

CHM 710 – Topics in Chemistry Education
Chemistry Misconceptions and Conceptual Change
Course Syllabus – Fall 2006
2 credits, Mondays, 5 – 7 p.m.

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COURSE OVERVIEW

This course critically examines the current status of research in the area of chemical misconceptions and conceptual change theories. Students will explore common misconceptions about chemistry, and examine different theories of conceptual change that describe how to correct such misconceptions. The course will provide students with opportunities to probe learners' prior ideas and to consider the role of assessment in emphasizing deeper understanding over memorization. The course is designed for graduate students in the sciences who may or may not be familiar with the theories and techniques of science education research.

COURSE OBJECTIVES

- To develop the ability to critically analyze published research.
- To develop an understanding of different research methodologies in chemistry education.
- To become familiar with some of the major models, theories, research questions, and studies of misconceptions and conceptual change as applied to chemistry.

TEXTBOOKS (Note: Copies of optional texts as well as other references available in 363 Hughes.)

1. Driver, R.; Guesne, E; and Tiberghien, A. (1985). *Children's Ideas in Science*. Philadelphia: Open University Press. (required)
2. Driver, R.; Squires, A.; Rushworth, P. and Wood-Robinson, V. (1994). *Making Sense of Secondary Science: Research into Children's Ideas*. New York: Routledge. (required)
3. Keeley, P.; Eberle, F.; and Farrin, L. (2005). *Uncovering Students' Ideas in Science: 25 Formative Assessment Probes*. Arlington: National Science Teachers' Association Press. (optional)
4. Stepan, J. (2003). *Targeting Students' Science Misconceptions: Physical Science Concepts Using the Conceptual Change Model*. Tampa: Showboard. (optional)

COURSE ASSIGNMENTS

Each week we will meet to discuss articles from the research literature regarding student misconceptions about chemical concepts. A partial bibliography is provided at the end of this syllabus. Students are encouraged to identify additional research studies beyond those listed.

Students will be required to actively participate in the discussion and analysis of each article every week, and they will also be required to work in pairs as lead discussants for articles on a rotating basis throughout the semester. Students will take turns selecting articles from the literature regarding the topics identified in the course calendar below.

Students are expected to actively participate in discussion, i.e., contribute in the form of both questions and comments regarding the readings. Lead discussants should assess their classmates' understanding of the topic during the week prior to the class they will lead. Lead discussants are expected to present a short summary of the reading and give their own reactions to the readings. The summary and discussion should be conducted in an interactive and interesting manner, not simply presented as a dry assembly of facts. We will discuss how to do this in class. A lead discussant is also expected to participate more actively in the discussion.

Students will keep a journal throughout the semester regarding their thoughts and reactions to course content, including recognition of their own conceptual understanding as well as that of their students and peers. In lieu of a final exam, students will write a paper (6-8 pages) reflecting on their journal entries. More details will be provided in a separate handout.

ASSESSMENT

Participation in discussion	40%
Performance as lead discussant	40%
Final Paper based on Journal	20%

90 -100% =A, 80-89% =B, 70-79% =C, 60-69% =D, 59% or lower = F

COURSE CALENDAR

<u>Week</u>	<u>Discussion Topic</u>	<u>Readings</u>
8/28	Nature of Misconceptions	“Minds of their Own” Chemical Concept Inventory
9/5 (Tuesday, switch day)	Nature of Misconceptions	Taber (2002a), Chapter 1 Driver (1985), Chapter 1 Bodner (1991)
9/11	What is a Concept?	Driver (1994), Introduction Taber (2002a), Chapter 2 Nakhleh (1992)

From 9/18 to 11/13, students will work in pairs as lead discussants from among the following topics:

- Particulate Nature of Matter
- Elements, & Compounds /Atoms, Ions & Molecules
- Physical Changes / States of Matter
- Chemical Changes /Chemical Reactions / Balanced Equations
- Heat & Temperature
- Equilibrium
- Electrochemistry
- Acids and Bases
- Reaction Mechanisms
- Chemical Bonding
- Water & Air
- Density
- Kinetics
- Energetics
- Light
- Gases
- Other topics with prior approval of Professor Bretz

11/20	Conceptual Change Models
11/27	Conceptual Change Models
12/4	Course Wrap-up

READINGS ON ELECTRONIC RESERVE (Note: access on Blackboard, password: CHM710)

- DeJong, O. and Treagust, D. (2002). The teaching and learning of electrochemistry. In J.K. Gilbert *et al.* (Eds.) *Chemical Education: Towards Research-based Practice*, pp. 317-337. Netherlands: Kluwer Academic Publishers.
- Duschl, R.A. and Hamilton, R.J. (1998). Conceptual change in science and in the learning of science. In B.J. Fraser and K.G. Tobin (Eds.) *International Handbook of Science Education*, Vol. 2, pp. 1047-1066. Netherlands: Kluwer Academic Publishers.
- Goedhart, M.J. and Kaper, W. (2002). From chemical energetics to chemical thermodynamics. In J.K. Gilbert *et al.* (Eds.) *Chemical Education: Towards Research-based Practice*, pp. 339-362. Netherlands: Kluwer Academic Publishers.
- Harrison, A.G. and Treagust, D.F. (2002). The particulate nature of matter: Challenges in understanding the submicroscopic world. In J.K. Gilbert *et al.* (Eds.) *Chemical Education: Towards Research-based Practice*, pp. 189-212. Netherlands: Kluwer Academic Publishers.
- Hewson, P.W., Beeth, M.E., and Thorley, N.R. (1998). Teaching for conceptual change. In B.J. Fraser and K.G. Tobin (Eds.) *International Handbook of Science Education*, Vol. 1, pp. 199-218. Netherlands: Kluwer Academic Publishers.
- Holcombe, E.S. (2001). (Mis)Understandings in Science. In *Science Teaching/Science Learning: Constructivist Learning in Urban Classrooms*, pp. 75-91. New York: Teachers College Press.
- Justi, R. (2002). Teaching and learning chemical kinetics. In J.K. Gilbert *et al.* (Eds.) *Chemical Education: Towards Research-based Practice*, pp. 293-315. Netherlands: Kluwer Academic Publishers.
- Stepan, J. (2003). Heat. In *Targeting Students' Science Misconceptions: Physical Science Concepts Using the Conceptual Change Model*, pp. 159-171. Tampa: Showboard.
- Stepan, J. (2003). Matter. In *Targeting Students' Science Misconceptions: Physical Science Concepts Using the Conceptual Change Model*, pp. 19-32. Tampa: Showboard.
- Stepan, J. (2003). Misconceptions and conceptual change: An introduction. In *Targeting Students' Science Misconceptions: Physical Science Concepts Using the Conceptual Change Model*, pp. 1-17. Tampa: Showboard.
- Stepan, J. (2003). More recent concepts. In *Targeting Students' Science Misconceptions: Physical Science Concepts Using the Conceptual Change Model*, pp. 235-259. Tampa: Showboard.
- Taber, K. (2002). Concepts in chemistry. *Chemical misconceptions-prevention, diagnosis and cure. Volume 1*, pp. 11-29. London: Royal Society of Chemistry.
- Taber, K. (2002). Alternative conceptions in teaching chemistry. *Chemical misconceptions-prevention, diagnosis and cure. Volume 1*, pp. 1-9. London: Royal Society of Chemistry.
- Taber, K.S. and Coll, R.K. (2002). Bonding. In J.K. Gilbert *et al.* (Eds.) *Chemical Education: Towards Research-based Practice*, pp. 213-234. Netherlands: Kluwer Academic Publishers.
- Van Driel, J.H. and Gräber W. (2002). The teaching and learning of chemical equilibrium. In J.K. Gilbert *et al.* (Eds.) *Chemical Education: Towards Research-based Practice*, pp. 271-292. Netherlands: Kluwer Academic Publishers.
- Wandersee, J.H., Mintzes, J.J. & Novak, J.D. (1994). Research on alternative conceptions in science. In D. Gabel (Ed.) *Handbook of Research on Science Teaching and Learning*. New York: Macmillan. Pages 177-210.

WEBSITES

- Duit, R. *Students' and Teachers' Conceptions and Science Education*, <http://www.ipn.uni-kiel.de/aktuell/stcse/stcse.html> (last accessed August 2006).
- Camacho, F.F. *Previous Ideas*, <http://ideasprevias.cinstrum.unam.mx:2048/presentation.htm> (last accessed August 2006).
- Beicher, R.J. *Assessment Instrument Information Page*, <http://www.ncsu.edu/per/TestInfo.html> (last accessed August 2006).

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- Carey, S. & Spelke, E. (1994). Domain-specific knowledge and conceptual change. In L.A. Hirschfeld & S.A. Gelman (Eds.), *Mapping the Mind*, 169-200. Cambridge: Cambridge University Press.
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