs about science: How does science instruction contribute? In B. K. Hofer & P. R. Pintrich (Eds.), *Personal Epistemology: The Psychology of Beliefs about Knowledge and Knowing* (pp. 321-346). Mahwah, NJ: Lawrence Erlbaum.

Week 9, 5/27 **Cognitive and linguistic images of science**

REQUIRED READINGS

Ochs, E., Gonzales, P. and Jacoby, S. (1996). "When I come down, I'm in the domain state": Grammar and Graphic Representation in the Interpretive Activity of Physicists. In *Interaction and Grammar*. Elinor Ochs, Emanuel A. Schegloff, and Sandra Thompson, eds. Pp. 328-369. Cambridge: Cambridge University Press.

Two of the following:

Kuhn, D. (1989). Children and adults as intuitive scientists. *Psychological Review, 96*(4), 674-489.

White, B. Y. (1993). ThinkerTools: Causal models, conceptual change, and science education. *Cognition and Instruction, 10*(1). (Excerpt: pages 1-16).

Koslowski, B. (1996). *Theory and Evidence: The Development of Scientific Reasoning* (selections). Cambridge, MA: The MIT Press.

Gopnik, A. (1996). The scientist as child. *Philosophy of Science, 63*(4), 485-514.

VOLUNTEER READINGS

Lemke, J. L. (1990). Teaching against the mystique of science, In *Talking science : Language, learning, and values* (pp. 129-151). Norwood, N.J.: Ablex Pub. Corp.

Week 10, 6/3 **Science as it appears on the public stage**

REQUIRED READINGS

Hilgartner, S. (2000). Introduction, The character of the national academy of science, Conclusion, *Science on stage: Expert advice as public drama* (pp. 3-29, 113-150). Stanford CA: Stanford University Press.

Jasanoff, S. (2001). Judicial fictions: The supreme court's quest for good science. *Society, 38*(4), 27-36.

Roth, W.-M., & Désautels, J. (2002). Science education as/for sociopolitical action: Charting the landscape. In W.-M. Roth & J. Désautels (Eds.), *Science education as/for sociopolitical action* (pp. 1-16). New York: Peter Lang.

VOLUNTEER READING

Roth, W.-M., & Lee, S. (2002). Breaking the spell: Science education for a free society. In W.-M. Roth & J. Désautels (Eds.), *Science education as/for sociopolitical action* (pp. 67-95). New York: Peter Lang.

Larochelle, M. (2002). Science education as exercise in disciplining versus a practice of/for social empowerment. In W.-M. Roth & J. Désautels (Eds.), *Science education as/for sociopolitical action* (pp. 209-236). New York: Peter Lang.

Désautels, J., Fleury, S. C., & Garrison, J. (2002). The enactment of epistemological practice as subversive social action, the provocation of power, and anti-modernism. In W.-M. Roth & J. Désautels (Eds.), *Science education as/for sociopolitical action* (pp. 237-269). New York: Peter Lang.

Administrative Notes about Teaching at the University of Washington

If you have any concerns about the course or your instructor, please see the instructor about these concerns as soon as possible. If you are not comfortable talking with the instructor or not satisfied with the response that you receive, you may contact Prof. Sheila Valencia (Chair of C&I), 543-6636, valencia@u.washington.edu.

If you are still not satisfied with the response that you receive, you may contact Prof. Steve Kerr, 543-4940, stkerr@u.washington.edu. For your reference these procedures are posted on the bulletin board just outside Student Services, 206 Miller.

If you would like to request academic accommodations due to a disability, please contact Disabled Student Services, 448 Schmitz, (206) 543-8924 (V/TTY). If you have a letter from Disabled Student Services indicating you have a disability that requires academic accommodations, please present the letter to the Area Secretary to discuss the accommodation you might need for class.