An exciting element of science fairs is that they give students the opportunity to explore various interests through scientific investigation. Many students, however, mistakenly think that all investigations are experiments. This lesson can help broaden students' conception of science.

More Than One Way to Investigate

By Tracy L. Coskie and Kimberly J. Davis

Both in and out of the classroom, the term *experiment* gets used to describe anything from a laboratory investigation to a hands-on activity to a trial-and-error venture. The loose usage of this word leads to misunderstandings about how science works.

Experiments Versus Descriptive Studies

Experiments are studies that allow scientists to manipulate a variable and observe its effects. For example: Does changing light affect the growth of radishes? In one type of *experiment,* all variables except the responding variable (e.g., radish growth) are controlled, thus ensuring that the manipulated variable is what influences the outcome. In another type of experiment, though one usually beyond the cognitive abilities of elementary-aged students, all of the variables except one are changed. If the result is the same, the unchanged variable is known to determine the outcome.

Consequently, experiments are powerful studies because they can conclusively establish whether a variable influences or determines an outcome. But sometimes experiments are neither possible nor desirable. Human subjects, for example, are often unsuitable for experimentation for ethical reasons. Other subjects such as stars, planets, volcanoes, weather patterns, and fossil records are nearly impossible to manipulate and control, and therefore must be studied by other means. Jane Goodall, wishing to discover the behavior and social structure of chimpanzees in their natural habitat, did not perform experiments with her subjects but instead observed them with minimal human interference. When subjects are studied "as is" rather than manipulated in controlled settings, they are part of *descriptive studies* (or observational studies) rather than experiments.

Prior to participating in a science fair, students should learn the key differences between experiments and other types of investigation. Once students understand the differences, they can choose which type of investigation is appropriate for them based on their study subjects and research objectives. For instance, some students will want to investigate the effects of light on pea germination or temperature on bread mold and should recognize that an experiment is warranted. Other students may choose to document tadpole development, record phases of the Moon, or survey the bird species in their favorite local park. In such cases students should recognize that while experiments are not appropriate, equally valid investigations can and should be used.

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Inquiring Into Investigations:

How do descriptive studies and experiments compare?

Objectives:

- To explore differences between a descriptive study and an experiment
- To develop observation and prediction skills
- To develop the ability to set up an experiment

Materials:

For the class:

- Food coloring (red works best)
- Stopwatch or clock with second hand
- Water (room temperature, hot, and cold)
- Hot plate for heating the water
- Clear plastic glasses or beakers
- Science notebooks (or note-taking sheet)

Grade Level: 3–6

Engage:

Ask students to describe what happens when a teabag is placed in a cup of hot water. What do they think is happening? Explain that today they will be doing two kinds of investigations of this phenomenon—a descriptive study and an experiment.

Explore:

1. Have students work with a partner or a small group. Provide each group with a clear cup or beaker of room-temperature water and some food coloring. Ask them to write a prediction in their notebooks of what will happen when they put in a drop of food coloring. (Tell students to wait until the water is still and to try not to bump the table or the cup.)

2. One student should put in a drop of food coloring while another starts the stopwatch. Have students watch carefully and time how long it takes for the food coloring to disperse until the water is a uniform color. Then ask them to write a description in their notebooks. They may want to include drawings.

3. Have groups share their findings as you record them on a t-chart on the board. On one side write "Descriptive Study," and on the other side write "Experimental Study." Explain to students that they have just completed a descriptive study. Ask students to share their ideas about what they think a scientist does in a descriptive study. Did they make a prediction? Observations? Record data? Did they do anything that might affect or change the way the coloring moved, or did they allow it to spread on its own?

4. Tell students that they are now going to conduct an *experiment*, and that in order to do that they need to change one variable, water temperature, to see if there is a difference in the outcome. Ask students to write a prediction about what they think will happen if the water is hot instead of room temperature. What if it is colder than room temperature?

5. Provide each group with three equal-sized cups, one with cold water, one with room-temperature water, and one with very warm water (all with the same amount of water). Have students repeat the activity, recording how long it takes for the food coloring to disperse in each.

6. Have the groups share their findings. (Note: The food coloring is dispersed as the molecules are bumped by moving water molecules. The color disperses faster in warm water because the molecules are moving faster.) Next, return to the t-chart. Ask students to share their ideas about what a scientist does in an experiment. List their ideas in the t-chart. Tell them that it is okay if some of what they write is the same as what they wrote down for the descriptive study.

7. Have the students compare their two lists in the t-chart and circle the traits that the two studies have in common. Discuss similarities and differences between the two types of studies.

8. Discuss with students why scientists might sometimes do a descriptive study and sometimes an experiment. Are there times when a scientist might want to study the effects of a changed variable? Are there times when a scientist might simply want to study an object "as is"?

Extensions/Assessment:

Have the students examine the following list of investigative questions and decide whether an experiment or descriptive study would be most appropriate.

1. How does baking temperature affect the chewiness of brownies?

2. What types of mating rituals do gorillas perform?

3. What is the average length of time that grizzly bears sleep during the winter?

4. How does the angle of a ramp affect the rolling speed of a ball?

5. Do water temperatures decrease as depth increases in the lake?

6. Will the amount of water you give sunflowers affect the height of the plants?

7. Does the saltiness of the water influence the number of brine shrimp eggs that hatch?

(Answer: Questions 1, 4, 6, and 7 should be investigated via experiments, while 2, 3, and 5 are ideal for descriptive studies.)

Resources

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academy Press.

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Standard B: Physical Science

- Properties of objects and materials (K–4)
- Properties and changes of properties in matter (5–8)