

New York University
Steinhardt School of Culture, Education, and Human Development
Department of Teaching and Learning
Science Education Program
637 East Building, 239 Greene Street

E14.2021 SCIENCE IN A HISTORICAL PERSPECTIVE
SPRING 2011

Instructor:

Dr Catherine Milne
637 East Building
Telephone: 212-998-5132
E-mail: cem4@nyu.edu

Class Time:

Wednesday 4.55-6.35 pm

Meeting Room:

Silver 412

Office Hours:

Monday 3.00 – 6.00 pm

COURSE OUTLINE

Why is it important that you, prospective or current educators, know about the history of science? This is the question that we will be addressing in this course as you examine science from an historical perspective appreciating that there exist multiple perspectives and accepting that the development of science cannot be understood without consideration of the social, political, theological and philosophical contexts in which science emerges. Duschl¹ describes some of the challenges facing educators as they attempt to relate history of science to the teaching and learning of science but before this can be considered it is helpful for teachers to have a richer appreciation for the history of science and the contexts that influenced the development of science and which were also influenced by developments within science. As Schama² notes history is always struggling with the gap between, a lived event and its subsequent narration.

History uses time sequences of historical chronologies to establish coherence and persuasiveness. Claims for historical knowledge must always be circumscribed by the prejudices of its narrator. Remember that! In this course you will be examining the telling of stories and be expected to ask yourself if science is any different. This course you will examine the emergence of Eurocentric science, which forms the basis of much of the science that is taught in schools, appreciating the many cultures and races that provided its foundation. In this section you will examine the vexed question of whether there is one science or many sciences. You will also examine aspects of the nature of science that are historically significant including forms of

¹ Duschl, R. A., (2000). *Using and abusing: Relating history of science to teaching and learning science*. Paper presented at the British Society for the History of Science (BSHS) conference on “Science Communication, Education and the History of Science”, London, 12-13 July, 2000.

² Schama, S. (1991). *Dead certainties (Unwarranted speculations)*. New York: Vintage Press.

reasoning, the role of worldview, and methods for constructing new knowledge. You will critically analyze and evaluate many representations of science.

Learning Outcomes

Learners will:

1. Read and analyze assigned readings and demonstrate their ability to synthesize this information on timelines and in group analysis.
2. Evaluate the relationship between science and society, the relationship between technology and science and the role of community to the development of science.
3. Develop critical skills necessary to examine the relationship between values and the development of facts in science especially with respect to gender and race.
4. Evaluate arguments about the structure of science as a discipline in education.
5. Examine the emergence of Eurocentric science including the emergence of inductivism as a methodology for science, matters of fact, a mechanical cosmology, the experimental report and the language of science.
6. Develop a richer understanding of the nature of science as a construct of human action.

Requirements

1. Group work, homework and participation associated with readings 10%
2. Book review (see Notes) 20%
3. Critical analysis of an historical science story. 10%
4. Synthesis and analysis of experimental report from Philosophical Transactions and comparison of this paper with a contemporary research paper. 25%
5. Developing an innovative resource incorporating the scientific history of a specific idea from a critical perspective for educational use appropriate to your situation. 25%

Attendance and Participation

Attendance and participation is expected. Absence for more than one class will result in a loss of grade.

Citations and Referencing

In this course it is expected that you will cite all sources of information that you use and that you will include a bibliography where necessary. Use American Psychological Association (APA) guidelines when not advised to use another form of referencing and citation. There is also an expectation that you will write in a scholarly manner using appropriate grammar and syntax.

Textbook

Milne, Catherine (in press). *The invention of science: why history of science matters for the science classroom*. Dordrecht, The Netherlands: Sense Publishers.

Course Outline

UNDERSTANDING THE CONSTRUCTION OF WESTERN MODERN SCIENCE

Class 1 – Are there similarities and differences between science and history? What can philosophy of science tell us about science and the history of science?

- Introduction
- Using library resources

Milne, C. Chapter 1.- What is Science?

Other Resources

Cooter, R., Crosland, M., Easlea, B., Gooding, D., Hall, A. R., & Hendry, J. (1985). What is the history of science? *History Today*, 35(4), 32-40.

Pickstone, J., Porter, R., Schaffer, S., Shapin, S., Young, R. M., Ziman, J. (1985). What is the history of science? *History Today*, 35(5), 46-53.

Class 2 - What is science? Western modern science and indigenous knowledge

- Science and non-science. What does this mean?

Milne, Chapter 1

Other Resources

Sommerville, J. (1941). Umbrellaology, or, methodology in social science. *Philosophy of Science*, 8, 557-566. (Exerpt)

Ogawa, M. (1995). Science education in a multiscience perspective. *Science Education*, 79, 583-593.

McKinley, E. (2005). Locating the global: culture, language and science education for indigenous students. *International Journal of Science Education*, 27, 227-241.

Coleman, Cynthia-Lou, & Herman, Douglas. (2010). Ways of knowing: "naked science" or native wisdom. *National Museum of the American Indian Journal*, 11(4), 29-33.

Class 3 – Making arguments

- Exploring some of the developments that provided the basis for western modern science
- Aristotle and the nature of reasoning

Milne, Chapter 2- Making Arguments

Other Resources

Brock, W. H. (2000). *The chemical tree: A history of chemistry*. New York: Norton and Company. Chapter 1.

Teresi, D. (2002). *Lost Discoveries: The ancient roots of modern science from the Babylonians to the Maya*. New York: Simon & Schuster. Chapter 1.

Stover, Shawn K. & Mabry, Michelle. (2007). Influences of teleological and Lamarckian thinking on student understanding of natural selection. *Journal of College Biology Teaching*, 33(1), 11-18.

Mayr, Ernst. (1961). Cause and effect in biology. *Science*, 134, 1501-1506.

Class 4 & 5 How people see the world?

- Aristotelianism
- Medieval Scholasticism
- Organic and individual
- Experimentation and axioms
- Ontology, epistemology, and axiology

Milne, Chapter 3 – Warring cosmologies and the emergence of Eurocentric science

Other Resources

Lindberg, David. (1995). Medieval science and its religious context. *Osiris*, 10, 60-79.

Grant, E. (1978). Aristotelianism and the longevity of the medieval world-view. *History of Science*, 16, 93-106.

Galilei, Galileo. (1638/1968). Henry Crew & Alfonso de Salvio (Trans.). Dialogues concerning two new sciences. Chicago, IL.: Northwestern University Press. Original translation 1913.

Class 6 & 7 What is the center of the universe? And other challenging questions What might have been some of the conditions that encouraged thinkers and scholars to challenge the status quo?

- Arab scholars save scholarship
- Exploration
- New technologies
- New movements

Milne Chapter 4 – Valuing patterns and the continuing emergence of Eurocentric science

Other Resources

Hooykaas, R. (1987). The rise of modern science: When and why? *British Journal for the History of Science*, 20, 453-473.

Class 8 & 9 Inventing new knowledge. Establishing 'matters of fact'.

- Context
- Induction

The experimental report and evaluating new knowledge

- Establishing 'matters of fact'
- Legitimizing knowledge
 - Autocratic rulers
 - Gentleman witnesses
 - Learned Societies

A new cosmology

- Atomism
- Mechanism
- Determinism

- Reductionism

Milne, Chapter 5 – Just the facts please. Inductivism has its day

Other Resources

Bowler, P. J. & Morus, I. R. (2005). *Making modern science*. Chicago, IL.: University of Chicago Press. The scientific revolution (Chapter 2).

Gasking, E. (1970). *The rise of experimental biology*. New York: Random House. Chapter 1.

Harré, R. (1981). *Great scientific experiments*. Mineola, NY: Dover. Introduction and Chapter 4 – Stephen Hales.

Class 10 What is the role of explanation and theory in Eurocentric science?

Milne, Chapter 6 – Understanding and explanation: a role for connected and separate knowing

Class 11 – Connected and Separate Knowing

Milne, Chapter 6 – Understanding and explanation: a role for connected and separate knowing

Other Resources

Belenky, Mary F., Clinchy, Blythe M., Goldberger, Nancy R., & Tarule, Jill M. (1986). *Women's ways of knowing— The development of self, body, and mind*. New York: Basic Books.

Class 12 Scientific discourses, words, and language

- Plain and simple
- Non-emotive
- New words
 - Exactness of language
- Reality and language
- Nominalization

- The practice of science and the report of science
 - Language
 - Diagrams
 - Structure
- Contemporary scientific discourse

Milne, Chapter 7 – Understanding discourses in science and science education

Other Resources

Savory, T. (1967). *The language of science*. London: Andre Deutsch. Chapter 3.

Class 13 Stories and science. Taking a critical eye to science stories

- Stories and science. Is there such a thing?
- Who constructs science?
- Who is recognized?
- How is science constructed?

Root-Bernstein, R. S. (1988). Setting the stage for discovery. *The Sciences*, 28(3), 26-34.

Milne, C. (1998). Philosophically correct science stories? Examining the implications of heroic science stories for school science. *Journal of Research in Science Teaching*, 35, 175-187.

OR

Milne, C. (2007). School science stories and a strategy of action for cultural transformation. In P. C. Taylor and J. Wallace (Eds.), *Contemporary qualitative research: Exemplars for science and mathematics educators*. Springer

Other Resources

Board, P. (1994). The aristocrat who revolutionised chemistry. *New Scientist*, 142(1924), 33-35.

Brush, S. G. (1978). Nettie M. Stevens and the discovery of sex determination by chromosomes. *Isis*, 69, 162-172.

Venville, G. & Milne, C. (1999). Three women scientists and their role in the history of genetics. *Australian Science Teachers' Journal*, 45(3), 9-15.

Dixon, B. (1980). The hundred years of Louis Pasteur. *New Scientist*, October 2, 30-32.

Wade, N. (1975). Discovery of pulsars: A graduate student's story. *Science*, 189, 358-364.

Fasto-Sterling, A. (1987). Society writes biology/Biology constructs gender. *Dædalus*, 116, 61-76.

Gwei-Djen, L. & Needham, J. (1980). Pains and needles. *New Scientist*, September 18, 860-863.

Sardar, Z. (1980). Can science come back to Islam? *New Scientist*, 23 October, 212-216.

Class 14 Final Presentations

Select Bibliography for the Course

References or Source Material

Alic, M. (1986). *Hypatia's heritage: A history of women in science from antiquity to the late nineteenth century*. London: The Women's Press.

Kohn, A. (1989). *Fortune or failure: Missed opportunities and chance discoveries*. Oxford: Basil Blackwell.

Ronan, C. A. (1982). *Science: Its history and development among the world cultures*. New York: Facts on File Publications.

Schama, S. (1991). *Dead certainties (Unwarranted speculations)*. New York: Vintage Press.

Schiebinger, L. (2000). Skeletons in the closet: The first illustrations of the female skeleton in eighteenth-century anatomy. In L. Schiebinger (Ed.), *Feminism and the body* (pp. 25-57). Oxford: Oxford University Press.

Some Possible Titles for Review

Aczel, A. D. (2001). *The riddle of the compass*. San Diego, CA: Harcourt Inc.

Bardi, J. S. (2006). *The calculus wars*. New York: Thunder's Mouth Press.

Bell, M. S. (2005). *Lavoisier in the year one*. New York: Norton.

Clark, D. & Clark, S. P. H. (2001). *Newton's tyranny*. New York: W. H. Freeman and Company.

Cohen, I. B. (2005). *The triumph of numbers. How counting shaped modern life*. New York: W. W. Norton.

Darwin, C. (1996). *The origin of species*. Oxford: Oxford University press (Original published in 1859).

Drake, S. (1990). *Galileo: Pioneer scientist*. Toronto: University of Toronto Press.

- Emsley, J. (2000). *The thirteenth element: The sordid tale of murder, fire and phosphorus*. New York: John Wiley and Sons.
- Emsley, J. (2005). *The elements of murder*. Oxford: Oxford University Press.
- Fenster, J. M. (2002). *Ether day*. Perennial.
- Galilei, G. (1661/1953). *Dialogue on the great world systems*. In the Salsbury translation. G. de Santillana (trans.) Chicago: University of Chicago Press.
- Garfield, S. (2000). *Mauve*. New York: Norton.
- Gorst, M. (2001). *Measuring eternity: The search for the beginning of time*. New York: Broadway Books.
- Gould, S. J. (1981). *The mismeasure of man*. New York: Norton.
- Gratzer, W. (2006). *Terrors of the table*. Oxford: Oxford University Press.
- Gribbin, J. (2005). *The fellowship. Gilbert, Bacon, Harvey, Wren, Newton, and the story of a scientific revolution*. Woodstock, NY: Overlook Press.
- Hoffman, R. (1995). *The same and not the same*. New York: Columbia University Press.
- Hooke, R. (1665/1961). *Micrographia*. New York: Dover Publications.
- Hooper, J. (2002). *Of moths and men: The untold story of the peppered moth*. New York: W.W. Norton.
- Johnson, S. (2006). *The ghost map*. New York: Riverhead Books (Penguin).
- Keller, E. F. (1983). *A feeling for the organism: The life and work of Barbara McClintock*. New York: W. H. Freeman.
- Larson, E. J. (2001). *Evolution's workshop: God and science on the Galapagos Islands*. New York: Basic Books.
- Lindley, D. (2001). *Boltzmann's atom: The great debate that launched a revolution in physics*. New York: The Free Press.
- Macfarlane, G. (1984). *Alexander Fleming: The man and the myth*. London: Chatto & Windus.
- Reston Jr., J. (1994). *Galileo: A life*. London: Cassell Publishers.
- Shapin, S. & Schaffer, S. (1985). *Leviathan and the air pump: Hobbes, Boyle, and the experimental life*. Princeton, NJ: Princeton University Press.
- Standage, T. (2005). *The history of the world in 6 glasses*. New York: Walker.
- Strathern, P. (2000). *Mendeleyev's dream: The quest for the elements*. New York: Berkley Books.
- Waller, J. (2002). *The discovery of the Germ*. New York: Columbia University Press.
- Wertheim, M. (1995). *Pythagoras' trousers: God, physics and the gender wars*. New York: Times Books, Random House.
- Winchester, S. (2002). *The map that changed the world: William Smith and the birth of modern geology*. New York: Perennial.

Personal Well-being

Any student attending NYU who needs an accommodation due to a chronic, psychological, visual, mobility and/or learning disability, or is Deaf or Hard of Hearing should register with the Moses Center for Students with Disabilities at 212 998-4980, 240 Greene Street:
www.nyu.edu/csd.

Evaluation Rubric

In this course, I am looking for scholars who creatively engage with the material.

A= Evidence of learning, thoughtful analysis, and creative

All major assessment tasks are completed in a way that demonstrates your skill as a composer of arguments, using evidence (in the form of excerpts and data analysis) and theory, to support the arguments made. Your writing flows well and is well organized. You participate in all classes and provide evidence during class that you have read and thought about the ideas in the readings prior to coming to class.

A-

Typically the level of creativity is less than that observed in tasks that are evaluated at an A. Also, absence from more than one class can result in a loss of grade.

B = Satisfactory

All major assignments completed to a good standard by addressing all the questions in the tasks. Writing is clear and concise but your arguments tend to capture a broad analysis somewhat lacking a creative focus.

C = Inadequate for Masters level

Writing lacks adequate structure and analysis is fairly perfunctory.

F = Fail

Required tasks not completed.

Academic Honesty, Dishonesty, and Plagiarism

The following is adapted from the NYU Steinhardt *Student's Guide* (p. 24) and from the Policies and Procedures of the NYU Expository Writing Program (available from http://www.nyu.edu/cas/ewp/html/policies_procedures.html):

The relationship between students and faculty is the keystone of the educational experience in the Steinhardt School at New York University. This relationship takes an honor code for granted. Mutual trust, respect, and responsibility are foundational requirements. Thus, how you learn is as important as what you learn. A University education aims not only to produce high quality scholars but also to cultivate honorable citizens.

Academic integrity is the guiding principle for all that you do: from taking exams, making oral presentations, to writing term papers. It requires that you recognize and acknowledge information derived from others, and take credit only for ideas and work that are yours. You violate the principle of academic integrity when you

- cheat on an exam;
- submit the same work for two or more different courses without the knowledge and the

permission of all professors involved;

- receive help on a take-home examination that calls for independent work;
- “collaborate” with other students who then submit the same paper under their individual names.
- give permission to another student to use your work for a class.
- plagiarize.

Plagiarism, one of the gravest forms of academic dishonesty in university life, whether intended or not, is academic fraud. In a community of scholars, whose members are teaching, learning, and discovering knowledge, plagiarism cannot be tolerated. Plagiarism is failure to properly assign authorship to a paper, a document, an oral presentation, a musical score, and/or other materials, which are not your original work. You plagiarize when, without proper attribution, you do any of the following:

- Copy verbatim from a book, an article, or other media;
- Download documents from the Internet;
- Purchase documents;
- Report from others’ oral work;
- Paraphrase or restate someone else’s facts, analysis, and/or conclusions;
- Copy directly from a classmate or allow a classmate to copy from you.

For a self-test on what constitutes plagiarism, please visit

<http://www.indiana.edu/~istd/practice.html>.