

Thinking Processes in the Science Curriculum

National Science Education Standards (NRC, 1996)

Science as Inquiry

Inquiry is a step beyond “science as a process,” in which students learn skills, such as observation, inference, and experimentation. The new vision includes the “processes of science” and requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science.

Engaging students in inquiry helps students develop

- Understanding of scientific concepts
- Appreciation of “how we know” what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- Dispositions to use the skills, abilities, and attitudes associated with science (p. 105)

National Science Education Standards

The development of the National Science Education Standards was guided by certain principles. Those principles are:

- Science is for all students.
- Learning science is an active process.
- School science reflects the intellectual and cultural traditions that characterize the practice of contemporary science.
- Improving science education is part of systemic education reform.

Learning Science is an Active Process

Learning science is something students do, not something that is done to them. In learning science, students describe objects and events, ask questions, acquire knowledge, construct explanations of natural phenomena, test those explanations in many different ways, and communicate their ideas to others.

In the *National Science Education Standards*, the term “active process” implies physical and mental activity. Hands-on activities are not enough—students also must have “minds-on” experiences. Science teaching must involve students in inquiry-oriented investigations in which they interact with their teachers and peers. Students establish connections between their current knowledge of science and the scientific knowledge found in many sources; they apply science content to new questions; they engage in problem solving, planning, decision making, and group discussions; and they experience assessments that are consistent with an active approach to learning.

Emphasizing active science learning means shifting emphasis away from teachers presenting information and covering science topics. The perceived need to include all the topics, vocabulary, and information in textbooks is in direct conflict with the central goal of having students learn scientific knowledge with understanding.

Intellectual and Cultural Traditions in Contemporary Science

To develop a rich knowledge of science and the natural world, students must become familiar with modes of scientific inquiry, rules of evidence, ways of formulating questions, and ways of proposing explanations. The relation of science to mathematics and to technology and an understanding of the nature of science should also be part of their education.

An explicit goal of the *National Science Education Standards* is to establish high levels of scientific literacy in the United States. An essential aspect of scientific literacy is greater knowledge and understanding of science subject matter, that is, the knowledge specifically associated with the physical, life, and earth sciences. Scientific literacy also includes understanding the nature of science, the scientific enterprise, and the role of science in society and personal life. The Standards recognize that many individuals have contributed to the traditions of science and that, in historical perspective, science has been practiced in many different cultures.

Science is a way of knowing that is characterized by empirical criteria, logical argument, and skeptical review. Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture.

Scientific Literacy

Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. It also includes specific types of abilities. In the National Science Education Standards, the content standards define scientific literacy.

Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately.

Individuals will display their scientific literacy in different ways, such as appropriately using technical terms, or applying scientific concepts and processes. Also, individuals often will have differences in literacy in different domains, such as more understanding of life-science concepts and words, and less understanding of physical-science concepts and words.