

Resources

“Conducting scientific inquiry requires that students have easy, equitable, and frequent opportunities to use a wide range of equipment, materials, supplies, and other resources for experimentation and direct investigation of phenomena.”

NSES, P. 218

This chapter brings together a collection of rich and varied resources that will help teachers and districts as they work to implement standards-based science programs.

Section 1: Science Program

A focused and coherent K-12 science program is essential in every school district. Included in this section are suggestions for designing a scope and sequence that is focused, developmentally appropriate, and meets the needs of all students. There are also guidelines for program development and a materials selection tool.

Section 2: Equity

Equity and excellence permeate the *National Science Education Standards* and should be evident in science programs in Minnesota. SciMath^{MN}'s *Statement of Equity for Mathematics and Science Education* is included in this section along with references and resources that can be used to address this important issue. Together, these resources provide a starting point for re-thinking and re-working science education programs to serve *all* students.

Section 3: Instructional Technology

Incorporating technology into instruction is more than using computers. This section provides guidance for using technology to effectively teach science.

Section 4: Safety

All teachers of science, kindergarten through grade twelve, must be able to teach science safely. This section includes suggestions for ensuring classroom practices that are safe. Also included are model safety contracts for elementary and secondary students and a list of resources that address safety issues in K-12 classrooms.

Section 5: Support and Opportunities

Many organizations provide professional support for teachers. This section includes a wealth of information for teacher professional development and curriculum implementation. The Minnesota Science Teachers Association (MSTA) and the National Science Teachers Association (NSTA) provide many opportunities for professional growth and a network to help teachers move toward better science teaching. The Minnesota Department of Children, Families and Learning along with SciMath^{MN} provide services to help teachers reach their goals. The lists of educational, business, professional, community, and governmental organizations is by no means a complete list, but will aid teachers in a variety of situations and contexts.

Section 6: Grants

As resources dwindle and expectations grow, teachers are always looking for additional financial resources. This section provides practical advice on finding and obtaining grants to improve science education.

The resources for professional development and curriculum included in the chapter are designed to be used in conjunction with and as support for the rest of the *Framework*. Implementing standards-based science education means the alignment of all areas that impact the learning of science.

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The resources listed and described in this chapter are certainly not all inclusive but represent a sample of the many resources available. Even as the Framework is printed, some addresses and phone numbers will change. This chapter of the Framework is dynamic and will be periodically updated on the World Wide Web at the MSTA home page: <http://www.informns.k12.mn.us/scimathmn/science>.

Science Program

“The program standards are rooted in the assumptions that thoughtful design and implementation of science programs at the school and district levels are necessary to provide comprehensive and coordinated experiences for all students across grade levels, and that coordinated experiences result in more effective learning.”

NSES, P. 210

A Look at District Science Programs

Many school districts are rethinking their programs of study because of the growing awareness of and belief in the need for scientific literacy for all high school graduates along with the implementation of the *Minnesota Graduation Standards*. The national and state standards movements recognize the need for, as well as the desirability of, universal scientific literacy. Standards can provide direction for an appropriate science curriculum, for all students grades K-12 as well as to judge the effectiveness of such a program. Standards are about focus and coherence.

The Third International Mathematics and Science Study (TIMSS) provides evidence suggesting that focus and coherence in curriculum are key to high student achievement. The scope and sequence of standards-based programs focus each grade or course on a limited and carefully selected number of important concepts woven together throughout a student’s school experience. Understanding of these concepts is facilitated by their use in applications and decision-making. The use of inquiry and quantitative skills in all science instruction ties together students’ experiences in science education and increases the likelihood of science being applied in their everyday lives.

The National Science Education Program Standards establish criteria for the quality of and conditions for K-12 science programs. These standards focus on issues at the school and district levels which relate to opportunities for teachers to teach and for students to learn science. They describe how content, teaching, and assessment are coordinated in classroom practice in order to provide all students with the opportunity to obtain high levels of science literacy.

These six program standards, in concert with the teaching, professional development, assessment, content, and system standards described in the NSES, provide a foundation on which to build K-12 district science programs. Those responsible for the design, development, selection, and adaptation of science programs, including teachers, department leaders, administrators, curriculum directors, publishers, and school committees should pay close attention to these program standards.

National Science Education Program Standards

A: All elements of the K-12 science program must be consistent with the other National Science Education Standards and with one another and developed within and across grade levels to meet a clearly stated set of goals.

B: The program of study in science for all students should be developmentally appropriate, interesting, and relevant to students' lives; emphasize student understanding through inquiry; and be connected with other school subjects.

C: The science program should be coordinated with the mathematics program to enhance student use and understanding of mathematics in the study of science and to improve student understanding of mathematics.

D: The K-12 science program must give students access to appropriate and sufficient resources, including quality teachers, time, materials and equipment, adequate and safe space, and the community.

E: All students in the K-12 science program must have equitable access to opportunities to achieve the National Science Education Standards.

F: Schools must work as communities that encourage, support, and sustain teachers as they implement an effective science program.

NSES, pp. 210-222

Excellence and Equity

Standards-based science education is about excellence and equity. It means that school districts focus on developing science programs, not courses. According to the NSES Program Standard A, standards-based programs include:

- A clear set of goals and expectations for students to guide the design, implementation, and assessment of all elements of the science program.
- Use of a district curriculum framework to guide the selection and development of units and courses of study.
- Teaching practices and assessment policies and practices that are consistent with district goals and the curriculum framework.
- Support systems and formal and informal expectations of teachers that include sufficient resources such as people, time, materials, finance, opportunities for staff development, and leadership to work toward program goals.
- Clearly defined responsibilities for determining, supporting, maintaining, and upgrading all elements of the science program, including a curriculum framework that highlights inquiry and makes this type of teaching possible.

Developing a consensus about what K-12 science education should be is never an easy task. The NSES represent a broad based consensus among the science and science education communities on what all students should know and be able to do. Just as effective science learning is constructivist, so must local school personnel take responsibility for learning about what they want science education in their schools to be. Without an informed conversation and local consensus on the science program, the prospect of having a major impact on student achievement is minimal (Anderson and Pratt, 1995).

The inclusion of all the National Science Education Content Standards (See *Chapter 3: Content*) in the district curriculum framework ensures the opportunity for all students to achieve science literacy. The district framework provides direction for appropriate instructional practice and assessment, aligned as described in the NSES Teaching and Assessment Standards. In the district framework, standards are described for each grade level, ensuring that all students will have the opportunity to develop understanding of science concepts included in ways that are developmentally appropriate, interesting, and relevant to their lives. Inquiry is the foundation of science programs at all levels. Designers of curricula and programs ensure that the approach to content, as well as the teaching and assessment strategies, reflect the attainment of scientific understanding through inquiry. Coordination between the science program and other school subjects, especially mathematics, helps students form strong conceptual connections and build understanding. (See *Chapter 4: Connections*.)

Attention must also be given to the conditions necessary for implementing a comprehensive program which provides appropriate opportunities for all students to learn science. Skilled teachers who are prepared to teach diverse students, and who are supported with sufficient instructional and preparation time to meet the needs of an inquiry-based science program have great potential for improving student achievement. Science programs must be equipped with the resources to obtain, safely store, and maintain materials and equipment. In addition, there must be adequate and safe space for students to do investigative work. Access to field trips, people in the community, and technology is important for quality programming.

Given the diversity of student needs, experiences, and backgrounds, as well as the goal that all students will achieve a common set of standards, schools must support high-quality, diverse opportunities for students to learn science. “Equal opportunity to learn often requires *unequal* distribution of time and personnel” (Texley, p. 129). Girls may need more laboratory time to counteract pressures during adolescence; many students may benefit from role models; students with limited English proficiency may require more and varied opportunities to express science ideas; students interested in and capable of moving beyond the basic program may need encouragement and additional opportunities; students with disabilities or other special conditions may need modified work spaces and/or assessments; and the wide range of learning rates and styles of students are an essential consideration in science program development.

School districts and communities support and encourage the reform efforts of teachers by establishing a collegial culture of open communication and trust, and consider teachers as professionals whose work requires understanding and ability. Teachers are provided with time to discuss, reflect, and conduct research around science education reform, and to communicate with and learn from other professionals within and outside the school. Leadership roles and responsibilities in the school are explicit, accountability is clearly assigned, and teachers are included in the leadership structure.

All facets of the educational process co-exist in a complex and dynamic system with students at the core. Describing good courses is not enough to achieve a quality science education program. The bigger questions of program consistency, developmental appropriateness, a focus on inquiry, interest and relevancy to students, mathematics connections, sufficient resources of personnel, time, materials, space, equity, and community support must be addressed in order to reach the goals of student achievement.

The following table summarizes the changing emphasis in standards-based program development.

Changing Emphases in Program Development

<i>Less emphasis on</i>	<i>More emphasis on</i>
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 <i>Standards</i> 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 maker

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“ A curriculum is the way content is organized and presented in the classroom. The content embodied in the NSES can be organized and presented with many different emphases and perspectives in many different curricula... The NSES provide criteria that people at the local, state, and national levels can use to judge whether particular actions will serve the vision of a scientifically literate vision of a scientifically literate society. They bring coordination, consistency, and coherence to the improvement of science education.”

NSES, p. 2-3

Science Program Development

Step 1: Set Standards

- A.** Gather data on student achievement and course evaluations. Survey teachers to further identify needs to be addressed. Provide opportunities for community input.
- B.** Assemble a committee that represents all parts of the community—teachers, parents, curriculum directors, students, administrators, counselors, special education teachers, and community members.
- C.** Use the *National Science Education Standards* (NSES), the *Minnesota Graduation Standards*, the *Minnesota K-12 Science Framework*, and your district goals to develop a K-12 science program (district curriculum framework) which includes goals for the science program, and standards for what students should know and be able to do at each grade level.
- D.** This district curriculum framework must:
 - Be aligned with district goals.
 - Include placement of the Preparatory and High Standards in the Profile of Learning.
 - Describe what students should know and be able to do at each grade level, K-12.
 - Address teaching practices and assessment practice and policy.

Step 2: Select Materials

- A.** Gather information from a variety of resources, supporting materials, and textbooks.
- B.** Have a subcommittee do a preliminary survey of the materials in order to eliminate any that do not fit these criteria:
 - Is the material research-based, utilizing Best Practices (See *Chapter 2*)
 - Has it been field tested?
 - Does it align with district standards?
 - Does it align with NSES and the *Minnesota Graduation Standards*?
 - Is it inquiry-oriented and constructivist?
 - Is the cost within your district's budget?
- C.** Selection of Materials
 - Rate the potential materials using the criteria in the selection tool included in this chapter.
 - Having used the selection tool, use your ratings and the “Specific Evidence” in each section to complete the summary chart at the end.
 - Make your selections. Remember to be open to piecing together a variety of resources to achieve a curriculum program that meets local, state, and national standards. Rarely will one text or package have everything you need.

Step 3: Implement and Provide Ongoing Support

A. As life-long learners, teachers must be provided with opportunities to further their understanding of national and state standards as well as district curriculum. Plan the professional development which is necessary to successfully implement the new materials including information related to:

- Content
- Instructional practice
- Assessment policies and practice
- Opportunities for teachers to network with colleagues.

B. Plan for ongoing support for the use of the new materials. How will consumables be stored and replenished?

C. Plan for ongoing evaluation of the program.

“Trying a new program is a little like skydiving—with the support of peers and the school community as the parachute.”

Texley, p. 131

Curriculum Materials Selection Tool

Curricular materials are the single biggest instructional expense for a school district during the year in which a new curriculum is adopted. Due to budgetary constraints, curriculum materials choices will impact students and teachers for several years. Therefore, spending the time necessary to carefully evaluate and wisely select materials can ensure the best selection for your district.

The following curriculum selection and evaluation tool reflects the *National Science Education Standards* and the *Minnesota Graduation Standards*. Materials selected according to these criteria will help promote standards-based science teaching and learning. It includes criteria for evaluating content, the delivery of instruction, assessment, equity, the goals of teaching and learning, and implementation of the materials. It is a place to begin an evaluation of science textbooks, kits, and other materials. Curricular materials also need to reflect local district goals, so be sure to keep them in mind as you develop your district science program and choose materials.

Key to success in using this materials selection tool is consensus by the team selecting materials on the selection criteria. Prior to beginning the process, it must be determined what constitutes evidence for decision making. It is suggested that individuals complete the evaluation of one set of materials and then discuss results with others. Doing this will make team members aware of assumptions and expectations as well as develop general agreement on criteria and supporting evidence.

Title of Material _____

Publisher _____

©Date _____

Type (e.g. text, kit, module) of Resource _____

Grade/Course this Materials is being Considered for _____

Evaluator _____
