SCIENCE EDUCATION

National Standards Finally Ready for Public Scrutiny

A year after the original deadline, and after input—some of it quite critical—from thousands of educators and scientists, the National Academy of Sciences (NAS) has unveiled a draft of its voluntary national science education standards. The document, released on 1 December, contains recommendations on the content of science classes from kindergarten through high school and on science teaching techniques.*

The standards, which are expected to be incorporated into state and local education plans around the country, focus on "concepts, not terms," said NAS President Bruce Alberts at a 1 December press conference. "We want to de-emphasize words, replace words by understanding," said Alberts, who has made improving science education a focus of his presidency. Educators and scientists alike seem happy with the approach. William Aldridge, director of the National Science Teachers Association, says, "I can tell you [the standards] are excellent." Robert Hazen of the Carnegie Institution, a geophysicist and science literacy expert on the content review committee, notes that the format "really gives the curriculum developer ... flexibility" without sacrificing sophistication. He cites a section on "geochemical cycles" that states: "Each element ... moves among reservoirs in the solid Earth, oceans, atmosphere, and living things. ..." Hazen notes that the principle can be taught to city kids via examples from waste recycling or to farm kids using the migration of crop fertilizer as an illustration.

The type of unbridled enthusiasm voiced by Hazen and Aldridge was not heard for earlier versions of the document. Last spring, in fact, a draft generated criticism from just about every quarter (*Science*, 16 September, p. 1848). Some reviewers thought it was too detailed, asking students to memorize too many facts and terms, while others thought there wasn't enough content. And some, such as Harvard University physicist and science historian Gerald Holton, were appalled at some of the "postmodernist" language used in the draft, particularly a passage that described science as a "social activity" of "constructing knowledge"—implying that attaining objective knowledge is impossible.

Standards project chair Richard D. Klausner, a cell biologist at the National Institute of Child Health and Human Development, is getting high marks for crafting a coherent document that steers clear of these problems. The offending postmodern passage has been deleted; physicist James Trefil of George Mason University, who says he "went ballistic" after reading the initial version, professes to be "delighted." And the content guidelines themselves "are not laden with scientific detail. The details are for the curriculum developers" to provide, says Klausner.

The truly important changes, Klausner says, were in organizing the material in a much clearer fashion and "integration of content with teaching and assessment." The content is divided into three student levels: kindergarten to grade 4, grades 5 to 8, and grades 9 to 12. Although the draft retains separate sections on teaching and assessment, discussions of each have been added to the specific content sections. For instance, the standards for young children in physical science contain not only information about the causes of change in wind and weather, but also have a hypothetical year-long project in which children learn how to measure the weather, analyze data, and communicate their findings to their school.

Testing, along with teaching and learning, comes in for renewed attention in the latest draft. The draft says many different types of measures—even the scorned multiple-choice test—may be appropriate. But teachers are encouraged to develop exercises that require some resourcefulness and that are relevant to real-world circumstances. The report offers an example based on the question: If you put a healthy plant in a covered glass jar of moist earth and put it in a window at a temperature of 60 to 80 degrees Fahrenheit, how long will it live? This acceptable response is from a fourth grader: "The plant could live. It has water and sunlight. It could die if it got frozen or a bug eats it. We planted seeds in third grade. Some kids forgot to water them and they died. ..."

The overall message of the standards is that knowledge once owned by the few is now a basic necessity to be a functioning citizen. "All of the understandings and abilities described in the science content standards should be achieved by all students," the introduction stresses. Long before that happens, however, the standards themselves have to be completely accepted by all reviewers. Already, copies have been sent out to more than 200 focus groups for their reactions. The feedback will be digested for a new round of standards-writing next spring. The truly final version, therefore, probably won't be available for another year.

–Constance Holden

WHAT TO KNOW AND WHEN

Excerpts from the proposed national science education standards for biological reproduction:

Kindergarten to 4th Grade: Life cycles of organisms

"Plants and animals have life cycles that include being born, developing into adults, reproducing and eventually dying. ..."

"Plants and animals closely resemble their parents."

"Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interaction with the environment. Inherited characteristics include the color of flowers and the number of limbs on an animal. ..."

5th to 8th Grade: Reproduction and heredity

"Reproduction is a characteristic of all living systems. ... Some organisms reproduce asexually. Other organisms reproduce sexually."

"... An egg and a sperm unite beginning the development of a new individual. This new individual has an equal contribution of information from its mother (via the egg) and its father (via the sperm). ..."

"Each organism requires a set of instructions for specifying its traits. Heredity is the passage of those instructions from one generation to another."

"Heredity information is contained in genes, located in the chromosomes of each cell. ... An inherited trait ... can be determined by either one or many genes."

9th to 12th grade: The molecular basis of heredity

"In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed of subunits of four kinds (A,G,C, and T). ... Each DNA molecule in a cell forms a single chromosome."

"Most cells in a human have two copies of each of 22 chromosomes. In addition, there is a pair of chromosomes that determine sex. ..."

"Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. ..."

*Copies of the draft can be obtained from NAS by calling 202-334-1399.