COMMENTARY: **Colleen Megowan-Romanowicz**

What Is Modeling Instruction?

By Colleen Megowan-Romanowicz

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Perhaps you have attended a conference or read an e-mail list for science teachers and heard or seen comments about Modeling Instruction or Modeling Workshops. You may even have heard people refer to themselves as "modelers." Have you ever wondered what these teachers are talking about?

High school physics teacher Malcolm Wells developed The Modeling Method of Instruction in the 1980s while doing classroom research for his doctorate in physics education research. Modeling Instruction is a guided inquiry approach to teaching science that reorganizes instruction around the handful of conceptual models that form the content core of the scientific disciplines. This method provides a framework for science instruction that approximates how scientists "do science." Students build, test, and deploy conceptual models of physical relationships. Research has shown that students in Modeling Instruction classrooms perform significantly better on measures of conceptual knowledge than similar students in traditional science classrooms.

Little or no lecturing occurs in a Modeling Instruction classroom. The teacher often poses a problem at the beginning of class. Students gather in small groups, collaborate to find a consensus solution, then represent their thinking on a 24" x 32" whiteboard. Moving from group to group while students discuss the problem and outline their solution on the whiteboard, the teacher listens to students' conversations, occasionally offering a comment or asking a question. When the small-group discussions are complete, the teacher convenes a "board meeting" in which the entire class shares and discusses their whiteboarded solutions.

The burden of sense-making in these discussions is on the students, who must make the case for their solution from the evidence. This "think-aloud" process provides the teacher a valuable opportunity to listen to students' thinking and reasoning as it develops and to identify gaps or persistent misconceptions that can be addressed. Skillful teachers find a way to draw students who are uncertain into the conversation so that the class must improve their explanation until even their most confused classmates understand. At the close of a board meeting, the teacher will often request that students summarize their understanding of the model, providing another opportunity to probe the group for uncertainties and misconceptions.

Modeling Instruction units follow a three-phase developmental sequence known as the Modeling Cycle: construct the model, improve and elaborate the model, apply the model. A typical unit begins with a paradigm lab. (Such laboratory activities are based on science education research about student misconceptions and naïve beliefs.) In the class discussion preceding the investigation, students observe a phenomenon, discuss what they observe, identify a relationship between two elements that they wish to quantify and correlate, and make predictions about the expected outcome. They then work in small groups to plan and conduct data collection; gather, analyze, and whiteboard data; and share findings with the whole class. Ultimately students arrive at a set of representations for the model they have constructed that includes a diagram, a graph, and an equation that quantifies the relationship. Once the model under investigation has been defined like this, students engage in a series of deployment exercises and tasks that are carefully sequenced to help them elaborate on this conceptual model and apply it in a variety of contexts.

The quality of classroom discourse is a critical component of Modeling Instruction. The key to establishing a good discourse community is to design a classroom culture that moves the teacher from "center stage" and calls for the students to depend on one another to advance the group's understanding of the model being investigated. This classroom dynamic is very different from the typical school culture, and requires teachers to develop skills in redirecting student questions to the group rather than simply giving the answers.

Modeling Workshops offer face-to-face professional development in which teachers work through a semester of content, just as their students might. They perform labs, whiteboard the results, participate in board meetings, solve problems, develop questioning skills, learn how to listen, read and digest classroom research literature, and have rich discussions in both "student mode" and "teacher mode," gradually recognizing how Modeling pedagogy fits with their own teaching situation. These two- to three-week workshops provide an opportunity for the reflective practice so necessary for building expertise.

Next time you meet a modeler, ask him or her what he or she thinks about the *Next Generation Science Standards* (*NGSS*). Modeling Instruction works well with the eight *NGSS* Science and Engineering Practices. A 2015 study revealed that modelers are significantly more confident in their ability to engage their students in the use of science and engineering practices than other science teachers. ●

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NSTA Reports

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