Demonstrations are sometimes perceived as merely entertaining and expendable ancillaries for lectures and laboratory sessions. Nothing can be further from the truth. If done properly, demonstrations have much more value than lectures and labs when used to teach critical thinking in the sciences (Shmaefsky 2004).

Science demonstrations were the hallmark of kindergarten through college teaching until the 1990s. However, various factors have led to their departure—an influx of faculty unfamiliar with classical demonstrations, budget cuts limiting the use of instructional materials, an overreaction to classroom safety by administrators, and the perception that demonstrations should be replaced with more lecture information to cover the burgeoning science content in textbooks.

An educationally effective demonstration must follow the same guidelines as any other pedagogical strategy (Figure 1). It must be accurate, informative, instructional, interactive, and relevant. Most importantly, a demonstration must incorporate an element that permits assessment of student learning. Plus, a good demonstration should reinforce the experimental design inherent in the scientific method. Instructors who use demonstrations should use them to introduce or reinforce abstract scientific concepts covered in lecture or lab. Stand-alone demonstrations done just for entertainment diminish the instructional value of subsequent classroom demonstrations.

Many faculty believe that it takes a certain personality to pull off an effective science demonstration. Personality helps, but it is not the main ingredient for a successful demonstration. The format in Figure 2, applied to an informative demonstrative, provides an effective learning experience for students.

**Example Demonstration 1**

**The Effects of Gravity on Falling Objects**

It is surprising how many students still believe that heavier objects fall faster than lighter objects. Plus, not all students fully understand the influence of atmospheric density on the rate and pattern of falling. This demonstration helps students evaluate the variables associated with falling objects.

The materials needed for this demonstration are two 16-ounce or larger paper cups, two 16-ounce or larger Styrofoam cups, two tennis balls, one hard baseball, one Ping Pong ball, one golf ball, and two equal size sheets of paper.

I begin by introducing the rationale for doing the demonstration. I then stand on a high surface within view of all students in the class and announce that they are to determine if the objects hit the ground at the same time, which many of them expect.

I drop the two tennis balls together, as a control, to see if they hit the ground at the same time. Next, I summarize what happened, question the students about why it happened, and drop a tennis ball and a baseball to see if they hit the ground at the same time. I summarize what happened and question the students about why it happened. I tell them to note that the balls are similar sizes but different densities. Then, I drop the golf ball and the Ping Pong ball to see if they hit the ground at the same time. Finally, I summarize what happened and question the students about why...
it happened. Again, students should note that the objects are similar sizes but have different densities.

Next, I drop the two paper cups with the bottoms facing down to see if they hit the ground at the same time. Again, I summarize what happened and question the students about why it happened. This is a control.

Next, I drop a paper cup and a Styrofoam cup with the bottoms facing down to see if they hit the ground at the same time. Again, I summarize what happened and question the students about why. They should say that the cups are similar sizes with different densities. I then drop the two Styrofoam cups, one with the bottom facing down and the other with the bottom facing up, to see if they hit the ground at the same time. I summarize what happened and question the students about why. Students should note that these are identical objects with the shape reversed.

Next, I wad up one piece of paper and drop it along with another piece of paper to see if they hit the ground at the same time. I summarize what happened and question the students about why it happened. I remind them that these are identical objects with different shapes and densities. Finally, I summarize the whole demonstration and state the principles involved. I use this demonstration to help students investigate the roles of density and shape on falling objects. It encourages students to think of everyday applications of the principles they observed.

In terms of safety, it is important to use caution when standing on the elevated surface. Also, it is necessary to use caution when dismounting. The objects should be dropped where they will not hit a student after hitting the floor.

Example Demonstration 2
From Correlational Study to a Cause-and-Effect Experiment
An essential skill in all of the sciences is the ability to set up properly controlled experiments that show cause-and-effect in the variables. This demonstration uses an environmental toxicology scenario to demonstrate how to design a correct experiment to resolve a toxicity issue. It is based on real research on the effect of environmental endocrine disruptors on wildlife development, physiology, and populations. The materials needed are one roll of masking tape or other sticky tape, 12 female students, eight male students, and six index cards or “sticky notes” with “Pesticide” written on them.

Before class I use the tape to make 3 x 3 meter squares on the floor within view of the whole class. I then tell the class that I made an interesting finding in two similar “ponds,” identified by the squares in front of the room. I say, “In one pond I found a population of fish made up of an equal number of female and male individuals” and then call down four female and four male students to stand together in one pond.

Next, I say, “In another pond identical to the first, I found a population of fish made up of only female individuals,” and then I call down eight female students to stand together in the other pond. I say, “I also noticed that a pollutant was running off into the pond that contained only female fish,” and then I gently throw the index cards into the pond saying they are the pollutant.

I then ask the class to hypothesize about the observation and if it is possible to make a definitive conclusion about the situation. I point out why the observation is based only on correlation and say that any explanations do not fulfill the criteria of the scientific method. The class then comes up
with an experiment to determine the cause of the population differences. I say, “Before you tell me about your experiments, let me conduct one to see if my hunch is correct.”

I ask all the students to leave the ponds and then invite four female students and four male students to stand in each pond. I say, “Let me start my experiment with two equal ponds. Now I will add some of the same pesticide found in the pond having all females in the population.” I explain that I am doing this because I think the pesticide is the cause of the observation.

I then throw the index cards into one pond, replace the four male students with four female students, and ask the class to explain the population change. I explain that research shows that this particular pesticide converts male fish into females. Finally, I ask the class how they would confirm this piece of evidence with another experiment. To summarize the results, I ask the class how this experiment could be applied to other environmental or health issues facing society and wildlife.

I use this demonstration to help students analyze news stories about pollution, cancer, or diets. It helps them to learn to recognize whether the information was gathered using controlled experiments. In terms of safety, it is important to be sure that students don’t step on each other’s toes during the shuffling around. Plus, I take care not to strain my back while taping off the “ponds.”

Demonstrations are powerful learning tools when properly used in combination with other teaching strategies. They are effective ways to model scientific principles in a manner that allows students to visualize, practice, and apply the information being presented.

References