ARIZONA STATE UNIVERSITY

Modeling Instruction in High School Science

MODELING PHYSICS

Modeling Instruction was developed at ASU over two decades. It integrates insights from physics education research with classroom experience of effective in-service teachers. In a series of intensive three-week workshops over two years, teachers improve their physics content knowledge. They are equipped with a robust teaching methodology for developing student abilities to make sense of physical experience, understand scientific claims, articulate coherent opinions of their own and defend them with cogent arguments, and evaluate evidence in support of justified belief ; i.e., **students become scientifically literate**.

Explore, explain, apply (in that order): Instruction is organized into two-week modeling cycles that engage students in building scientific models, evaluating them, and applying them in concrete situations. Rather than lecture, the teacher guides the class to ask questions of nature. To answer the questions, teams of students design experiments and use the computer to gather data. From their data they construct mathematical models and defend them to the class. They apply models to different situations. The physics course becomes coherent because it is centered on a few basic models. It brings the classroom closer to the workplace because a central activity of scientists, engineers, and many in business is making models.

For example, in a physics experiment students are asked to develop principles of motion for a pendulum. With the teacher as recorder, students brainstorm about properties of the pendulum that might affect its period. Teacher and students decide which properties should be investigated. In this case they decide to investigate how changes in mass of bob, length of string and amplitude of motion affect the period. Students then work in teams and determine their own procedure for collecting data. After collecting data, they plot it to look for relations among variables and then relate it to equations of motion. Then, in a technique called "whiteboarding", groups present results to the class. The class reaches consensus on an appropriate model to describe the behavior of the pendulum. They do this without being given the answer.

Infusion of technology into the classroom is secondary to pedagogical reform. With the exception of computers, lab interfaces and probes, most lab equipment used is already found in any reasonably well-equipped high school lab. (Classroom technology is not crucial but is highly advisable.)

Modeling Instruction is a curriculum *design*, rather than a fixed curriculum; thus teachers can flexibly adapt it to different courses and student abilities. Student gains in understanding under Modeling Instruction are typically *double* those under traditional instruction. **Modeling Instruction has proven success with students who have not traditionally done well in physics, while enhancing the performance of all students.**

Experienced modelers report increased enrollments, parental satisfaction, and enhanced achievement in college courses (across the curriculum!).

http://modeling.asu.edu