Research and practice in teaching and learning science
Education 286

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Spring 2003
Center for Adaptive Optics conference room
1:00-2:45

The Research and practice in teaching and learning science course is specifically designed for scientists who want to explore science inquiry teaching and learning. The course will focus on undergraduate and graduate level teaching but is applicable for those teaching high school students as well as in informal learning settings, such as museums. The focus will be on three areas: research on best teaching practice, for example teaching in both small and large groups; learning, what research says about learners; and last, how both of these relate to science inquiry. Each class participant will be expected to design and put into practice several lessons based on these three main areas, science teaching, learning and inquiry.

Logistics
• This is designed as a five-credit course, including both seminar and lab.
• No prior education courses are required.
• The laboratory component will focus on science inquiry; two laboratory sessions will be held at the Exploratorium; these are scheduled for April 7 and 28
• Regular meetings at UCSC on Mondays and Wednesdays from 1:00 to 2:45 in the CfAO building conference room. May 14 no class.
• We will have video and teleconference links with other CfAO sites and this course coordinates with the Maui graduate professional development inquiry workshop.
• There are two readers; one with core readings; the second contains supplemental readings that can be used for the design project.

DRAFT 1— 2.17.03

Evaluation

Evaluation will be based on the following

Classroom attendance and participation	10 %
Teaching and Assessment Design	
Project Research and Background	20 %
Assessment plan	20 %
Teaching Event practice	20 %
Final documentation	30 %

Narrative Evaluation Format

Overall, this student's participation and written assignments indicated
- impressive
- well-developed
- a good working
- satisfactory
- uneven
- minimal
- understanding of the ideas in the course.

Class participation:
- made strong contributions to class meetings
- was clearly engaged during class meetings
- contributed insightful ideas and supported other students' learning
- listened actively and contributed to the classroom dynamics
- attended class regularly
- was usually present
- attended irregularly
- was often absent

Written assignments

The required Teaching and Assessment Design was:
- extraordinary, with coherent analysis that integrated ideas and evidence in well-developed and eloquent reflections
- very well developed, with clear connections between ideas and evidence to support the arguments
- of good sound quality, reflecting active engagement with the topic, though in places the work would have benefited from being pushed further
- satisfactory though somewhat uneven times sketchy and not sufficiently grounded in the course materials or not addressing the topic fully
- not satisfactory, either showing a lack of adequate engagement with the topic or not turned in at all.

Day 1 **April 2**

Introduction

Overview of the course
Readings, Scheduling
Design Events, four part design
in teaching and assessment in inquiry science
Part 1 due April 16

Classroom discussion
Discussion on views of Science.

For April 7
Preparation for next week at the Exploratorium
WWW.exploratorium.edu
Visit the Teacher Institute website
http://WWW.exploratorium.edu/ti/
Find one activity that interests you for potential teaching—
Down load and be ready to discuss.
Visit the Institute for Inquiry site and view 3 kinds of hands-on teaching
http://www.nsf.gov/pubs/2000/nsf99148/ch_6.htm

Week 1

Inquiry and other forms of teaching **April 7**

At the Exploratorium April 7 1-4 PM
(Time before that to observe 10-12)
A laboratory exercise in distinguishing inquiry from other ways of teaching science
With Exploratorium experts
Barry Kluger-Bell and Candice Brown

For April 9
1. National Academy Press (1999). How people learn., Bridging Research and Practice (if you haven't read this already)
2. National Research Council (1996). Images of inquiry in the classroom, National Science Education Standards

Debrief and discussion of the Exploratorium experience **April 9**
Reflective video of the experience
Forms of assessment to match this kind of teaching and learning
Some samples

For April 14
Using the resources list at the end of this document, come prepared with information on one of science education researcher in a content area (astronomy. physics, biology, etc) or choose one of your own that explores high school or college students understandings of science.
Have ready a one page synopsis from which to teach others.

Week 2 **April 14**

Design principles for science teaching and assessment
Backwards design
Match activity to purpose
Deliberate sequencing

April 16

1. Wiggins, G. and McTighe, J. (1998). What is Backward Design? Understanding by Design, Association for Supervision and Curriculum Development.
2. California State Science Content Standards 9-12 scan

The Design Project part 1 **April 16**

Designing for Inquiry
Part 1 is due—Discussion

For April 21 --Jigsaw

Each person will read one of these

1. Assessing the inquiry experience Black, P. & Wiliam, D. (1998). Inside the black box. Kappan.
2. National Academy Press (2001) The nature of assessment and reasoning from evidence, In Knowing What they Know. Chapter 2
3. The Astronomy test/the physics diagnostic tests

Week 3 **April 21**

Assessment continued
Jigsaw of reading

For April 30

Content readings in the sciences

Choose one of the following

1. Cartier, J. & Stewart, J. (2000) Teaching the nature of inquiry: Further development in a high school genetics curriculum Science and Education (9): 247-267
2. Hammer, D, (1996). More than misconceptions: Multiple perspectives in student knowledge and reasoning, and an appropriate agenda for education research. American Journal of Physics 64(10) pp 1316-1325.
3. Minstrell, J. (1999). Implications for teaching and learning inquiry: A summary. . In Teaching and Learning in an inquiry-based classroom (Eds.) J. Minstrell & E. Van Zee: AAAS.

April 23

Jigsaw on content
Role of teaching structures, matching activity to purpose

For April 28
TBA

Week 4

Exploratorium inquiry experience 9-4 April 28

At the Exploratorium 9-4

A day-long inquiry experience with Exploratorium experts Barry Kluger-Bell and Candice Brown

For April 30

1. Read Brown et al, 1993, Distributed Expertise or
2. How People Learn chapter on Classroom Design or
3. Wiggins, G. and McTighe, J. (1998). Implications For Organizing Curriculum. Understanding by Design, Association for Supervision and Curriculum Development.

Matching assessment to design April 30

Part 2 of design due
The assessment piece

For May 5

1. Trends in Undergraduate Education, Science 293 (5535) p. 1607-1626
2. Gallas, K (1995) What is science? In Talking their way into science. Teachers College Press.
3. Wiggins, G. and McTighe, J. (1998). Thinking Like An Assessor. Understanding by Design, Association for Supervision and Curriculum Development.

Week 5-6 May 5

Teaching
Large group ands mall
Participation structures

For May 7
TBA

May 7

Matching teaching to assessment
Large format lecture

For May 12

Read on e of the following

1. Lemke, J. (1993). Two minutes in one science classroom. Talking Science; Language, Learning and values. Ablex.
2. Ogborn, et al (1995) Classroom explaining and science, in Explaining Science, Open University Press.
3. Ogborn, et al (1995) Dynamics of explanation, in Explaining Science, Open University Press.
4. Wells, G (1999). Dialogic Inquiry chapter in Action, Talk and Text, Teachers' College Press

May 12

Discussion on talking science

Different viewing of making sense of sense dialogically

No class May 14

Week 7-8 **May 19**

Equity and Science Teaching and Learning

An overview of equity issues

For May 26

Read

1. Rosebery, A.S., Warren, B, Conant, F. R., & Hudicourt-Barnes, J. (1992) Cheche Konnen: Scientific sense-making in bilingual education. Hands On! 15(1), 1, 16-19.

2. Stigler, J. and Hiebert, J. (1999). Teaching is a cultural activity. In The Teaching Gap. (Chapter 6, pages 85-101). The Free Press

May 21

Design project part 3 is due

May 26

Reading

As above

May 28

Reading

TBA

Week 9

Putting it all together **June 2**

June 4

Last class

Resources

Physics
Physics education research group
Univ of Washington
http://www.phys.washington.edu/groups/peg/
Physics by Inquiry
http://www.phys.washington.edu/groups/peg/pbi.html
Physics demos
http://www.physics.ncsu.edu/pira/demosite.html
Univ of Maryland Physics lecture/demo facility
http://www.physics.umd.edu/deptinfo/facilities/lecdem/

Biology
Biology undergraduate education
http://www.hhmi.org/BeyondBio101/

Astronomy
Undergraduate Research Educational Initiative
At Haystack

Improving the Quality of Undergraduate Astronomy Courses
A Selected List of Web Sites for Instructors of Introductory
Astronomy Courses
http://www.physics.ncsu.edu/pira/demosite.html

Astronomy diagnostic test
http://solar.physics.montana.edu/aae/adt/
http://www.physics.umd.edu/deptinfo/facilities/lecdem/services/demos/subtopicse.htm

University of Maryland Demos
E1. GRAVITATION AND ORBITS
E2-24: UMBRA AND PENUMBRA - COLOR FILTERS
http://www.physics.umd.edu/deptinfo/facilities/lecdem/services/demos/demose2/e2-24.htm

Other
Collaborative Learning
NISE
National Institute of Science Education
http://www.wcer.wisc.edu/nise/cl1/
http://www.wcer.wisc.edu/nise/cl1/CL/doingcl/DCL1.asp
http://www.wcer.wisc.edu/nise/cl1/CL/resource/R1.asp

Role-Playing and Problem-Based Exercises for Teaching
Undergraduate Astronomy
http://msowww.anu.edu.au/%7Epfrancis/roleplay.html

Other Online resources

National Research Council (1995) **National science education standards.** (1995) Center for Science, Mathematics, and Engineering Education (more titles from CSMEE)
http://books.nap.edu/books/0309053269/html

Steve Olson and Susan Loucks-Horsley, Editors (1998**). Inquiry and the National Science Education Standards: A Guide for Teaching and Learning**. Committee on the Development of an Addendum to the National Science Education Standards on Scientific Inquiry, National Research Council
http://www.nap.edu/catalog/9596.html

Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom: A monograph for professionals in science, mathematics, and technology education
Written by Institute for Inquiry Staff and Colleagues for the FOUNDATIONS series, published by the National Science Foundation.
http://www.exploratorium.com/IFI/resources/ifibook.html

Core Reader

Black, P. & Wiliam, D. (1998). In side the black box. Kappan.

Brown, A. L., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A., & Campione, J.C. (1993). Distributed expertise in the classroom. In G. Salomon(Ed.), Distributed Cognitions.

California State Science Framework and Content Standards, K-12

Cartier, J. & Stewart, J. (2000) Teaching the nature of inquiry: Further development in a high school genetics curriculum Science and Education (9): 247-267.

Gallas, K (1995) Science Talk In Talking their way into science. Teachers College Press.

Hammer, D. (1995) more than misconception: Mulktiople persectives on student knowledgfe and reasojnging, and an aplpropriate role for education research. American Jourhnal of Physics **64**(10), 1316-1325**.**

Lemke, J. (1993). Two minutes in one scence classroom. Talking Science; Language, Learning and values. Ablex.

Minstrell, J. (1999). Implications for teaching and learning inquiry: A summary. . In Teaching and Learning in an inquiry-based classroom (Eds.) J. Minstrell & E. Van Zee: AAAS.

National Academy Press (2001) The nature of assessment and reasoning from evidence, In Knowing What they Know.

National Academy Press (1999). Learning and Transfer. In How People Learn.

National Research Council (1996) National science education standards.

Ogborn, et al (1995) Classroom explaining and science, in Explaining Science, Open University Press.

Ogborn, et al (1995) Dynamics of explanation, in Explaining Science, Open University Press.

Stigler, J. and Hiebert, J. (1999). Teaching is a cultural activity. In The Teaching Gap. (Chapter 6, pages 85-101). The Free Press.

Rosebery, A.S., Warren, B, Conant, F. R., & Hudicourt-Barnes, J. (1992) Cheche Konne: Scientific sense-making in bilingual education. Hands On! 15(1), 1, 16-19.

Wells (1999) Dialogic Inquiry chapter in Action, Talk and Text, Teachers' College Press.

Wiggins, G. and McTighe, J. (1998). What is Backward Design? Understanding by Design, Association for Supervision and Curriculum Development.

Wiggins, G. and McTighe, J. (1998). Implications For Organizing Curriculum. Understanding by Design, Association for Supervision and Curriculum Development.

Wiggins, G. and McTighe, J. (1998). Thinking Like An Assessor. Understanding by Design, Association for Supervision and Curriculum Development.

Supplemental

Barnett, J. & Hodson, D. (2001). Pedagogical context knowledge: Toward a fuller understanding of what good science teachers know Science Education 85(4) pp. 426-453.

Brown, A. (1997) Transforming schools into communities of thinking and learning about serious matters. American Psychologist. 52(4) pp 399-413.

Brickhouse, et al. Young Women's Scientific Identity Formation in an Urban Context. Journal of Research in Science Teaching. Vol. 38, No. 8, PP. 965-980 (2001).

Bowen, et al. (2002). Constructions of nature and Scientific Authority in Ecotourism Activities: Learning to "look" at whales. Paper presented at AERA, New Orleans

Chiappetta. et al 1, (1998) The nature of Science (chap 1) in Science Instruction in the Middle and Secondary Schools. Prentice Hall.

Hogan, K. Small Groups' Ecological Reasoning While making an Environmental Management Decision. Journal of Research in Science Teaching. Vol. 39, No. 4, PP. 341-368 (2002).

Lehrer, et al. Reasoning about Structure and Function: Children's Conception of Gears. Journal of Research in Science Teaching. Vol. 35, No. 1, PP. 3-25 (1998).

Linn, M. et al, (2000). Beyond fourth-grade science: why do US and Japanese students diverge. Educational Researcher 29(3). pp 4-14.

Linn, R., (2000). Assessments and accountability, Educational Researcher (March) pp 4-16.

Lynch, S. Conclusion "Science for All" Is Not Equal to "One Size Fits All": Linguistic and Cultural Diversity and Science Education Reform. Journal of Research in Science Teaching. Vol. 38, No. 5, PP. 622-627 (2001).

Mayr, E. (1988). Is there an autonomous biology? in Toward a new philosophy of biology.

Metz, K. (1995). Reassessment of developmental constraints on children's science. In Review of Educational Research.

Moje, et al. "Maestro, What is 'Quality'?": Language, Literacy, and Discourse in

Project-Based Science. Journal of Research in Science Teaching. Vol. 38, No. 4, PP. 469-498 (2001).

Pittman, K. Student-Generated Analogies: Another Way of Knowing? Journal of Research in Science Teaching. Vol. 36, No. 1.PP. 1-22 (1999).

Roth, K. Talking to Understand Science, Unpublished paper

Southerland, S. A. et al (2001) Understanding students' explanations of biological phenomena: Conceptual frameworks or P--prims. Science Education 85(4) 328-347.

Van Zee, et al. Student and Teacher Questioning during Conversations about Science. Journal of Research in Science Teaching. Vol. 38, No. 2, PP. 159-190 (2001).

Warren, et al. Rethinking Diversity in Learning Science: The Logic of Everyday Sense-Making. Journal of Research in Science Teaching. Vol. 38, No. 5, PP. 529-552 (2001).

Windschitl, M.. (2002). Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice? Science Education

Wright, R. (1999). The accidental creationist: why Stephen Jay Gould is bad for evolution. New Yorker. December. pp 56- 65.