Kindergarten Instructors for Discovery-based Science
Teaching Activity #1: Scientists Ask Questions

Summary: The main goal of this teachable unit is for the students to learn that science is all about asking questions. Too often, science is taught as a series of facts about the natural world that students are asked to memorize and regurgitate during assessments. While it is true that new knowledge of natural systems is a chief outcome of science, it is really the dynamic process acquiring this knowledge by the application of the scientific method that excites and motivates most scientists. This teaching activity includes (i) a pre-experiment discussion, where students are presented with a problem and asked to reflect on what they already know about the properties of ice, (ii) an investigative series of experiments that leverage students’ prior knowledge to solve the problem, and (iii) an exploratory experiment that introduces a new variable with fun results (because after all, science should be fun too!).

Materials:

- Cooler
- Forceps
- Bag of ice cubes
- Agarose gels (1 gram agarose powder per 100 mL H₂O; make 200-300 mL and cut gel to make look like ice cubes)
- Bag of dry ice, at least 30 pieces
- Small soda bottles (one per student)
- 3 brown paper towels
- 3 small beakers
- 2 gallons of water (not needed if there is a faucet in the room)
- Liquid soap
- Lab coat
- Safety glasses

Pre-experiment:

Problem: We have three clear plastic bags that are only labeled A, B, and C; we know one of these contains ice and the other two do not, but we are not sure which is which.

Discussion: Gather the students in front of a whiteboard or chalkboard and introduce them to the problem. Tell them that we are going to try to solve this problem using science, and science is all about asking questions (repeat this phrase several times throughout the day, and get the students to repeat it as well). Use the whiteboard to make a list of everything the students know about ice. Answers should come from the students, but the instructor can ask leading questions. There is no limit to how long this list is, but make sure that the following three items make it on: (i) ice is cold, (ii) ice is wet (or ice melts), and (iii) ice floats in water. Transition to the next stage by describing how we can use what we already know about ice to ask questions about the three mysterious substances.
Experiment:

Activity #1: Create a grid on the whiteboard as laid out in Figure 1. The first question asks whether the substances are wet. Begin the experiment by placing three dry paper towels on the table, one in front of each beaker. Place one jello chunk (item A), one ice cube (item B), and one piece of dry ice (item C) on the paper towel and describe that if the substances are wet, then they will leave a wet mark on the paper towel. While the substances are sitting on the towel, move on to question number 2 by asking if the substances are cold. Beginning with item A, walk the beakers around to allow the students to briefly touch the BOTTOM of each beaker. Beaker A will be room temperature, beaker B will be cold, and beaker C will be very cold. It is important not to let the students handle the dry ice, and only to allow them to touch the bottom of the beaker briefly to avoid injury due to the extreme cold. An alternative experimental approach towards question #2 is to use a thermometer and record the temperature, however in our experience, the tactile investigation helps to engage the students. After recording the results for question #2 in the grid, examine the paper towels from question #1. Substances A and B will have left a wet mark on the paper towel, while substance C will not. Record these results in the grid as well. At this point there is enough information in the grid to discern that Substance B is the ice, so do not be surprised if many of the students are already guessing the correct answer. If this is the case, it is best to engage them in discussion about how they arrived at this conclusion. Finish the activity by asking the students if you should do one more experiment just to be sure (they will say yes). To determine if each substance floats, begin with Substance A and B and add water to the flasks. The Jello will remain at the bottom of the beaker, while the ice will float to the top. Fill in these results to the grid, and ask the students to predict what will happen when you add water to Substance C. This is the surprise finale; when water is added to the dry ice, the mixture will bubble vigorously and produce dense water vapor ‘smoke’. Finish by engaging the students in a discussion about this surprising observation.

Activity #2: Have the students return to their desks and place a small plastic soda bottle half-full with soapy water in front of each student. Describe to the students that a piece of dry ice will be added to each bottle. Emphasizing the difference in this experiment to what was observed before (the soap in the water), ask the students to predict what will happen to their bottles when the dry ice is added. Record these predictions on the whiteboard. Next go around the room and add one piece of dry ice to each bottle using forceps. Again the mixture will bubble vigorously, and a snake-like chain of bubbles with form and emerge from the bottle. Students can pop the bubbles with their fingers, but otherwise should be instructed not to touch the bottles. Finish by having students draw pictures of the experiment as a way of recording their observations.

Figure 1: Sample whiteboard notes following discussion session. Top half of board is dedicated to recording what students know about ice, and bottom half of board records data from Activity #1. Photo on right shows class around a single foaming bottle from Activity #2.