Course syllabus:

Foundations of Science Education

BTNY/CHEM/GEO/MICR/PHYS/ZOOL 3570
Fall 2009

Overview

This course will introduce you to science teaching by analyzing what science is and how we learn it. You will investigate what science is by doing some of it yourself, understanding major arguments from the philosophy of science, and analyzing the portrayal of science in the classroom. You will also understand research in science education that attempts to make sense of how we learn science and where we do not learn science as it should be. Assembling these ideas for yourself should enable you to understand your own philosophy of science teaching and allow you to better implement teaching strategies and develop science curricula for your classroom in the future.

Learning objectives

- Develop a personal understanding of the goal of scientific literacy, and be able to produce and justify a philosophy of teaching based on such an understanding.
- Understand current research regarding science learning, as well as its application to science teaching and assessment.
- Understand the nature of scientific knowledge and its philosophical underpinnings and be able to integrate these understandings with traditional discipline specific content knowledge and scientific inquiry.
- Become familiar with national and state level science curriculum standards and recommendations.

Details

Instructor: Adam Johnston
Office: SL 207
Phone: 626-7711 (Ext. 7711 on campus)
E-mail: ajohnston@weber.edu
Office Hours: Tue/Wed/Thur, 8:30 – 10:20a

Note that "office hours" are not the only times that I'll be in my office. If you would like to stop by and I'm around, I'm almost always happy to talk to you. (On Mondays, Fridays, and Thursday afternoons I am in the university's *Teaching & Learning Forum* office in the library, room 057B.) You are also welcome to schedule appointments as necessary.

Meeting time: Tue/Thur 10:30 - 11:45a
Final exam period: Thur, Dec. 10; 10:30a - 12:20p
Meeting place: LL 230
Course Web Page: http://physics.weber.edu/johnston/scied/

From this web page, links to other resources, information, and class research will be given. In addition, course announcements and assignments will be posted here, as well as a space for posting student work and online discussions.

Texts/readings

All assigned readings for this course will be placed on reserve and/or ereserve in the library, or will otherwise be made readily accessible (e.g., as a link to an electronic journal or other website). Selections of readings will come from some of the following, as well as others:

- *The New York Times*, available Monday – Friday in campus newsstands (free to students). In particular, we'll highlight some case studies in science from the *Science Times* in the Tuesday edition.
- AAAS (1990). Science for All Americans: Project 2061. Oxford University Press.
- Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). Making Sense of Secondary science. London: Routledge. Kuhn, T. S. (1962). Historical structure of scientific discovery. Science, 136(3518), 760-764.
- McComas, W. F. (1996). Ten myths of science: Reexamining what we think we know . . . School Science and Mathematics, 96(1), 10-16.
- National Research Council (2005). How Students Learn: Science in the Classroom. National Academies Press.
- National Research Council (2007). Taking Science To School. National Academies Press.
- Popper, K. R. (1962). Conjectures and Refutations: The Growth of Scientific Knowledge. New York: Basic Books.
- Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. Science Education, 66(2), 211-227.
- Reynolds, R. E., Sinatra, G. M., & Jetton, T. L. (1996). Views of knowledge acquisition and representation: A continuum from experience-centered to mind-centered. Educational Psychologist, 31(2), 93-104.
- Settlage, J., & Southerland, S. A. (2007). The Nature of Science. In Teaching Science to Every Child: Using Culture as a

Starting Point (pp. 185-209). New York: Taylor & Francis.
- Smith, M. U., & Scharmann, L. C. (1999). Defining versus describing the nature of science: A pragmatic analysis for classroom teachers and science educators. Science Education, 83(4), 493-509.
- Windschitl, M. (2008). What is inquiry? A framework for thinking about authentic scientific practice in the classroom. In J. Luft, R. L. Bell & J. Gess-Newsome (Eds.), Science as Inquiry in the Secondary Setting (pp. 1-20). Arlington, VA: NSTA Press.

Assessment & Evaluation:

You will be assessed/graded on a spectrum of activities, skills, and understandings:

- **Professionalism**: 10%. Professional behavior is expected at all times in class and while collaborating outside of class with others to complete work related to the class. These behaviors include, but are not limited to: attendance, punctuality, excellence in class assignments, constructive class participation, being a positive contributor in group work, taking advantage of opportunities to broaden personal knowledge and skills, effectively communicating with your course instructor, members of the class, and of the wider science education community. Note: A student who neglects professional behavior regularly or who does not participate in major assignments and presentations will not receive a passing grade in the course.
- **Response papers**: 20%. Students are expected to prepare for classes by writing responses to specific questions and/or reading assignments. These papers will be assigned along with course readings approximately every week.
- **Class laboratories, assignments, and other investigations**: 20%. In addition to class discussions, students will be expected to participate in and report upon mini-laboratory investigations in the course, appropriate for multiple disciplines and a range of learning goals (i.e., these labs will be both scientifically worthy in the university classroom and appropriate for the middle school classroom). You will also be doing an array of assignments, ranging from developing a teaching philosophy to deciding whether or not the study of umbrellas is "science".
- **Scientific research project**: 20%. Each student will develop and conduct a scientific investigation and present results in a written report. This project will take place over most of the semester and will involve a proposal to a hypothetical grant agency, conduction of the research, submission to a journal editor (your friendly course instructor) and peer review (from your classmates). We will compile our findings in our own research journal.
- **Science education research project**: 20%. Each student will investigate in depth an issue in science learning. This work will be disseminated to the rest of the class and archived for future sections of the same class.
- **Portfolio**: 10%. At the end of the regular semester, you will re-submit previous work, including (but not limited to) all previous response papers. After re-reading and reconsidering your own thinking and experiences during the semester, you will compose a final essay that summarizes your changes in ideas during the semester. More details of this assignment will be handed out towards the end of the semester, but you should be aware of this task so that you are sure to *save* all of your work throughout the course.

Important notes

- You are a vital part of this course and its success, and for this reason you need to show up regularly. Many other reasons exist to justify you waking up for a 10:30 AM class: First, the material covered in class is such that it is very difficult to get the same understandings and experiences on your own time outside of class. Second, there will occasionally be stuff to play with and/or assignments to hand out. Third, your grade is determined by your participation and contributions to class. Finally, your instructor is known for doing idiotic, life-threatening (to himself, not to you) labs and demonstrations, and it is always interesting to see what might happen next.
- Late work will be accepted for half credit if it is turned in within a week of its due date. Individual "dog-ate-it" and "had-to-get-married" stories will be considered on a case-by-case basis. To get more leniency, notify the instructor prior to any problems you might anticipate.
- Of course, if you're ill, there are good reasons *not* to be in class. Please stay home when you're sick, and make arrangements to turn in work electronically. We can supplement instruction with online discussion and email, and whenever possible assignments and readings will be made available via the course website. In addition, in the case that class can't be held (because the instructor is sick, campus is closed, etc.), class announcements will be made via email and course webpage tools.
- Academic dishonesty on any work will not be tolerated. Extreme violations will result in automatic failure of the course. In this course, it is difficult to imagine what academic dishonesty would look like, since so much work is a creative, personal endeavor. Be aware, however, that professionalism is a part of your course grade, and you should reflect the same integrity that you would expect from your own students.
- Any student requiring accommodations or services due to a disability must contact Services for Students with Disabilities (SSD) in room 181 of the Student Service Center. SSD can also arrange to provide course materials (including this syllabus) in alternative formats if necessary. You are also welcome to discuss any special needs with the instructor, though you are not required to do so.

- This is intended to be a very interactive and student centered classroom. Please help us to make it so both by participating in class and by offering suggestions as to how to better structure the class. An inherent philosophy of this class is that knowledge is constructed in social arenas, so the expectation is that there will be great inspirations and new realizations made as we interact with one another. In fact, one of the benefits of teaching this class is that an instructor tends to learn as much (or more) from students as students should learn from instructors.
- Please do not hesitate to visit the instructor if you have any questions, concerns or comments about the course, or to discuss favorite cross-country ski routes, photography, music, poetry, physics, pottery, yeast, backpacking trails, etc. Often an instructor sits in an office, lonely and sad, during hours that should be filled with student interactions; so please feel free to drop in, even if it isn't during a posted office hour. (The worst that could happen is you would be told to come back at another time.) Also, email tends to be an incredibly useful mechanism for getting in contact with instructors and getting your questions or comments responded to.

Calendar:
The following is our current plan. Plans change, of course, but this will be in effect unless you're told otherwise. Updates will be made to the course webpage.

Tuesday	Thursday
August 25 **Introductions**. **Discuss**: What is "science" and what is "learning"?	**27** **Lab:** Blowing of bubbles and stirrings of hot chocolate **Assign:** Scudder, Collins, Lee et al.; response paper
Sept. 1 **Introduce** science research projects (*Cross Section*). **Form** research groups and standards. **Lab:** Fluid mass and volume.	**3** **Debrief** fluids lab **Lab**: Copters data collection and data analysis
8 **Lab [continued]**: Copters data collection and data analysis **Assign**: Popper, Kuhn, Lightman; response paper	**10** ***Cross Section* proposals DUE** **Discuss**: "Scientific method" and the question of umbrellaology.
17 Meeting of the AACD: **Present Copter research** ***Cross Section* proposals returned**	**17** **Debrief:** Data analysis **Discuss**: Demarcation, utility, and knowledge of science **Assign**: Settlage & Southerland, McComas; response paper
22 **Workday**: Research projects	**24** **Discuss**: Fact, Law, Theory, and Myths of science. Define/refine meanings of science, and perspectives from psychology **Assign**: Johnston & Southerland; response paper
29 **Discuss**: Data -- observation and inference; "Tracks" **Lab**: Measuring a molecule	**1** **Lab:** Pseudoscience **Assign**: Park; Smith & Scharmann; Pseudoscience analysis
6 **Debrief/Report:** Pseudoscience	**8** **Discuss**: Science and religion and the nature of knowing(s) **Assign:** "Letter to the editor" (response paper)
13	**15** **Discuss**: A brief history of science education and an

Lab: Teaching philosophy inventory **Assign**: Reynolds et al.; response paper	Introduction to learning theory
20 **Discuss:** Private Universe(s) **Assign:** Misconception interviews	**22** **Lab:** Misconceiving the Moon and other phenomena -- activity and interviews
27 **Discuss**: What does it mean to learn? A brief overview of learning theory(ies) through the ages.	**29** **Report:** Misconception interviews **Assign:** Driver et al., Strike & Posner; response paper
Nov. 3 **Discuss**: Misconceptions, constructivism and conceptual change theory; Theoretical frameworks, ontological categories, and phenomenological primitives! **Assign:** Misconception research	**5** **Discuss**: Misconceptions and teaching the Nature of Science **Assign:** Windschitl, Settlage, Johnston; response paper
10 **Discuss**: Other views of learning: Identity, extrarational considerations	**12** **Discuss:** The ideal of inquiry: What, How, and Why? **Assign:** Ladson-Billings; response paper
17 **Discuss:** What are YOUR misconceptions? What makes a good instrument?	**19** **Lab**: The perfect curriculum: Goals, objectives, assessments, and ideals **Assign:** Carlone; response paper
24 **Discuss:** Diverse learners in the science classroom	**26** HOLIDAY
Dec. 1 **Discuss**: Identity and learning	**3** **Lab**: The Utah State Core Curriculum: Standards and Objectives and Indicators, oh my! Final debriefing and loose ends
Thursday, Dec.10; 10:30a **Misconception Research Symposium**	