

Science Education Reform



More Emphasis . . . Less Emphasis

The Changes Recommended in the National Science Education Standards: Visions for Needed Changes

Goals for School Science

The goals for school science that underlie the National Science Education Standards are to educate students who are able to:

- Experience the richness and excitement of knowing about and understanding the natural world;
- Use appropriate scientific processes and principles in making personal decisions;
- Engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- Increase their economic productivity through the use of the knowledge, understandings, and skills of the scientifically literate person in their careers.

Changes are needed in the way teachers teach, the way they continue to grow as teachers, how learning is assessed, the way content is defined, how science programs are built, and how the entire school system supports the needed reforms. Following is a summary of the changes envisioned by the Standards. In a sense the “less emphasis” conditions describe what commonly occurs; the “more emphasis” descriptions are the recommendations for gaining more successes in terms of learning. These contrasts represent excellent directions for change if the visions for reform are to succeed.

Teaching Standards

Less Emphasis On	More Emphasis On
Treating all students alike and responding to the group as a whole	Understanding and responding to, individual student's interests, strengths, experiences, and needs
Rigidly following curriculum	Selecting and adapting curriculum
Focusing on student acquisition of information	Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes
Presenting scientific knowledge through lecture, text, and demonstration	Guiding students in active and extended scientific inquiries
Asking for recitation of acquired knowledge	Providing opportunities for scientific discussion and debate among students
Testing students for factual information at the end of the unit or chapter	Continuously assessing student understanding (and involving students in the process)
Maintaining responsibility and authority	Sharing responsibility for learning with students
Supporting competition	Supporting a classroom community with cooperation, shared responsibility, and respect
Working alone	Working with other teachers to enhance the science program

Professional Development Standards

Less Emphasis On	More Emphasis On
Transmission of teaching knowledge and skills by lectures	Inquiry into teaching and learning
Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice in school settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of continuing professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as educators	Staff developers as facilitators,

	consultants, and planners
Teacher as technician	Teacher as intellectual, reflective practitioner
Teacher as consumer of knowledge about teaching	Teacher as producer of knowledge about teaching
Teacher as follower	Teacher as leader
Teacher as an individual based in a classroom	Teacher as a member of a collegial professional community
Teacher as target of change	Teacher as source and facilitator of change

Assessment Standards

<i>Less Emphasis On</i>	<i>More Emphasis On</i>
Assessing what is easily measured	Assessing what is most highly valued
Assessing discrete knowledge	Assessing rich, well-structured knowledge
Assessing scientific knowledge	Assessing scientific understanding and reasoning
Assessing to learn what student do not know	Assessing to learn what student do understand
Assessing only achievement	Assessing achievement and opportunities to learn
End of term assessments by teachers	Students engaged in ongoing assessments of their work and that of others
Development of external assessments by measurement experts alone	Teachers involved in the development of external assessments

Content and Inquiry Standards

<i>Less Emphasis On</i>	<i>More Emphasis On</i>
Knowing scientific facts and information	Understanding scientific concepts and developing abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
Separating science knowledge and science process	Integrating all aspects of science content
Covering many science topics	Studying a few fundamental science concepts
Implementing inquiry as a set of instructional processes	Implementing inquiry as strategies, abilities, and ideas to be learned
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Process skills out of context	Process skills in context
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusions	Groups of students often analyzing and synthesizing data after defending conclusions
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry, and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

Program Standards

Less Emphasis On	More Emphasis On
Developing science programs at different grade levels independently of one another	Coordinating the development of the K-12 science program across grade levels
Using assessments unrelated to curriculum and teaching	Aligning curriculum, teaching, and assessment
Maintaining current resource allocations for books	Allocating resources necessary for hands-on inquiry teaching aligned with the <i>Standards</i>
Textbook- and lecture-driven curriculum	Curriculum that supports the Standards, and includes a variety of components, such as laboratories emphasizing inquiry and field trips
Broad coverage of unconnected factual information	Curriculum that includes natural phenomena and science-related social issues that students encounter in everyday life
Treating science as a subject isolated from other school subjects	Connecting science to other school subjects, such as mathematics and social studies
Science learning opportunities that favor one group of students	Providing challenging opportunities for all students to learn science
Limiting hiring decisions to the administration	Involving successful teachers of science in the hiring process
Maintaining the isolation of teachers	Treating teachers as professionals whose work requires opportunities for continual learning and networking
Supporting competition	Promoting collegiality among teachers as a team to improve the school
Teachers as followers	Teachers as decision makers

System Standards

Federal System	
Less Emphasis On	More Emphasis On
Financial support for developing new curriculum materials not aligned with the Standards	Financial support for developing new curriculum materials aligned with the Standards
Support by federal agencies for professional development activities that affect only a few teachers	Support for professional development activities that are aligned with the Standards and promote system-wide changes
Agencies working independently on various components of science education	Coordination among agencies responsible for science education
Support for activities and programs that are unrelated to Standards-based reform	Support for activities and programs that successfully implement the Standards at state and district levels
Federal efforts that are independent of state and local levels	Coordination of reform efforts at federal, state, and local levels
Short-term projects	Long-term commitment of resources to improving science education
State System	
Less Emphasis On	More Emphasis On
Independent initiatives to reform components of science education	Partnerships and coordination of reform efforts
Funds for workshops and programs having little connection to the Standards	Funds to improve curriculum and instruction based on the Standards
Frameworks, textbooks, and materials based on activities only marginally related to the Standards	Frameworks, textbooks, and materials adoption criteria aligned with national and state standards
Assessments aligned with the traditional content of science	Assessments aligned with the Standards and the expanded education view of science content
Current approaches to teacher education	University/college reform of teacher education to include science-specific pedagogy aligned with the Standards
Teacher certification based on formal, historically based requirements	Teacher certification that is based on understanding and abilities in science and science teaching

District System	
Less Emphasis On	More Emphasis On
Technical, short-term, in-service workshops	Ongoing professional development to support teachers
Policies unrelated to Standards-based reform	Policies designed to support changes called for in the Standards
Purchase of textbooks based on traditional topics	Purchase or adoption of curriculum aligned with the Standards and on a conceptual approach to science teaching, including support for hands-on science materials
Standardized tests and assessments unrelated to Standards-based program and practices	Assessments aligned with the Standards
Administration determining what will be involved in improving science education	Teacher leadership in improvement of science education
Authority at upper levels of educational system	Authority for decisions at level of implementation
School board ignorance of science education program	School board support of improvements aligned with the Standards
Local union contracts that ignore changes in curriculum, instruction, and assessment	Local union contracts that support improvements indicated by the Standards