NOTES FOR TEACHING

Fluid Patterns

You can obtain the most benefit from the *Doing Science* activity sheets by applying them sequentially. Start by mapping currents out of doors; next, detect currents inside; go on to make patterns in water with starch and food color; and finish by moving water around objects in Ivory dish-washing soap. This series progresses from a large scale to a much smaller scale, and from a less controlled to a more controlled situation. The rationale is to show that one can model happenings in nature on a small scale in the laboratory. Of course, the small scale results are not exact replicas of the larger situations, and the techniques have other limitations. Nevertheless, the series of activities can provide useful insight into fluid motion.

A range of techniques makes the movement of air or water visible. The first two techniques confront the students with a number of observational difficulties. However, repeated, careful observations will reveal specific patterns. Outside, bubbles sometimes blow in all directions. Indoors, smoke sometimes diffuses too quickly. The vortices and spirals may not manifest themselves very readily. The third, fourth and fifth activities, by contrast, readily provide definite patterns that are both informative about the motion of fluids and esthetically delightful. Classroom try-outs have shown that the materials and results fascinate students who use them.

As a teacher, you can use that fascination to open your students' eyes to the essence of scientific discovery. But to do so, you must be sensitive to the properties of the materials, and to the way in which the students carry out their investigations. Remember that none of the activities is meant to be performed by a solo instructor in front of a classroom. They are, rather, designed to show students that simple manipulations can lead to small discoveries that in turn yield meaningful patterns. Classroom experiments are often presented as problems to be solved by the students acting as **detectives**. In contrast, with these activities you will encourage your students to be **explorers** in the world of fluid motion.

To guide the students effectively, you must become familiar with the materials. Try each activity in advance, using the *Doing Science* sheets to determine just what can go right—and wrong. Use the rehearsal to think about how you will present the activity to the class. Imagine yourself as a jazz musician, whose improvisation in performance stems from many hours of practice, experimentation with different melodies and, despite the freestyle sound, adherence to all the basic rules of musical structure.

Encourage your students to think of their work with the materials as a form of play. Despite its image, play is not really an uncontrolled frivolous form of behavior. Poets, after all, play with the sounds of words to obtain the perfect combination for their creations. Scientists and engineers play with models or ideas in order to understand better how things work. Play has boundaries and rules, just as do formal games. Players determine the kind of game they will undertake by defining the boundaries and rules. American football, Canadian football, and rugby all belong to the same family of games; they differ from each other because of variations in the rules and the size of the fields.

In the same way, you as the teacher determine the boundaries and nature of your students' explorations by the selection of equipment and materials that you give them. When you move on from the third activity to the fourth, for example, you maintain the boundary—the tray—but alter the rules by switching from starch to Ivory detergent. Because of such changes, similar types of exploration bring about different discoveries—which will point the way toward yet new types of exploration. Your role as teacher here resembles that of the conductor in a jazz orchestra, who simultaneously plays and directs. Set up an agenda for the experimentation, and keep to it. Use words of encouragement and carefully phrased questions to guide your students' explorations most effectively.

Another critical point: Students must record and communicate their discoveries to gain maximum benefit from the experiments. They should discuss their results, rather than just report what they found. Of course, some students either don't really know what they saw or have difficulty expressing their observations. Encourage them to develop those skills by listening carefully to their classmates' reports. Listening will help all students to realize that there was more to discover than they found themselves.

Finally, remember that interpretation and analysis play vital roles in science. Encourage students to look for patterns in their observations, and to try to explain how and why the patterns occur. Even though the explanations may seem too general or too vague to be useful at first, the fact that the students are thinking them up is important. Experience will enable the students to refine their analyses and use them to suggest further exploration. Science is a social process in which communication is as important as experimentation, because one of its essential ingredients is the shared view of nature arrived at by replication of the results obtained by others.