An Overview of the Pedagogical Approach Used in This Module

Mathematics and science distinguish themselves from other disciplines in that they have certain absolutes and fixed principles. Science further distinguishes itself in that most students arrive at school with their own ideas and explanations of many of these absolutes. Unfortunately, many of their ideas are at odds with current scientific understanding. The discrepancy between naive and expert understandings gives science teachers an unusual and exciting opportunity—to help students move from incomplete or incorrect explanations to ideas consistent with current understanding.

A considerable and growing body of research shows that one of the best ways to change students' thinking is to first make them aware of their preconceptions and then provide experiences that probe or challenge those preconceptions. Say that students conduct an experiment that produces an unexpected result. If their preconceived ideas cannot explain the observations, the students should be encouraged to construct new explanations. If these explanations are superior to the ones they previously held, the students are likely to change their ideas. If a student's new explanation is better than his or her old one but is still incomplete or incorrect, the educator can provide another experience and repeat the cycle until the student's understanding is consistent with current scientific understanding.

> *The well established methods of inquiry are not only desirable but also are absolutely necessary for students to construct ideas, test them, and, if necessary, reject them and begin again in their search for ideas that more accurately reflect the real world.*
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> "Pathways to the Science Standards—High School Edition," National Science Teachers Association, 1997, p. 3

To help educators identify students' preconceptions, each activity begins with a preassessment question. These questions help students become aware of their own ideas, take a position on a particular question, and have a personal stake in the activity. To avoid any embarrassment associated with feeling ignorant or uninformed, the students hand their answers in to the educator rather than state their ideas in a group or class discussion. At the end of each activity, the students are asked to respond to the preassessment question again and compare how they answered it before and after the activity. As the educator, you can use this comparison as:

- An assessment of student understanding
- An assessment of the effectiveness of the learning experience
- An indication of whether additional experiences are necessary to develop concept mastery
- A way to structure your class discussion of the experimental observations
- A way to document how students develop an understanding of a concept

The activities early in the module are more proscribed than those later in the module. Progressing from structured to more open-ended investigations lays an indispensable foundation for the inquiry-based learning later in the module. This "guided" approach helps students become increasingly independent investigators by:

- Assuring the mastery of a core set of concepts
- Developing skills required in scientific inquiry
- Providing students a common set of experiences to refer to as they investigate their own questions

Furthermore, the module promotes inquiry-based learning by providing students opportunities to design experiments, develop procedures, or pursue their own ideas. By the end of the module, the students will have developed the skills and understanding they need to investigate their own questions.