UNIVERSITY OF ARKANSAS

College of Education and Health Professions

Department of Curriculum and Instruction

Course Number: **CIED 6333**
Course Title: ***Nature of Science: Philosophy of Science for Science Educators***
Credits: 3
Semester: Fall 2008
Time: Tuesdays 5-7:50 pm
Room: PEAH 106
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Course Description:

The *Nature of Science* is a rich hybrid discipline that uses aspects of the philosophy, history and sociology of science along with elements of the psychology of scientific observations to provide an accurate description of how science functions. This course is designed for individuals who are interested in learning more about the methods and goals of science, the role of scientists and the place of science in society science and how philosophical issues can and should be reflected in science teaching and learning. We will read and discuss selections from the works of major philosophers of science and commentaries on science education from a philosophical perspective. Throughout this course we will explore the content of the nature of science and use that knowledge as a guide in improving science instruction and developing philosophically appropriate science curricula.

Course Objectives:

The course will focus on discussions and analyses of:

- the methods of science;
- knowledge production in science;
- competing views of science and its processes;
- the development and status of laws and theories in science;
- paradigms, revolutions, research programs and falsification;
- the psychological basis for scientific discovery and knowledge generation, and
- philosophically valid science teaching models.

Required and Recommended Texts:

You are also expected to have available the set of reading outlined in the Syllabus of Readings. In most

cases these readings are extracted from larger works and as such may be somewhat incomplete in terms of illustrating the author' s complete view of the subject. Therefore, you are encouraged to seek out the entire book or article and make your judgments based on that source rather than relying solely on the selection included here. I have provided both the entire original reference and the citations included with the original to help you explore topics of interest more deeply.

Strongly Suggested: APA. (2001). Publication manual of the American Psychological Association (5th edition). Washington, DC: American Psychological Association. Assignments are to be completed using the current APA style (which is also the style used throughout most of the science education community)

Also, the following works on specific aspects of the nature of science are recommended:

Carey. S. S. (1994). *A beginners guide to scientific method*. Belmont, CA: Wadsworth Publishing Co.

Feynman, R. (1992). *The character of physical law*. Cambridge, MA: The MIT Press.

McComas, W.F. (Ed.)(1998). The nature of science in science education: Rationales and strategies. Boston: Kluwer (Springer) Academic Publishing Company.

National Academy of Sciences (1998). *Teaching about evolution and the nature of science*. Washington, DC: National Academy Press.

Powell, J. L. (1999). *Night comes to the Cretaceous: Comets, craters, controversy and the last days of the dinosaurs*. New York: Harcourt, Brace & Co.

Organization of the Course:

The course readings are organized into major theme areas with some divided further into subsets (noted with common letters). The title of each section will provide some clues as to the focus of the reading set. In most cases, the instructor will present a mini-lecture focusing on the central theme of the readings set, but the dominant activity will be student-based discussion. In all cases, it is critical that you come to class having thoroughly read and studied the material so that you can contribute to an insightful discussion of it.

Grades will be based on the following:

A) **Class Participation**; you will be awarded three points for each class session during which you make a continuing contribution (of course, this is only possible if you are actually in the room!)

B) **Paper POMS (Points of Most Significance)** (Paper POMS); these are POMS inspired by an individual paper set and represent what you think are the most important points made **by the authors** of a given paper set or subset. There are three types of POMS, each with its point value.

Type I **SUMMARIZE** - reflect the major idea(s) of a paper set within the current readings set (30 words maximum, 3 points maximum); or

Type II **SYNTHESIZE** - state how you think the major idea(s) of a current set of readings relate to the major idea(s) contained in papers dealt with earlier in the course (30 words maximum, 4 points maximum), or

Type III **APPLY** - state a major implication for science teaching (*not* directly provided by the author) that you draw from a given readings set and discuss the means by which the implication can be put into practice (40 words maximum, 5 points maximum).

Type IV **ASSESS** – design a way for you to *authentically or creatively* assess what students have learned about the nature of science following some lesson in the nature of science. With a Type IV POMS you must briefly discuss the lesson but focus on how to measure its impact (50 words maximum, 6 points maximum). You may attempt only TWO of these.

Your POMS statements must be carefully written and **thoroughly reviewed for clarity and for sense** (a matter of whether the statement says what you want it to say and whether what you want to say is clear).

You may revise a POMS set any time before it is collected. After a collected POMS set is returned to you, you may revise it (since it may be collected again). However, you may do this backward but not forward. In other words, any set of POMS should refer only to readings that would already have been encountered at the time the POMS was originally written. You should be prepared to hand in ***any*** *set of POMS up* ***through*** *the readings set assigned for the current class session. Please see Rules and Hints of POMS for more information.*

C) Global POMS (Course POMS); these POMS are due at the beginning of the *last* session of the course and should consist of the over-arching ideas communicated within the entire readings package. In other words, these are the BIG ideas of the entire course. You should write eight of these global POMS, each one addressing one of the MAJOR themes of the *Nature of Science* exhibited in the total paper set. By definition these are Type II POMS. Each global POMS is worth 4 points for a total of 32 points.

Rules and Helpful Hints for Writing POMS

Rule 1: Each individual POMS statement is to be no more than 30-50 words long (depending on the kind of POMS – review all directions and count words carefully.

Rule 2: For each POMS Indicate the type (I, II, III or IV) you intended to write.

Rule 3: You may (but not must) write a **maximum** of FOUR POMS per set of readings.

Rule 4: During the course you MUST attempt at least 60 points in POMS, but there is no maximum. At the end of the course, your personal denominator will be raised to 60 points if you do not attempt at least that many. (For the arithmetically challenged, this is *not* good!)

Rule 5: ALL POMS for a current set of readings must include a reference to AT LEAST ONE of the papers in that week's set.

Rule 6: Points may be lost if significant and obvious connections (citations) are omitted. For instance, you may lose points if you write a Type I POMS that logically could have been a Type II.

Rule 7: State author's name and paper number(s) to make your point (These names and numbers will not be counted for the 30 words maximum).

Rule 8: Where possible, you should cite all of the authors (by using paper numbers rather than APA style) who support or refute a position with which you would like to draw comparisons or conclusions.

Rule 9: POMS should be typed or neatly handwritten on one side of a piece of paper with wide margins and spaces between each POMS. Put your name in the top right corner and the readings set related to the POMS in the top left corner of the page.

D) **Theory/Law Project (Individual)**; in this quick assignment you will find at least five well known reference books (like dictionaries, encyclopedias, etc.) and five recent science textbooks (from a particular level like secondary biology) and look up in the index, glossary, table of contents the terms "law" and "theory." For the data section of this paper you will simply list what you find. For the analysis section, summarize, analyze and otherwise make sense of what you have found by examining the consensus, utility and accuracy of the definitions and descriptions provided.

E) **NOS History Project (Individual)**; the task is to read a current book (from the list below or one agreed upon with the course instructor) on the nature/philosophy/history of science and extract from the book a list of NOS topics that author has emphasized. In addition, please provide at least one example (preferable a historical one) from the book used to illustrate each NOS topic.

Current books addressing aspects of the history and/or nature of science written for general readers:

1) Ben-Ari, Moti (2005). *Just a Theory: Exploring the Nature of Science*. Amherst NY: Prometheus Books.

2) Chalmers, A. (1999). *What is this Thing Called Science? (Third edition).* Indianapolis, IN Hackett Publishing Company.

3) Cromer, A. (1993). *Uncommon Sense: The Heretical Nature of Science*. New York: Oxford University Press.

4) Derry, N. G. (1999). *What Science is and How it Works*. Princeton, N.J. Princeton University Press.

5) Dunbar, R. (1995). *The Trouble with Science*. Cambridge: Harvard University Press.

6) Hakim, J. (2004). *Story of Science: Aristotle Leads the Way*. Washington, DC: Smithsonian Institution Press.

7) Hakim, J. (2004). *Story of Science: Newton at the Center*. Washington, DC: Smithsonian Institution Press.

8) Hakim, J. (2007). *Story of Science: Einstein Adds a New Dimension*. Washington, DC: Smithsonian Institution Press.

9) Okasha, S. *(2002). Philosophy of Science: A Very Short Introduction.* Oxford: Oxford University Press.

10) Sardar, Z. and Van Loon, B. (2002). *Introducing Science*. Cambridge, UK: Totem Books.

11) Thompson, M. (2001). *Teach Yourself. Philosophy of Science.* New York: McGraw Hill.

12) Wolpert, L. (1992). *The Unnatural Nature of Science.* Cambridge: Harvard University Press.

13) Dear, P. (2007). Science as natural philosophy, Science as instrumentality. From *The Intelligibility of Nature.* Chicago: The University of Chicago Press

F) **NOS Research Team Project**; Design a study designed to access to public views with respect to the following three questions (although these issues do not have to be phrased exactly as stated below):

1) What is Science?
2) Can Science Answer all Questions?
3a) What is the Scientific Method?
3b) What Methods are Used in Science?

Your task (along with **one** partner, if you like) is to collect enough information targeting a specific group of persons (e.g. K-3, 4-6, 7-8, 9-12, adults) to propose conclusions. Where possible provide verbatim quotes/comments made by respondents as your data along with any interview responses and/or impressions. This assignment is due before Session #13. Please deliver a hardcopy to my office or mail to my home on or before that date. Please complete this assignment as you would the report of a laboratory investigation with all of the customary parts such as purpose, method, data, discussion, conclusions and recommendations (implications).

G) **Final Examination**; a traditional assessment of your knowledge, impressions and implications of the big ideas of this course.

Assessment Overview

Assignments:		Points Possible	Percent
A)	Participation (3 pts x 14 classes) (ongoing)	42	11.5%
B)	Paper POMS (ongoing)	60 (average)	16%
C)	Global POMS (Session #14)	32	8.5%
D)	NOS History Project (Session #13)	60	16%
D)	Theory/Law Project (Session #7)	45	11%
E)	NOS Research Project (Session #12)	80	21%
F)	Final Examination	60	16%
Total Points Possible		379	100%

The Fine Print

Grading Scale: Until the College of Education and Health Professions permits "+" and "-" grading, final grades in this course will be based on a 9 point scale whereby 91% will be the lowest A, 82% the lowest B, 73% the lowest C and 65% the lowest D.

Lateness: I realize that working professionals must occasionally submit an assignment late. To encourage everyone to hand in all assignments, I will accept late work. However, in fairness to those who do turn things in on time there will be a price to pay for late work. I will grade all late assignments and then deduct 10% for any assignment turned in within one week late and 25% for each week or part of a week of additional lateness. Note, this policy does *NOT* relate to POMS. If POMS are collected and you do not have them available, you may *NOT* hand them in later.

The Grade of Incomplete: A grade of IN can be assigned **only** if there is work not completed because of a documented illness or other emergency occurring after the 12th week of the semester. Arrangements for the IN and removal of the IN are the responsibility of the student with advance agreement with the instructor.

Students with Disabilities: Students requiring accommodations based on a disability are required to register with the Center for Educational Access (CEA) each semester. A letter of verification for approved recommendations can be obtained through CEA. Please be sure I receive the letter early in the semester.

The Nature of Science for Science Educators / Class Schedule / Fall 2008

Session	Date	Topic
1	AUG 26	An Introduction to the Social Studies of Science (I)
2	SEPT 2	An Introduction to the Social Studies of Science (II)
3	SEPT 16	The Logic of Science and the Issue of Demarcation
4	SEPT 23	Science and Its Methods
5	SEPT 30	Inductivism-empiricism and Hypothetico-deductivism
6	OCT 7	Images of Science: The Issue of Methods Revisited
	OCT 14	NABT MEETING (Memphis, TN) NO CLASS
7	OCT 21	Theories and Laws: Products and Tools of Science
8	OCT 28	Visions of Reality: Observation and Creativity in Science
9	NOV 4	Conceptual Change in Science and in the Classroom
10	NOV 11	Science and Science Education (I)
11	NOV 18	Science and Science Education (II)
12	NOV 25	The Society of Science: Watching Scientists at Work
13	DEC 2	Science & Society: A False Conflict between Science & Religion
14	DEC 9	Final Thoughts
	DEC 16	FINAL EXAMINATION

NATURE OF SCIENCE - READING LIST

Please read the articles in the order in which they are listed and be sure to read all articles assigned for discussion during a given session. Please note that the articles appear in groups for a reason

Supporting Materials

Study Guide Handout: Theory/Law Comparison
Study Guide Handout: Traditional vs. New Views of Science
Glossary of the Philosophy of Science
Definitions of Science and Other Statements about its Nature
The Arch of Aristotelian Knowledge

Session #1 Theme: *AN INTRODUCTION TO THE SOCIAL STUDIES OF SCIENCE (I)*

1.1a Brush, S. (2000). Postmodernism vs. Science vs. Fundamentalism: An Essay Review. *Science Education, 84*(1), 114-117.
1.2a Wolpert, L. (1992). Chapter 1, "Unnatural Thoughts" from *The Unnatural Nature of Science*. Cambridge, MA: Harvard University Press.
1.3a Dear, P. (2007). Science as natural philosophy, Science as instrumentality. From *The Intelligibility of Nature.* Pp. 1-14. Chicago: The University of Chicago Press.

Session #2 Theme: *AN INTRODUCTION TO THE SOCIAL STUDIES OF SCIENCE (II)*

2.1a Lindberg, D. C. (1992). What is Science? From *The Beginnings of Western Science*. Chicago, IL: The University of Chicago Press. (Pp. 1-4)
2.2a Gjertsen, D. (1989). *Science and Philosophy: Past and Present from Science and Philosophy: Past and Present*. London: Penguin Press. (Pp 1-7)
2.3a Klemke, E. D., Hollinger, R. and Kline, A. D. (1988). What is Philosophy of Science? from *Introductory Reading in the Philosophy of Science, Revised Edition*. Buffalo: Prometheus Books. (Pp. 19-26)
2.4b Rhodes, R. (1986). Atoms and Void, from *Making of the Atomic Bomb*. New York: Simon and Schuster. (Pp. 29-39)
2.5c Gould, S. J. (1990). Selections from *Wonderful Life*. New York: W. Norton and Company. Originally on pgs 277-79 and 282-291 in the original.
2.6c Casti, J. L. (1989). Faith, Hope and Asperity, from *Paradigms Lost* New York: William Morrow and Company, Inc. (Pp. 1-15)
2.7c McComas, W. F., Clough, M, and Almazroa, H. (1998). The Role and Character of the Nature of Science (Part I), in W. F. McComas (ed). *The Nature of Science in Science Education*. Boston: Kluwer Academic Publishing Company (Pp. 3-20). Note, the remainder of this article is included in Section 11.

Session #3 Theme: *THE LOGIC OF SCIENCE and THE ISSUE of DEMARCATION*

3.1a Wallace, W. L. (1971). Edited selections from *The Logic of Science in Sociology*. New York: Aldine Publishing Company. (Pp. 11-24)
3.2a Anderson, O. R. (1976). Contemporary Perspectives from *The Experience of Science.* New York: Teachers College Press. (Pp. 9-13)
3.3b Richards, S. (1983). Scientific Argument. The Role of Logic from *Philosophy and Sociology of Science: An Introduction*. Oxford: Basic Blackwell (Pp. 14-27)
3.4b Horgan, J. (1992). Intellectual warrior: Karl Popper. Scientific American (November) (Pp. 38-40).

Session #4 Theme: *SCIENCE AND ITS METHODS*

4.1a Gjertsen, D. (1989). Is There A Scientific Method? from *Science and Philosophy: Past and Present*. New York: Penguin Books. (Pp. 87-113).
4.2a Richards, S. (1983). Philosophies of Scientific Method Theories of Science (Part of Chapter 4) from *Philosophy and Sociology of Science: An Introduction*. Oxford: Basic Blackwell. (Pp. 44-59)
4.3a Hempel, C. G. (1966). A Philosopher Gives His Account of the Scientific Method from *Philosophy of Natural Science*. Englewood Cliffs, NJ: Prentice-Hall, Inc. (Pp. 3-18) Note; this is an edited version.
4.4a Mayr, E. (1991). Darwin's Scientific Method from *One Long Argument.* Cambridge, MA: Harvard University Press. (Originally on Pp. 9-11, here reduced to two pages).
4.5a Bauer, H. H. (1994). Chapter 2 from Science literacy and the myth of the scientific method. (p. 19-41). Urbana: University of Illinois Press.
4.6a Chamers, A. (1990). *Against Universal Method from Science and Its Fabrication.* Minneapolis: University of Minnesota Press. (Pp. 11-23)

4.7a Millar, R. (1988). What is the 'Scientific Method' and Can It be Taught? from *Skills and Processes in Science Education: A Critical Analysis*. Wellington, J. J. (Ed.) London: Routledge. (Pp. 47-62)
4.8b Horgan, J. (May, 1993). Paul K. Feyerabend: The Worst Enemy of Science. *Scientific American* (Pp. 36-37).
4.9b Feyerabend, P. K. (1993) Selection from *Against Method*. New York: Verso. This selection from S. Rosen (ed) (2003). The Philosopher's Handbook. New York: Random House. p. 495-502.
4.10c Medawar, P. B. (1963). Is the Scientific Paper a Fraud? In P. B. Medawar (1990). *The Threat and the Glory*. New York: Harper Collins.

Session #5 Theme: *INDUCTIVIST-EMPIRICISM and HYPOTHETICO-DEDUCTIVISM*

5.1a Johsua, S. and Dupin, J. (1986). Is Systematization of Hypothetico-Deductive Reasoning Possible in a class situation? *European Journal of Science Education*. *8*(4), 381-388.
5.2a Holton, G. (1975). Selection from Mainsprings of Scientific Discovery. In *The Nature of Scientific Discovery*. Gigerich, O. (ed.) Washington, DC: Smithsonian Institution Press. (Pp. 203-208)
5.3a Medawar, P. (1982). Two Conceptions of Science from *Pluto's Republic*. New York: Oxford University Press. (Pp. 28-34).
5.4a Pagels, H. R. (1982). Selection (Pp. 56-59) from *The Cosmic Code*. New York: Simon and Schuster.
5.5a Trefil, J. (1989). Science in Context in *Reading the Mind of God: In Search of the Principle of Universality*. New York: Anchor Books (Originally on pgs 31-44)
5.6a Rachelson, S. (1977). A Question of Balance: A Wholistic View of Scientific Inquiry. *Science Education, 61*(1), 103-117.

Session #6 Theme: *IMAGES OF SCIENCE: THE ISSUE OF METHODS REVISITED*

6.1a Richards, S. (1985). Philosophies of Scientific Method: Theories of Science from *Philosophy and Sociology of Science: An Introduction* (Concluding part of chapter 4). Oxford: Basil Blackwell.
6.2a Nadeau, R. and Desautel, J. (1984). The Khun Development in Epistemology and the Teaching of Science. Toronto, Canada: Guidance Center of the University of Toronto. (Pp. 11-21).
6.3a Anon. (n.d.) Summary of Kuhn's Model of Science.
6.4a Horgan, J. (1991). Reluctant revolutionary: Thomas Kuhn. *Scientific American* (May). (Pp. 48-9).
6.5a Anon. (1964). Book Review: *The Structure of Scientific Revolutions* from *Scientific American*.
6.6a Kuhn, T. (1993) Selection from *The Structure of Scientific Revolutions, 3rd edition*. Chicago: University of Chicago Press. This selection from S. Rosen (ed) (2003). The Philosopher's Handbook. New York: Random House, Pp. 503-519.
6.7a Wallace, B. A. (1989). Views of Science and Reality through History. *Choosing Reality: A Contemplative View of Physics and the Mind*. Boston: New Science (Pp. 24-33).

6.8a Barrow, J. D. (1988). The Different Views of Science from *The World Within the World* Oxford: Clarendon Press. (Pp. 10-12)
6.9a Hodson, D. (1982). Selection from Science -- The Pursuit of Truth? Parts I. *School Science Review, 63 (*225), originally on pages 643-652.
6.10b Gould, S. J. (1993). Selection from The First Unmasking of Nature. *Natural History, 102*(4), (Originally on pages 14-21).
6.11b Margetson, D. (1982). Some Educational Implications of the Uncertain Identity of Science. *European Journal of Science Education, 4*(4), 357-365.

Session #7 Theme: *THEORIES AND LAWS: THE PRODUCTS & TOOLS OF SCIENCE*

7.1a Dilworth, C. (1994). On the Nature of Scientific Laws and Theories, from *Scientific Progress, Third Edition*. Boston: Kluwer Academic Publishers. (Pp. 174-194)
7.2a Trusted, J. (1979). Theories and Laws in *The Logic of Scientific Inference*. New York: Macmillan. (Pp. 70-77).
7.3a Rhodes, G. and Schaible, R. (February, 1989). Fact, Law and Theory: Ways of Thinking in Science and Literature. *Journal of College Science Teaching*. (Pgs. 228-232, 288)
7.4a Sonleitner, F. J. (1989). Theories, Laws and All That. National Center for Science Education. *Newsletter, 9*(6).
7.5a Fleisher, P. (1987). What is a Natural Law (Pp. 1-4) from *Secrets of the Universe: Discovering the Universal Laws of Science*. New York: Athenaeum.
7.6a Strahler, A. (1992). Selection from *Understanding Science*. Buffalo: Prometheus Books (Pp. 40-1).
7.7a Crick, F. (1988). Selection from *What Mad Pursuit*. New York: Basic Books, Inc. (Pp. 137-142).
7.8a McComas, W. F. (2003). A Textbook Case of the Nature of Science: Laws and Theories in the Science of Biology. *International Journal of Science and Mathematics Education 1*(2), 141-155.

Session #8 Theme: *VISIONS OF REALITY: OBSERVATION & CREATIVITY IN SCIENCE*

8.1a Chalmers, A. F. (1999). Realism and anti-realism (Pp. 226-246) from *What is This Thing Called Science*? Third edition. Indianapolis, IN: Hackett Publishing Company.
8.2a Munby, A. H. (1976). Some Implications of Language in Science Education. *Science Education, 60*(1), 115-124.
8.3b Casti, J. L. (1989). Faith, Hope and Asperity from *Paradigms Lost.* New York: William Morrow and Company, Inc. (Pp. 16-55).
8.4b Hodson, D (1986). The nature of scientific observation. *School Science Review 68,* (1), 17-29.
8.5b Hainsworth, M. D. (1956). The effect of previous knowledge on observation. *School Science Review, 37*(132), 234-242.
8.6b McComas, W. F. and Moore, L. S. (1997). The expectancy effect in the secondary school laboratory: Issues and oPportunities. *American Biology Teacher*, 63(4), 246-252.
8.7c Holton, G. (1995). Chapter 4 Imagination in Science from *Einstein, history and other*

passions. New York: Addison-Wesley.

Session #9 Theme: *CONCEPTUAL CHANGE IN SCIENCE AND IN THE CLASSROOM*

9.1a Barber, B. (1961). Resistance by scientists to scientific discovery. *Science, 134*, 596-602.
9.2a Lessem, D. (1993). Weird Wonders Fuel the Battle over Evolution's Path. *Smithsonian, 23*(10), 107-115.
9.3a Lewin, R. (1992). Whose View of Life? *Discover, 15*(5) 18-19.
9.4b Morris, S. C. and Gould, S. J. (1998, December). Showdown on the Burgess Shale. *Natural History*, 48-55.
9.5c Strike, K. A. and Posner, G. J. (1982). Conceptual Change and Science Teaching. *European Journal of Science Education, 4*(3), 231-240.
9.6c Gauld (1989). A Study of Pupil's Responses to Empirical Evidence. In *Doing Science*. R. Millar (Ed.) Philadelphia: The Falmer Press/Taylor and Francis. (Pp. 62-82).
9.7c Millar, R. (1989). Bending the Evidence: The Relationship between Theory and Experiment in Science Education. Philadelphia: The Falmer Press/Taylor and Francis. (Pp. 38-61)
9.8d Finley, F. (1983). Science Processes. *Journal of Research in Science Teaching, 20*(1), 47-54.
9.9d Driver, R. (1983). From Theory to Practice from *The Pupil as Scientist?* Philadelphia: Open University Press (Pp. 73-84).
9.10e Driver, R. (1983). Invention and Imagination from *The Pupil as Scientist?* Philadelphia: Open University Press. (Pp. 41-49)

Session #10 Theme: *SCIENCE AND SCIENCE EDUCATION (Part I)*

10.1a Abimbola, I. O. (1983). The Relevance of the 'New' Philosophy of Science for the Science Curriculum. *School Science and Mathematics. 83*(3), 182-190.
10.2a Martin, M. (1972). Introduction to *Concepts of Science Education.* Glenview, IL: Scott, Foresman and Company. (Pp. 1-4).
10.3a Matthews, M. (1989). A Role for History and Philosophy in Science Teaching. *Interchange 20*(2), 3-15.
10.4a Hodson, D. (1988). Toward a Philosophically More Valid Science Curriculum. *Science Education, 72*(1), 19-40.
10.5a Matthews, M. (1992). History, Philosophy and Science Teaching: The Present Rapprochement. *Science and Education, 1*(1), 11-47.
10.6a McComas, W. F. (1997). The Discovery and Nature of Evolution by Natural Selection. *American Biology Teacher, 59*(8), 492-500.

Session #11 Theme: *SCIENCE AND SCIENCE EDUCATION (Part II)*

11.1a American Association for the Advancement of Science (1994). The Nature of Science: Benchmarks from *Benchmarks for Science Literacy*. New York: Oxford University Press.
11.2a National Research Council (1996). The Nature and History of Science sections from *The National Science Education Standards.* Washington, DC: National Academy Press.

The selection above is *not* included in the readings packet since I assume (and hope) that you

own a copy of the *National Science Education Standards*.

11.3a McComas, W. F., Clough, M, and Almazroa, H. (1998). The Role and Character of the Nature of Science (Part II), in W. F. McComas (ed). *The Nature of Science in Science Education*. Boston: Kluwer (Springer) Academic Publishing Company (Pp. 21-39).

Session #12 Theme: *THE SOCIETY OF SCIENCE*

12.1a Kiefer, G. F. (1979). Science and Society from *Bioethics: A Textbook of Ideas* (Pp. 413-442).Reading, MA: Addison-Wesley, Inc.
12.2a Thompson, D. (November 23, 1992). Science's Big Shift. *Time*. (Pp. 34-35)
12.3b Collins, H. M. (1983). The Sociology of Scientific Knowledge: Studies of Contemporary Science. *Annual Review of Sociology. 9*(1), 265-285.
12.4b Mendelsohn, E. (1977). The Social Construction of Scientific Knowledge. E. Mendelsohn, P. Weingart and R. Whitley (Eds.) *The Social Production of Scientific Knowledge. Sociology of the Sciences*, Vol I, 3-26. Boston: D. Reidel Publishing Co.
12.5b Lemonick, M. D. (2006). *The Rise and Fall of the Cloning King*. Time, *167*(2).

Session #14 Theme: *SCIENCE and SOCIETY: A CONFLICT BETWEEN SCIENCE & RELIGION?*

13.1a Gould, S. J. (1997, March). Nonoverlapping magisteria. *Natural History, 106*(2), 16-18, 22, 60-62.
13.2a Woodward, K. L. (1998, July 20). How the heavens go. *Newsweek*, 52.
13.3a Lemonick, M.D. and Nash, M. (2004, November 29). Cosmic Conundrum. *Time*, 58-61.
13.4a Larson, E. J. and Witham, L. (1999, September). Scientists and Religion in America. *Scientific American*, 88-91.
13.5a Tyson, N. deG. (1999, October). Holy wars. *Natural History, 108*(8), 80-82.
13.6a Shermer, M. (2000). Selection from *How We Believe: The Search for God in the Age of Science.* New York: W. H. Freeman and Company.
13.7a Will, G. F. (1998, November 9). The Gospel from Science. *Newsweek.*
13.8a Ruse, M. (2003). The Mismeasure of Science. *Natural History, 112*(6), 52-55 & 58.
13.9a McComas, W. F. (2005). Philosophical Challenges in Evolution Education. Chapter 3 in W.F. McComas (ed). Investigating Evolutionary Biology in the Laboratory: An Extended Laboratory Resource Guide. Dubuque, IA: Kendal Hunt Publishing Company.
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FINAL EXAMINATION Time TBA