FOR THE TEACHER

Modeling Background Information for Teachers

Modeling in Chemistry
Different people have different ideas about what a “model” is. Exploring students’ beliefs about models and modeling before they are asked to engage in a modeling activity is critical to guiding student learning.

What to do?
Have students compare and contrast different types of models used in daily life (e.g., car models, paper models) and in science classrooms, asking them to identify differences and similarities. Use their ideas to develop the concept of “scientific models” as conceptual, mathematical or physical representations of a real-world system or phenomenon.

Chemists build and use different types of scientific models to explain, predict, and control properties and processes involving different chemical substances. These models are built to represent systems at different scales, from the macroscopic, to the molecular, to the subatomic level. Many students struggle to connect these models with real systems and phenomena, and to use these models in productive ways to describe, explain, and predict properties and behaviors. Many opportunities should then be created for students to use, build, and evaluate models in the chemistry classroom. It is important to explicitly point out when we are using a model and how we use it to explain systems or phenomena.

What to do?
Create many opportunities for students to observe different phenomena, collect data, identify patterns in the data, and generate models about the system of interest that provide a reasonable explanation for the patterns that are observed.

Introduce the idea of modeling at different levels in chemistry, including:
- **Macroscopic:** Descriptions of the bulk properties of matter that students typically observe with their senses.
- **Particulate:** Descriptions of the behaviors of individual particles (i.e. atoms and molecules). In a particulate model, the particles that make up a system are broadly represented as simple spheres, without specific internal composition or structure.
- **Molecular:** Particulate models that include details regarding the composition and structure of the particles (i.e. molecular geometry).
- **Atomic:** Descriptions of the components, structure and behaviors within an atom.
- **Symbolic:** Descriptions of matter using chemical symbols and diagrams. This type of modeling is used within macroscopic, molecular and atomic modeling.
- **Mathematical:** Using charts, graphs and equations to represent systems. Like the symbolic, this type of modeling is used within macroscopic, molecular and atomic modeling.
Models should allow us to explain what has been observed and also guide predictions for experiments we haven’t done yet. It is important that students recognize that models should be evaluated based on existing experimental data, and that these models can and should be revised if new data becomes available that cannot be explained using the initial model. Models are never fixed, but change to explain new observations. We shouldn’t expect our students to have an ideal model right away. That’s not how science works.

**What to do?**
Establish a classroom culture where students feel safe sharing, collaborating on and presenting models. Engage students in a variety of activities that ask them to build models of different systems based on experimental data and prior chemistry knowledge. These activities should create opportunities to compare and contrast different models, and identify the models’ scope and limitations. As students formulate their own models and then refine them through collaboration, use your observations as formative assessment to guide instruction. Revisiting anchoring phenomena multiple times throughout the year demonstrates the iterative process of modeling to students. Both student and teacher can assess growth not only on content (Disciplinary Core Ideas), but also science process (Science and Engineering Practices).