The Role of the Instructor

Other than the post-activity discussion, the instructor plays a minimal role during the activity. Since the goal of mini-lab activities is to elicit the students' ideas about how and why something happens, the instructor should minimize his or her input into the process, other than to engage in limited Socratic questioning and to ensure the safety of the lab. The instructor should stress that understanding is the goal of the activity, and if aspects of the lab do not seem to make sense, the student should think about them more deeply and perhaps discuss them with their classmates. It is particularly important for the instructor to be aware of and sensitive to the frustration level of the students during the mini-lab. Several of these activities have non-intuitive outcomes, and students may initially find this not only puzzling but also discouraging. Encouraging the students to apply what they know and to struggle to understand what is happening is critical to the success of the activity.

In our experience, playing the role of the observer is a way to discern what the students are thinking. Usually, after about 10 min of struggling with the questions, the noise level increases as discussions and questions fly back and forth between students and groups. What, at first, appeared to be a simple process has now become a challenge, and it is interesting to observe how animated and engaged the students become when they realize that the instructor is not going to provide an answer. Unfortunately, there will be some students who do not move past the point of frustration, especially when they have only experienced one or two mini-lab activities. This is why the post-activity discussion is vital; it allows the instructor to lessen some of the frustration and explain how applying the principles of science can help to clarify a confusing situation.

Formative Assessment of Student Understanding

Part of the assessment value of the mini-lab is the observation of student discussions during the collaborative phase of the activity. The collaborative phase of a mini-lab harnesses the power of collaborative learning, while the presence of an individual assessment at the end of the mini-lab, which the students are aware of and can discuss, is an example of cooperative learning. The combination of collaborative and cooperative learning, along with an individual assessment, makes the mini-lab program unique. It is in the individual student's answer to the final question that the instructor can glean some indications of the student's understanding of chemical principles. Also, by immediately discussing the activity, the students have the opportunity to assess their own level of knowledge. Therefore, this formative assessment is meant to benefit both the instructor and the student.

To assist the instructor, we have also prepared activity-specific instructions and guidance. Each Mini-Lab file has the student activity as the first page with the instructor's page(s) following. We usually administer the mini-lab shown in Figure 1 after lessons covering thermodynamics and spontaneity. We anticipated that the well-informed students, especially those selected because of high achievement in science, would quickly complete this activity. However, in three semesters, we have been consistently amazed at the level of deep discussion about thermodynamics we observe during this mini-lab. In fact, things progress in a fairly predictable way: The first 5 or 10 min is spent exploring and being amazed at what they experience, especially when the rubber band contracts (it gets noticeably colder). Then, the students spend 20 or 25 min in animated discussions about the rest of the questions, especially the one about the entropy change for the spontaneous process. Finally, after about 35 min of thinking and discussing, a sizable percentage of the students start saying things such as “It just doesn't make sense!” and “My head hurts from thinking about it.” Usually, about 70-80% of the class will answer the final question correctly, although non-intuitively: the rubber band will NOT expand when heated. The rest of the students will stick with their intuition that things should get “floppy” and stretch out when heated. When the instructor demonstrates that this is not the case, that the rubber band even contracts slightly when heated, and explains how the thermodynamic analysis arrives at that conclusion, the majority of students appear convinced.

Employing the Mini-Lab Concepts in the Classroom

We designed the mini-lab concepts as a general approach to engage students in an active-learning environment. We viewed these exercises as a way to provide formative assessment of student learning at the end of major units of the curriculum or at intermediate points during a major topic. For example, an instructor might use a mini-lab to test student understanding of molecular motion in a system partway through a unit on kinetics. Then, at the end of the unit, or perhaps partway into the next unit of the course, the instructor might use another mini-lab that tests understanding of temperature effects on rates of reaction. These exercises are not meant to replace traditional laboratories or lectures but to supplement them and provide formative assessment of student learning.