Syllabus: CHM 594: Modeling Instruction in High School Chemistry II
(2 semester hours)
Summer at Arizona State University

Prerequisites: In-service teacher of chemistry or physics, or instructor approval.
CHM 594: Modeling Instruction in High School Chemistry I, or instructor approval.

COURSE DESCRIPTION:

Secondary-level chemistry teachers will participate in 60 hours of training in Chemistry: Modeling Instruction. The workshop will focus on an evidence-based approach to the internal structure of the atom, periodicity and covalent bonding, intermolecular forces, equilibrium and acids and bases. The name **Modeling Instruction** refers to making and using conceptual models of real systems and processes (both natural and artificial) as central to learning and doing science and engineering. Instruction is organized into modeling cycles rather than traditional content units. This promotes an integrated understanding of modeling processes and the acquisition of coordinated modeling skills. The two main stages of this process are model development and model deployment. The modeling cycle addresses the deficiencies of traditional instruction by assisting students to construct understanding from observations, by confronting student preconceptions, by examining student thought processes through the process of “whiteboarding” and Socratic dialoguing. Participants will receive both printed and electronically stored versions of the course manual, as well as ancillary materials.

The goal of this Modeling Method workshop is to provide a meaningful form of professional development for in-service teachers using student-centered, inquiry-based, constructivist practices. 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.

**Unit 10 – Models of the atom**

From an examination of the radiation emitted by hot metals and atomic gases, we conclude that atoms must have internal structure not explained by Thomson’s model.

**Unit 11 – Periodicity and bonding**

We extend the Bohr model to many-electron atoms, using it to provide a structural explanation for the organization of the Periodic Table, and to examine ionic and covalent bonding in compounds.

**Unit 12 – Intermolecular Attractions and Biological Macromolecules**

We use an electron density model to account for the attractions between molecules and their effect on physical properties. Then we move to an investigation of organic molecules important to life.
Unit 13 – Equilibrium
Various equilibria in processes (liquid-vapor, solute-solution, partition) and reactions are modeled by the exchange of particles between "containers". This exchange explicitly models rates of opposing processes.

Unit 14 – Acids and bases
Exchange of the acidic proton between species in acid-base equilibria and relative strengths of acids and bases is viewed in terms of competition by bases for H$_3$O$^+$ ions.

Because these concepts are ones with which teachers have less direct experience, as much emphasis will be placed on deep discussion of this chemistry content as on pedagogy.

There is additional enrichment on entropy (for AP and honors courses) on the probable direction of change. We adopt a "probability" view to account for the spontaneity of processes involving both structural and thermal change. This approach puts the “dynamics” back into thermodynamics!

LEARNING GOALS: Through successful completion of this course, teachers will
- Improve their instructional pedagogy by incorporating the modeling cycle, inquiry methods, critical and creative thinking, cooperative learning, and effective use of classroom technology,
- Deepen their understanding of content in 2nd semester high school chemistry,
- Experience and practice instructional strategies of model-centered discourse, Socratic questioning/whiteboarding, and coherent content organization,
- Strengthen local institutional support as school leaders in disseminating standards-based reform in science education,
- Increase their skill in all eight scientific practices recommended by the National Research Council in “A Framework for K-12 Science Education.”

The development and use of models are at the core of the NGSS Science and Engineering Practices.

ASSIGNMENTS, GRADING POLICIES AND PERCENTAGES:
A. Attendance:
You are expected to attend all days of this workshop. If you miss more than one class (6 contact hours), your maximum grade will be a B; if more than 2, you can earn no higher than a C. Please be on time and ready to go! Report any expected absences to the instructor as soon as possible. ASU credit-seeking students who miss course time are to complete and write a reflection for all activities missed, design an activity modified or developed for pilot use in the classroom this coming year, and present results to the course instructor and peers when appropriate.

B. Assignments and grading policy:
All participants, whether seeking ASU credit or not, are expected to do activities and homework as described below for a “B” grade.

To be considered for a letter grade of “B”, you are expected to do the following:
- Keep a course notebook. (90 points: 30% of course grade)
  This should take the form of an electronic journal in Google Drive. Participants should record clear, focused comments and notes on how each lab and problem set is viewed from both the student and teacher perspectives. Entries should include any additional suggestions for implementation, changes, and questions for Socratic Dialogue and class discussion. Teachers can take notes via paper and pencil, then scan or take pictures of pages to enter into their course folder.
• **Keep a reflection journal (90 points: 30% of course grade)**
  At the end of each unit, write a more detailed analysis of the unit, including strengths and weaknesses, how it is either resonant or dissonant with your own thinking about the content, how you might modify parts of the unit to fit your own style or teaching situation, etc. This ought to be 1-2 pages in Google Docs. Another option we’d like you to consider is to make at least one 10-15 min narrated screencast using Screencast-o-Matic* (or similar program) or Explain Everything** presentation for your unit reflection in place of the written reflection. This could include some clips of any experiment or demo you performed. There are 5 units; I’ll award up to 10 points for unit 10 and 20 points for the remaining units (which are longer and more involved).
  * [https://screencast-o-matic.com/](https://screencast-o-matic.com/)
  ** [https://explaineverything.com/download/](https://explaineverything.com/download/)

• **Participate actively and thoughtfully in lab whiteboarding sessions, discussion of readings, activities, and problem-solving whiteboarding. (60 points: 20% of course grade)**

• **To be considered for a “A”, teachers must do all of the above plus submit a final paper (60 points: 20% of course grade) due on Tuesday, July 18.**
  The paper (at least 4 pages, double-spaced, 12 point font) should address how Modeling Instruction in 2nd semester chemistry differs from your current practice and what changes you plan to incorporate, or the issues with which you will have to deal in order to implement materials and strategies from the course in your classroom.

C. **Tentative grading scale:**

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<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A+</td>
<td>97-100</td>
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<tr>
<td>A</td>
<td>93-96.9</td>
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<td>A-</td>
<td>90-92.9</td>
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<td>87-89.9</td>
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<td>C-</td>
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**Policies of Arizona Board of Regents (ABOR) and ASU:**

Each student is expected to spend a minimum of 45 hours per semester hour of credit. Pass-fail is not an option for graduate courses. [https://students.asu.edu/grades](https://students.asu.edu/grades)

“B” grade means average; 3.0 GPA is minimum requirement for MNS & other graduate degrees.

Incomplete: only for special circumstances. Must finish course within 1 year, or it becomes “E”.

An instructor may drop a student for non-attendance during the first two class days (in summer).

An instructor may withdraw a student with a mark of "W" or a grade of "E" only in cases of disruptive classroom behavior."

**Academic dishonesty policy:** Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to: appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see [http://provost.asu.edu/academicintegrity](http://provost.asu.edu/academicintegrity).

**Disability policy:** Refer to [https://eoss.asu.edu/drc/](https://eoss.asu.edu/drc/). Qualified students with disabilities who require disability accommodations in this course are encouraged to make their requests to the instructor on the first class day or before. Note: Prior to receiving disability accommodations, verification of eligibility from the Disability Resource Center (DRC) is required. Disability information is confidential.
REQUIRED INSTRUCTIONAL MATERIALS:
Chemistry Modeling 2 curriculum framework and 3-ring binder (available on first day of class).

REQUIRED READING: (available in the course readings folder)

Ashkenazi, Guy and Weaver, Gabriela. “Using lecture demonstrations to promote the refinement of concepts: the case of teaching solvent miscibility” Chemistry Education Research and Practice, 2007, 8(2), 186-196


RECOMMENDED RESOURCES:
Web resources for use in Units 10 – 14 are embedded in the teacher notes and curriculum materials. It is recommended that you preview the resources the students will be using during each unit.

NGSS Science and Engineering Practices (Poster – in readings folder)