

## Concepts of Science

A US Department of Education guide for parents

<http://www2.ed.gov/pubs/parents/Science/Concepts.html>

The National Center for Improving Science Education recommends that elementary schools design curricula that introduce nine scientific concepts. Many of the activities described in this handbook teach these concepts, which are drawn from the center's recent report, *Getting Started in Science: A Blueprint for Elementary School Science Education*.

The nine concepts are:

- 1. Organization.** Scientists have made the study of science manageable by organizing and classifying natural phenomena. For example, natural objects can be assembled in hierarchies (atoms, molecules, mineral grains, rocks, strata, hills, mountains, and planets). Or objects can be arranged according to their complexity (single-celled amoeba, sponges, and so on to mammals). Primary grade children can be introduced to this concept by sorting objects like leaves, shells, or rocks according to their characteristics. Intermediate grade children can classify vegetables or fruits according to properties they observe in them, and then compare their own classification schemes to those used by scientists.
- 2. Cause and effect.** Nature behaves in predictable ways. Searching for explanations is the major activity of science; effects cannot occur without causes. Primary children can learn about cause and effect by observing the effect that light, water, and warmth have on seeds and plants. Intermediate grade children can discover that good lubrication and streamlining the body of a pinewood derby car can make it run faster.
- 3. Systems.** A system is a whole that is composed of parts arranged in an orderly manner according to some scheme or plan. In science, systems involve matter, energy, and information that move through defined pathways. The amount of matter, energy, and information, and the rate at which they are transferred through the pathways, varies over time. Children begin to understand systems by tracking changes among the individual parts. Primary children can learn about systems by studying the notion of balance--for example, by observing the movements and interactions in an aquarium. Older children might gain an understanding of systems by studying the plumbing or heating systems in their homes.
- 4. Scale refers to quantity, both relative and absolute.** Thermometers, rulers, and weighing devices help children see that objects and energy vary in quantity. It's hard for children to understand that certain phenomena can exist only within fixed limits of size. Yet primary grade children can begin to understand scale if they are asked, for instance, to imagine a mouse the size of an elephant. Would the mouse still have the same proportions if it were that large? What changes would have to occur in the elephant-sized mouse for it to function? Intermediate grade children can be asked to describe the magnification of a microscope.

5. **Models.** We can create or design objects that represent other things. This is a hard concept for very young children. But primary grade children can gain experience with it by drawing a picture of a cell as they observe it through a microscope. Intermediate grade children can use a model of the earth's crust to demonstrate the cause of earthquakes.

6. **Change.** The natural world continually changes, although some changes may be too slow to observe. Rates of change vary. Children can be asked to observe changes in the position and apparent shape of the moon. Parents and children can track the position of the moon at the same time each night and draw pictures of the moon's changing shape to learn that change takes place during the lunar cycle. Children can also observe and describe changes in the properties of water when it boils, melts, evaporates, freezes, or condenses.

7. **Structure and function.** A relationship exists between the way organisms and objects look (feel, smell, sound, and taste) and the things they do. Children can learn that skunks let off a bad odor to protect themselves. Children also can learn to infer what a mammal eats by studying its teeth, or what a bird eats by studying the structure of its beak.

8. **Variation.** To understand the concept of organic evolution and the statistical nature of the world, students first need to understand that all organisms and objects have distinctive properties. Some of these properties are so distinctive that no continuum connects them--for example, living and nonliving things, or sugar and salt. In most of the natural world, however, the properties of organisms and objects vary continuously. Young children can learn about this concept by observing and arranging color tones. Older children can investigate the properties of a butterfly during its life cycle to discover qualities that stay the same as well as those that change.

9. **Diversity.** This is the most obvious characteristic of the natural world. Even preschoolers know that there are many types of objects and organisms. In elementary school, youngsters need to begin understanding that diversity in nature is essential for natural systems to survive. Children can explore and investigate a pond, for instance, to learn that different organisms feed on different things.