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ABSTRACT

The National Research Council is coordinating the effort to develop national standards for science education. The goal is to develop, and publish by fall, 1994, science education standards that represent the consensus of teachers and other science educators, scientists, and the general public about what is important for all students to attain in science education. The standards consist of three facets: curriculum, teaching, and assessment. Section 1 of this document introduces the project. Section 2 is entitled "Charge to the Working Groups." Section 3 consists of questions and answers about standards. The next section presents a timeline for the standards. Section 5 lists the names and titles of people involved in the standards project. (PR)

SECTION ONE: ABSTRACT

The National Research Council (NRC), the principal operating agency of the National Academy of Sciences and the National Academy of Engineering, is coordinating the effort to develop national standards for science education. The goal is to develop, and publish by Fall, 1994, Science Education Standards that represent the consensus of teachers and other science educators, scientists, and the general public about what is important for **all** students to attain in science education. The standards consist of three facets: curriculum, teaching, and assessment. The curriculum standards are narrative descriptions of what all students should understand and be able to do in science; they describe the phenomena, concepts, processes, and attitudes that must be experienced and learned. Teaching standards are criteria which will be used to judge teaching environments, including opportunities to teach, and selection of teaching strategies and instructional materials that give students opportunities to learn. Assessment standards are the criteria used for judging and guiding the development and implementation of assessments of systems, programs, teaching, and student learning. These three facets of science education--curriculum, teaching and assessment--are intrinsically linked and the science education standards will demonstrate the linkages.

Concurrent with the development of the standards, the critique and consensus process was initiated by identifying individuals to serve as liaisons for their organizations, to provide a two-way interchange of information and ideas. The critique and consensus effort will maintain relationships with organizations, states, districts, and focus groups that are already involved; respond to inquiries from individuals and organizations; and initiate relationships with additional groups.

The science education standards development process is clearly evolving, with development and critique components continually interacting and refining each other. The plan for 1993-1994 will take shape according to the experiences of the first year of full-scale activity, with the aim of submitting a final standards draft for review in Fall, 1994, and publication by the end of calendar 1994.

SECTION TWO: CHARGE TO THE WORKING GROUPS

The charge to the working groups on science standards is to develop, in cooperation with the larger science and education communities, standards for school science. The standards, founded in exemplary practice and contemporary theories of learning, will provide a vision of excellence to guide the science education system in productive and socially responsible ways. Standards for science curriculum, teaching, and assessment will be integrated in a single document. The standards will contain criteria used to judge the quality of school science and to guide the future development of the science education enterprise.

Science curriculum standards will define:

- the nature of school science experiences that exemplary practice and learning research propose are effective in producing valued science learning outcomes;
- the scientific information (facts, concepts, laws, theories), modes of reasoning, and proficiency in conducting scientific investigations that all students are expected to attain as the result of the experiences; as well as
- the attitudes and inclinations to apply scientific principles and ways of thinking outside the formal education system that all students are expected to attain.

Science assessment standards will define:

- methods for the assessment and analysis of student achievement and opportunities that programs afford students to achieve the valued outcomes of school science;
- methods for achieving appropriate correspondence between assessment data and the purposes that the data will serve; as well as
- the characteristics of valid and reliable science assessment data and appropriate methods for collecting them.

Science teaching standards will define:

- the skills and knowledge teachers need in order to provide students with school experiences to achieve the valued science learning outcomes;
- the preparation and professional development needed by teachers in order to fulfill their roles; as well as
- the necessary support systems and resources needed for effective science teaching.

SECTION THREE: QUESTIONS & ANSWERS

Why are national science education standards needed?

Within the science education community, the process of identifying the extent of professional agreement on standards and giving everyone a common language to communicate that agreement began some time ago and is beneficial, but that is simply the starting point for communicating with the outside world with one voice. The mathematics education community has clearly demonstrated the utility of standards for identifying, rewarding, and defending best practice. No longer can supervisors tell innovative mathematics teachers that they must drill students on meaningless computational exercises without facing a strong counterargument based on the National Council of Teachers of Mathematics (NCTM) *Standards*. No longer can publishers and producers of instructional materials and tests claim that innovative districts and states are exceptional in their requests for materials that support reasoning and problem-solving without facing a strong counterargument based on the NCTM *Standards*. And soon it will be evident to people designing compensatory education programs for disadvantaged students that the NCTM *Standards* are intended for and realistic for all students and that their policies and procedures need to be aligned with the statement of the profession about what is best for all students.

Standards by themselves may provide guidance and support to individual teachers, curriculum developers, and policy makers, but the value of standards will come in their collective influence on all of the people who share responsibility for K-12 science education. National standards for science curriculum, teaching, and assessment will provide the criteria upon which curriculum, sound practice, and judgments about student work can be based. They can and ultimately will influence the context in which every student and teacher functions. Thus, we need standards to identify, reward, and defend sound practice.

Why is the National Academy of Sciences doing the national science education standards? Where does the authority come from?

The standards effort is being coordinated by the National Research Council (NRC), the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The NRC usually undertakes work that is requested by the federal government. In the case of the science education standards, requests came from several parties: First, the unanimous vote of the Board of Directors of the National Science Teachers Association; presidents of several scientific societies; the United States Secretary of Education; the Assistant Director of the National Science Foundation for Education and Human Resources; and the Co-Chairs of the National Education Goals Panel.

Once the task is accepted, however, the NRC recognizes that its reputation rests on the procedures it uses to ensure a high standard of quality. In the case of the science education standards, the additional criterion of a high degree of professional consensus is also recognized as an essential requirement. Through the process of engaging the widest possible number of people in the development and refinement of the standards, we seek to develop a high quality product for which there is widespread consensus. To be successful, the consensus must exist within and be understood by the science, science education, policy, and public advocacy communities. Thus, our authority will ultimately come from the professions and communities who are affected by the standards.

How is the NRC developing national science education standards?

The NRC has established the National Committee on Science Education Standards and Assessment, which will oversee the standards development process. The Committee Chair, Dr. James Ebert, the Vice President of the National Academy of Sciences, has already begun to meet with a Chair's Advisory Committee, consisting of representatives of seven major scientific and science education organizations, to

advise him on committee and staff appointments. A small staff has been identified and has prepared slates for approval of the three working groups--Curriculum, Teaching, and Assessment. The Chair's Advisory

Committee has identified qualified individuals with a wide range of personal and professional perspectives so that the views of classroom teachers, research scientists, and the community at large will be central in the discussions.

Committee and working group members will build upon the extensive work that has already been done by professional organizations, states, localities, and other nations, which is currently being collected, reviewed, and summarized for their use. They will work intensively in the summer of 1992, with Curriculum taking the lead and Teaching and Assessment following close behind, so that initial working papers from the Curriculum Standards Working Group will be available for critique in the fall of 1992. At the same time as the work is being organized, a plan for critique and consensus is being developed to engage the largest possible number of people in the review of drafts and refinement of the standards. The development teams will incorporate this input and develop another version during 1993, with the goal of achieving high quality standards that have a broad base of support by the end of calendar 1993.

Why is the timeline so short? Can high quality work be done?

The window of opportunity provided by the national political interest in education is only one reason for having a short timeline. Many educators in the field, seeing the influence of the mathematics education standards, are seeking a comparable professional statement for science as soon as it can practically be produced. Many people feel that there is substantially more agreement within the science and science education communities than is recognized; this agreement needs public acknowledgement if we are to speak with one voice about the direction of reform. If, indeed, there is extensive agreement about the vision for science education for the future, then harvesting the work already done should not take as long as would be predicted if we were starting from scratch.

There are, of course, predictable areas of disagreement among the varied communities who are interested in the standards. The extent to which technology and health should be addressed in science standards will be debated. Whether evolution should be accorded special status is controversial in some communities and not an issue in others. Such disputes are likely to be with us for decades, rather than years; they will have to be settled on scientific merit. By taking a relatively short timeline and using the time well, particularly spending more time on critique and revision than on the development *per se*, we hope to achieve a high standard. And while we are aiming for the dates in the current timeline, we will not complete the work until it is done--to a high standard and with a high degree of consensus.

Will this standards effort be different from the hundreds of national educational reports that have come out in the last decade?

There are several distinguishing features to this science education standards effort. First, there are no existing national standards for science education. There are state and local frameworks and there are professional society statements under development (e.g., NSTA's *Scope Sequence and Coordination Content Core*, AAAS's Project 2061's *Science for All Americans* benchmarks) but they do not yet have the widespread consensus that would allow them enjoy "national status." Second, the standards are being developed under the supervision of the National Research Council, whose statements on science policy issues are widely respected. Third, the Curriculum Standards are being developed in conjunction with Teaching and Assessment Standards, so that people who want students to achieve the Curriculum Standards have explicit guidance about how to give teachers and students the opportunity to achieve them and how to ascertain that they have been achieved.

The critique and consensus process that is integral to the development effort is a mechanism by which we will solicit input at every stage of the standard setting effort so that when it is finished, the support for standards will already exist, in all parts of the United States, not only in Washington, DC. In fact, it will not be possible to have national standards without achieving a national consensus. There will be little support for a laundry list of everyone's favorite topic; "less is more" is clearly part of the emerging vision. Similarly, finding the "lowest common denominator" or minimum competencies will not be the development strategy; consensus is more easily built by taking the high road and setting high expectations. Thus, the process being used is intended to create an influential set of statements.

Finally, as part of the overall national reform effort in education, groups such as the National Education Goals Panel are likely to endorse and use these standards for a variety of purposes, including the alignment of standards with a national assessment system, which is likely to give them considerable influence.

Can we be sure that the standards promote equity instead of putting up a high hurdle that only traditionally successful students will be able to clear?

Although there is no guarantee that standards will be used constructively, there are two important points to consider related to equity. First one should question the assumption that students from historically underrepresented groups are disadvantaged by high expectations, when there's considerable evidence that low expectations are one of the primary causes of the underachievement of such students. Second, standards for Curriculum, Teaching, and Assessment will be issued together, so that the opportunity to learn the curriculum (which will be reflected in the teaching standards) can be judged in conjunction with the student's attainment of the curriculum standards. Accepting the premise that students' performance cannot be judged independent of their opportunities to learn is the first step to achieving equitable science education.

Are there plans for supporting implementation of the standards?

As understanding of the standards development process is achieved and people are engaged in critical review, it is hoped that states and localities will begin to develop action plans to respond to the standards document at the same time that it is being refined. Thus, the dissemination process will begin with examples of ways in which state and local educational authorities are reviewing their own work in light of the national effort. By the time the document is finally approved, there should be a widespread agreement about its usefulness and examples of communities that have incorporated the standards in their planning and procedures. Similarly, funders of educational innovations may well have anticipated the final standards document in their requests for proposals and catalyzed attention to its goals.

We also plan to work with states to develop strategies for localities. A direct strategy will be undertaken with regard to large urban districts. Some cities have alliances, science and/or mathematics collaborative, and public education funds. The Association for Science and Technology Centers (ASTC) and the Triangle Coalition for Science and Technology Education are examples of national organizations with strong local connections that will be incorporated. There are also urban organizations, such as the Council of Great City Schools and the Urban League, with whom we shall work.

Why are so many people involved in the consensus process? Will the standards become "watered down"?

Not at all. The stake holders in the science education standards effort are not only members of national organizations, they are residents of states and districts where educational policies and practices are crafted and implemented. They also hold perspectives that come from the likely impact of the standards on their professional lives (e.g., publishers and producers of instructional materials and examinations). Unless all of the stakeholders are involved from the start, the chances for voluntary implementation are low.

SECTION THREE: TIMELINE

Completed Work

1991

NSTA, other professional organizations, U.S. Secretary of Education, NSF Assistant Director for Education, & Co-Chairs of National Education Goals panel ask NRC to take the lead on developing national science education standards.

U. S. Department of Education awards a grant to NRC to initiate design and development process.

James Ebert, VP of NAS, is appointed chair of National Committee on Science Education Standards and Assessment (NCSESA); he appoints an Advisory Committee to assist with planning and recruiting (see Appendix C).

Staff gather and analyze guidelines, frameworks, & position papers from professional organizations, states, & other countries (see Appendix D).

Design conceptualized and timeplan developed, reviewed by CCE, and approved by NRC Governing Board.

1992

Directors Rigden & Stage; Chairs Champagne, Heikkinen, & Worth; and over ninety volunteers are recruited and appointed to NCSESA and the Working Groups on Curriculum, Teaching, & Assessment (see Appendix C).

Charges to working groups established (see text page 2); NCSESA approves plan.

Liaisons established with science/education organizations (Appendix E), anticipating additional organizations (Appendix F).

Summaries of others' work used as starting point for Spring organizational and Summer writing meetings of working groups.

Presentations made to science and teaching organizations; planning for 1992-93 review of draft materials.

Planned Work

Fall: Major national meetings, including NSTA Regionals; AAAS Forum, October 30&31; MSEB Coalition/ECS/Eisenhower, December 5-8; others as invited (e.g., Secretary's Invitational Conference, October 8-9).

Mid-to-late Fall: Draft curriculum standards material released and circulated for review; state and local meetings to critique; NGA systemic reform forums, NSF SSI meetings, and other state and national organizations.

1993

Winter: Discussion of new strategies for staff development and technical assistance to make the implementation of standards possible.

Spring: Additional draft materials from Working Groups (Curriculum, Teaching, and Assessment); second draft circulated; meetings to solicit critical review.

Summer: Revisions based on critique.

Fall: First complete draft (addressing Curriculum, Teaching, and Assessment) of National Science Education Standards released.

Widespread circulation of drafts for critical review; meetings to anticipate appropriate uses of the standards.

1994

Winter & Spring: Review and revision cycles continue, with increasing numbers and range of participants in the discussion of the evolving standards, including national, state, & local policy leaders, parent & advocacy groups, business & industry.

Early Fall: Final draft submitted to NAS for review & publication.

Late Fall: National Science Education Standards released.

1995

State and l reform efforts continue to align with National Science Education Standards.

SECTION FIVE: PEOPLE INVOLVED DIRECTLY

NATIONAL COMMITTEE ON SCIENCE EDUCATION STANDARDS AND ASSESSMENT

EBERT, James D. (Chair), Vice-President, National Academy of Sciences, Washington, D.C.; President, Marine Biological Laboratory, Woods Hole, Massachusetts.

ALBERTS, Bruce M., American Cancer Society Research Professor of Biochemistry, University of California, San Francisco, California.

ALEXANDER, JR., Joseph K., Assistant Associate Administrator, NASA Office of Space Science and Applications, Washington, D.C.

ARCENEAUX, Janice M. H., Chair, Chemistry Department, Milby High School Science Academy, Houston, Texas.

ATKIN, J. Myron, Professor of Education, Stanford University, Palo Alto, California.

BARTON, Jacqueline K., Professor of Chemistry, California Institute of Technology, Pasadena, California.

BELTER, Catherine A., Chair, National Parent Teachers Association Education Commission, Springfield, Virginia.

BROWN, Rexford G., Executive Director, State Systems Change Initiatives; Director, Policy and Higher Literacies Project, Education Commission of the States, Denver, Colorado.

BRUNKHORST, Bonnie J., Professor of Science Education/Geology, Institute for Science Education, California State University, San Bernadino, California.

BUGLIARELLO, George, President, Polytechnic University, Brooklyn, New York.

CHAMOT, Dennis, Executive Assistant to the President, Department for Professional Employees, AFL-CIO, Washington, DC.

DELACOTE, Goery, Executive Director, The Exploratorium, San Francisco, California.

FRYE, Shirley M., Independent Mathematics Consultant, Scottsdale, Arizona.

GLASER, Robert, Director, Learning Research and Development Center, University of Pittsburgh.

GLASHOW, Sheldon Lee, Mellon Professor of Science, Harvard University, Cambridge, Massachusetts.

GOODLAD, John I., Director, Center for Educational Renewal; and Professor of Education, University of Washington, Seattle

GOULD, Stephen Jay, Professor of Earth Sciences, Harvard University, Cambridge, Massachusetts.

HERNANDEZ, Sonia C., Director, Education Policy, Office of the Governor of Texas, Austin, Texas.

LANG, Michael, Science Superintendent, Arizona Department of Education, Phoenix, Arizona.

LINDER-SCHOLER, William, Director, Community Affairs, Cray Research, Inc., Mendota Heights, Minnesota.

LONGREED, William, Adjunct Instructor, Biology and Chemistry, Navajo Community College; Teacher, Biology and Biological Sciences, Tuba City High School, Tuba City, Arizona.

MALCOM, Shirley M., Director, Education and Human Resources, American Association for the Advancement of Science, Washington, D.C.

MCLAIN, Sandra S., Teacher, Keels Elementary School, Columbia, South Carolina.

MILLS, Richard P., Commissioner of Education, State of Vermont, Montpelier.

MOHLING, Wendell G., Instructor, Space Education Workshops for Teachers; Director, Outdoor Laboratory at Shawnee Mission Northwest High School, Shawnee Mission, Kansas.

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OGLESBY, James R., Assistant to the Chancellor, and Professor of Education, University of Missouri-Columbia, Columbia, Missouri; Former President, National School Boards Association.

OLLIE, C. Arthur, Iowa State Representative; Chair, Iowa House of Representative's Education Committee; Teacher, Washington Middle School, Clinton, Iowa.

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RUSSELL, Juanester C., Principal, Daniel Boone Elementary School, University City, Missouri.

SANCHEZ, Bobby J., Teacher, Science and Mathematics; Advisor, Mesa Middle School, Reswell, New Mexico.

SCOTT, Lana, Teacher, Science, Indian Mound Middle School, McFarland, Wisconsin.

STOKES, Gerald M., Director, Global Studies Program, Pacific Northwest Laboratory, Richland, Washington.

TINKER, Robert F., Physicist and Founder, Technical Education Research Center, Cambridge, Massachusetts.

WYATT, Terry L., Teacher, Physics and Chemistry, Roy C. Start High School, Toledo, Ohio.

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HEIKKINEN, Henry W. (Chair), Director, Mathematics and Science Teaching Center; Professor, Department of Chemistry and Biochemistry, University of Northern Colorado, Greeley.

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