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National Standards and Benchmarks in Science Education: A Primer. ERIC Digest.

In the midst of our national quest for what students should know and be able to do in science, what is the bottom line for teachers? What should teachers know and be able to do in the science classroom? The following questions and answers are intended to highlight the key features of the science education reform movement as it relates to curricula and classroom practice. Reform of science and mathematics education has been on the national agenda for over a decade, and key leaders have offered their perspectives of progress to date (Rutherford, 1996; Strassenburg, 1996; Vos, 1996). The ideas presented here have been gleaned from the National Science Education Standards (National Research Council, 1996) and the Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993) Both documents elaborate ideas emerging from Project 2061 (Rutherford & Ahlgren, 1990) and other efforts that have focused on the science knowledge and skills literate citizens should possess.

WHAT ARE BENCHMARKS AND STANDARDS?

Both benchmarks and standards are commonly defined as reference points for judging quality, but the "Benchmarks" and "Standards" documents differ in form and purpose. The "Benchmarks" are intended to serve as curriculum design tools to help schools promote science literacy, specifying the levels of understanding and ability that all students are expected to reach along the way to becoming literate in science. The "Standards" complement the "Benchmarks" by going beyond science content considerations to provide frames of reference for judging the quality of teaching, professional development, assessment, science education programs, and educational systems.

WHAT ARE BENCHMARKS AND STANDARDS NOT?

* They are not "regulations" to specify uniform programs based on a particular

curriculum, philosophy, or instructional approach, but rather can be interpreted and implemented in a variety of ways.
* They do not imply that separate science teaching units should support each other in isolation.

* They do not diminish the responsibility of local and state agencies to design, select, and implement curriculum materials, instructional practices, and assessment strategies (BSCS, 1995).

WHAT ARE THE GOALS AND PURPOSES OF "STANDARDS" AND "BENCHMARKS?"

The main goal is scientific literacy for all. It is proposed that teachers know their students well enough to adapt curricula and teaching so that all students learn. This is not a lowering of standards, so that all can succeed, but rather a defining of standards so that all students accomplish the same learnings through various means. It is recognized (Benchmarks, p. 317) that "in the real and imperfect world, 'all' cannot possibly be absolute. When pressed for an operational definition, we have settled for 'at least 90 % of all future adults will have acquired at least 90 % of the knowledge and skills recommended in [Science for all Americans].'"
The Standards provide maps for:

*Students to establish their own goals for learning.

*Teachers to develop curricula with improved content, teaching methods, and assessment.

*Science supervisors to create coherent, integrated, long-term action plans.

*Institutions of higher education to refine programs for learning science through inquiry.

*School administrators to plan adequate resources for classrooms and professional development of teachers.

*Those who work in museums, zoos, and science centers to establish learning environments.

*Parents and community members to support excellence in education.

*The scientific community to provide unique support to teachers and students.

*Business and industry to provide guidance and resources in developing programs.

*Legislators to mold policies and funding priorities.

Benchmarks complement the Standards by addressing the content that students are expected to master at certain grade levels while giving coherence to the whole. Benchmarks can be used by:

*Teacher groups, administrators, school-board members, parents, interested citizens, and scientists to relate science literacy to the school setting.

*Committees of teachers and specialists to measure the curriculum and make improvements.

*Developers of curriculum to create materials.

*Test writers to develop appropriate materials and assessment techniques.

*Institutions of higher learning to prepared teachers.

*Researchers to pinpoint areas where further studies are needed.

HAVEN'T WE DONE THIS BEFORE?

Yes, but it didn't work. We need to do more than update science content. For this reason, the "Standards" emphasize teaching, assessment, program, and system as well as content. The "Standards" soften the boundaries between traditional subject matter categories and emphasize connections through conceptual themes such as systems, evolution, cycles, and energy. Also, the "Standards" require students to know fewer details; key concepts and thinking skills are emphasized over specialized vocabulary and memorization. The Standards introduce some relatively uncommon topics such as the nature of scientific enterprise, the history of science and technology, and how science, mathematics, and technology relate to society.

WHAT'S THE REAL AGENDA BEHIND THESE PROJECTS?

To some extent the "Standards" are reactions to dissatisfaction with the status quo. Earlier reforms did not address science literacy for all students and were considered by some to be ill articulated and short-sighted. "Benchmarks" and "Standards" represent efforts by diverse collaborative communities to plot a new course for science education and produce long term changes.
A key aphorism from Project 2061 is "less is more," since we cannot hope to teach the entire body of science content knowledge. We must help students see the big picture and work with important constructs, models, and theories to develop both critical reasoning skills and deeper understanding of the processes as well as the essential content of science.

The movement to standards-based education is widespread. Many professional

organizations representing different content areas have published, or are currently working on, national standards for their disciplines.

HOW DO GUIDELINES REGARDING SCIENCE CONTENT COMPARE

BETWEEN "BENCHMARKS" AND "STANDARDS?"In addition to science, the "Benchmarks" describe goals in social studies, mathematics, and technology that are not included in the "Standards." Otherwise, "the many individuals who developed the content standards sections of the...'Standards' made independent use and interpretation of the statements of what all students should know and be able to do that [were] published in Science for All Americans and Benchmarks" (NRC, 1996, p.15).

HOW MIGHT "BENCHMARKS" AND "STANDARDS" INFLUENCE

STATE AND DISTRICT CURRICULA, AND INDIVIDUAL TEACHERS?"Science for All Americans" and the "Benchmarks" have strongly influenced state and local science curriculum frameworks. Educators and legislators at the state and local levels have acknowledged the need to reform science education and design curricula to help students understand essential concepts to become prepared to play a part in national and global economies. Teachers will be seeing curriculum guidelines and learning objectives that bear striking resemblance to those found in the "Benchmarks." Since the National Science Teachers Association has endorsed the "Standards," further adjustments to state and local frameworks are likely in upcoming years.

HOW DO WE MEASURE PROGRESS TOWARDS ACHIEVING "BENCHMARKS" AND "STANDARDS?"

Since both the "Benchmarks" and the "Standards" are intended only as resources or guidelines from which to create coherent and comparable state frameworks and local curricula, it will be up to each state, district, school, and teacher to assess and evaluate achievement of their selected standards. The National Assessment of Educational Progress has been testing randomly selected students across grade levels and disciplines throughout the country for some years. It seems likely that some similar means of assessing the educational system and discipline-based knowledge and skills will continue.
The "Standards" include consideration of assessment issues. Project 2061 is also developing additional resources which will include various means of assessment for

reaching specific benchmarks and overall scientific literacy.

HOW IS PROFESSIONAL DEVELOPMENT ADDRESSED BY

THE "BENCHMARKS" AND "STANDARDS?"The "Benchmarks" do not address professional development issues. The "Standards" include a chapter on professional development issues relating to (1) learning science, (2) learning to teach science, (3) learning to learn, and (4) the characteristics of quality professional development programs at all levels. A description of what is to be learned by educators, and how learning opportunities would be best designed, is provided for each of the four dimensions.

I ALREADY HAVE LEARNING OBJECTIVES FOR MY CLASSES. DO I NEED TO REWRITE MY

LESSONS?Teachers can use the "Benchmarks" to compare and contrast their lessons and objectives with those advocated by the reform movement. The "Benchmarks" provide what is needed to produce guidelines for what students should know at each level, grades K-12. It outlines what should be introduced, in all major disciplines, at every educational stage. The "Standards," Chapter 7, emphasizes the importance for teachers to re-evaluate their objectives and teaching methods. Consistency, relevance, and integration of math and science are key issues under these standards.

SELECTED INTERNET RESOURCES

-National Academy Press
http://www.nap.edu/readingroom/books/nses/

Full text of the Standards online along with ordering information.

-American Association for the Advancement of Science

http://www.aaas.org/project2061/2061main.htm

The homepage for Project 2061.

-National Science Teachers Association

http://207.22.231.50/nsta_ssandc/

-Information on the Scope, Sequence and Coordination project.

The NSTA home page is: http://www.nsta.org/

-Eisenhower National Clearinghouse

http://www.enc.org/online/

Online documents include many articles on education standards.

-Related Materials

http://www.ed.gov/pubs/IASA/newsletters/standards/

Newsletters on issues in school reform, many relating to setting and meeting educational standards.

-Developing Educational Standards

http://putwest.boces.org/standards.html

An annotated list of Internet sites with educational standards and curriculum frameworks documents by state or subject matter.

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