Modeling Instruction in High School Chemistry - 1

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REQUIRED TEXT:

- There is no required text for this course

SUPPLEMENTAL READING:

The articles listed here will be provided electronically to the teachers.

- Abud, Gary, Jr. "'For Every' Speak: A Cognitive Approach to Teaching Proportional Reasoning." *Productive & Constructive*. N.p., n.d. Web. 27 Dec. 2012. <http://blog.abud.me/>.
- - - -. "Making Thinking Visible: Using Whiteboards in the Chemistry Classroom." *Productive & Constructive*. N.p., n.d. Web. 27 Dec. 2012. <http://blog.abud.me/>.
- Bowen, Craig W., and Diane M. Bunce. "Testing for Conceptual Understanding in General Chemistry." *The Chemical Educator,* 2.2 (1997): 1-17. Print.
- Dukerich, Larry. "Applying Modeling Instruction to High School Chemistry To Improve Students' Conceptual Understanding." *J. Chem. Educ.*, 2015, 92 (8), pp 1315–1319
- Gabel, Dorothy. "Improving Teaching and Learning through Chemistry Education Research: A Look into the Future." *Journal of Chemical Education,* 76.4 (1999): 548-54. Print.
- Galley, William C. "Exothermic Bond Breaking: A Consistent Misconception." *Journal of Chemical Education,* 81.4 (2004): 523-25. Print.
- Gillespie, Ronald J. "The Great Ideas of Chemistry." *Journal of Chemical Education,* 74.7 (1997): 862-64. Print.
- Kind, Vanessa. "Beyond Appearances: Students' Misconceptions about Basic Chemistry Ideas."
  A Report Prepared for the Royal Society of Chemistry. 2004, Print.
- Michaels, Sarah & Cathy O'Connor. "Talk Science Primer", TERC 2012.
- Royce, Brenda and Larry Dukerich. *Managing Discourse during Class Discussions*. Tempe: Arizona State University, 2005. Print.
- Smithenry, Dennis. "Teaching with Crystal Structures: Helping Students Recognize and Classify the Smallest Repeating Particle in a Substance." *The Science Teacher,* September (2009): 53-57. Print.

COURSE DESCRIPTION:

- This workshop acquaints teachers with all aspects of Modeling Instruction in order to develop skills necessary to implement this student-centered, research-informed, standards-based and evidence-based curricular philosophy with their students. Participants will frequently be asked to play two roles. First, they will be asked to take the role of a novice student in chemistry (similar to their actual students) as they perform

all the laboratory investigations and problem solving that such students will be asked to do. Armed with a taxonomy of common preconceptions and misconceptions students hold will give participants a useful perspective from which they will be better able to address their own student's learning obstacles. Second, they will be asked to play the role of the classroom chemistry teacher where they will be able to practice the techniques of managing student discourse, using Socratic dialogue, and general classroom management in an inquiry-based classroom. Throughout the course, teachers are asked to reflect on their practice and how they might apply the techniques they have learned in the course to their own classes. The principles learned here can be readily transferred to any other sort of classroom instruction.

COURSE TOPICS:

The course addresses both content and pedagogy used to teach the core concepts in a high school chemistry course. The specific units are listed below:

- Unit 1: Physical Properties of Matter – The Particle Model
- Unit 2: Energy and States of Matter – Part 1
- Unit 2: Energy and States of Matter – Part 2
- Unit 4: Describing Substances
- Unit 5: Counting Particles Too Small to See
- Unit 6: Particles with Internal Structure
- Unit 7: Chemical Reactions: Particles and Energy
- Unit 8: Stoichiometry – Part 1

LEARNER OUTCOMES

By the end of this course, students (teachers) will be able to:

- Comprehend and implement a model-centered, guided inquiry method of teaching high school chemistry.
- Integrate computer courseware effectively into the chemistry curriculum.
- Utilize an electronic network support and a learning community among participants.
- Strengthen local institutional support for participants as school leaders in disseminating standards-based reform in science education.

BIG IDEA:

To help participants learn to actively guide their students in the use of scientific models in order to develop experimental and analytical skills, including: experiment design, graphical analysis, mathematical, and diagrammatic model building.

The NGSS standards addressed in this course are:

- NGSS Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

- NGSS Disciplinary Core Ideas

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

TENTATIVE COURSE SCHEDULE

* This syllabus is a tentative schedule of class activities which may be changed to meet student needs. Any changes will be announced ahead of time.

TENTATIVE COURSE SCHEDULE*

Date	Topic	Assignment
Day 1	ABCC pre-test Unit 1: Physical Properties of Matter – The Particle Model overview of Mass and Change-sample data, discuss particle representations measurements of volume, precision and accuracy, mass-volume lab	Read Gabel's *Improving Teaching and Learning Through CER,* Abud, Gary, Jr. *"'For Every' Speak: A Cognitive Approach to Teaching Proportional Reasoning."* - write reaction
Day 2	Interpret mass-volume data -> density, particle representations to account for differences in density in solids, liquids and gases, applications of density, estimates of size of atom	Review Unit 1 Teacher notes, wrote unit reflection
Day 3	Unit 2: Energy and States of Matter – Part 1 Diffusion as evidence of particle motion, temperature as measure of thermal energy, gas pressure and molecular collisions, collect and analyze P-V, P-n and P-T data	Read Abud, "*Making Thinking Visible: Using Whiteboards in the Chemistry Classroom*.", Gillespie: *Great Ideas of Chemistry,* reactions
Day 4	Whiteboard gas relationships, features of KMT, worksheets Unit 3: Energy and States of Matter – Part 2 (phase changes), Icy-Hot lab Intro energy bar charts to represent energy storage and transfer	Unit 2 reflection, Unit 3 energy reading
Day 5	Develop concept of heat capacity, calorimetry, worksheets, teachers practice guided questioning	Unit 3 reflection
Day 6	Unit 4: Describing Substances Characterize mixtures vs pure substances, separation of mixtures, compounds vs mixtures, Dalton model of atom, start empirical formula lab, worksheets	Unit 4 reflection Read Kind: "Beyond Appearances: Students' Misconceptions about Basic Chemistry Ideas."Parts 1-4

	Begin Unit 5: Counting, relative mass lab, molar mass	
Day 7	Discuss reading, finish empirical formula lab, analysis, conclusions, mass-mole problems, Unit 6: Particles with internal structure, sticky tape lab, evidence for Thomson model of atom, begin nail lab	Read Kind: “Beyond Appearances: Students' Misconceptions about Basic Chemistry Ideas.”Parts 5-8
Day 8	Discuss reading, finish nail lab, evidence for ions as charged particles , distinguishing ionic and molecular compounds, Mercury software to visualize structures	Read Smithenry, Dennis. "Teaching with Crystal Structures: Helping Students Recognize and Classify the Smallest Repeating Particle in a Substance." Units 5 & 6 reflection, work on final paper
Day 9	Unit 7: Representing Chemical change, balancing equations, reaction types, representing chemical energy, worksheets Unit 8: Stoichiometry, BCA method, start Cu-$AgNO_3$ lab, limiting reactants	Read Galley, William C. "Exothermic Bond Breaking: A Consistent Misconception." Unit 7 reflection work on final paper
Day 10	Finish lab, analysis of data, worksheets, discuss reading, ABCC post-test, overview of units 9-14	