DEPARTMENT OF EDUCATION

Minnesota Academic Standards in Science – 2019

First Draft November 2018

Introduction

The First Draft of the Science Standards represents the work of the Science Standards review committee. This group of 36 includes K-12 teachers, administrators, college faculty, informal educators, and community members. The committee membership, timeline and assumptions that guide their work are found on the Minnesota Department of Education (MDE) Science webpage.

This draft of the standards represents a major shift in approach to standards and science learning, hence we suggest that you read the introductory material carefully, especially the foundational research.

We encourage you to provide feedback and comments about this draft of the standards via the online feedback survey from **November 9-26.** Town Hall meetings are scheduled at several locations across the state and via an online conference. These meetings provide background about the standards and provide an opportunity for input. The survey and the meeting schedule are posted at the above link.

The second draft of the standards will be published in February and the final draft will be available in May. The final draft will be available for planning purposes and the standards become law through the Minnesota rulemaking process. More information on the standards development process is at the Science webpage linked above.

Minnesota Statutes require that there be statements of standards and benchmarks. Standards are a summary description of student learning. The benchmarks identify the learning that is to be accomplished by all students by the end of each grade for K-8 and by the end of high school for the grade band 9-12.

Foundational Research influencing the Science Standards

The Assumptions for Guiding the Science Standards Committee's Work (Assumptions) direct that "the standards will be informed by *A Framework for K-12 Science Education*[1] (Framework) and include the dimensions of the scientific and engineering practices, crosscutting concepts, and disciplinary core ideas." The Framework document utilizes the research on science learning and instruction that has occurred in the past fifteen years to present a new vision for science standards. The *Framework for K-12 Science Education* is available as a free download at www.nap.edu. As you read the first draft, you will notice that the standards are based on Science and Engineering Practices and the benchmark statements integrate all three dimensions.

Dimension 1: Science and Engineering Practices

This dimension focuses on the important practices used by scientists and engineers which all students should learn to use with increasing sophistication over their years in school.

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Dimension 2: Crosscutting Concepts

This dimension lists key concepts, or themes, which connect knowledge from the various disciplines of science and engineering into a coherent scientific view of the world.

1. Patterns
2. Cause and effect: mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: flows, cycles, and conservation
6. Structure and function
7. Stability and change

Dimension 3: Disciplinary Core ideas

This dimension includes the core ideas from the physical sciences, life sciences and earth and space sciences. Engineering, technology, and applications of science are included to provide an understanding of the built world.

Physical Sciences

PS 1: Matter and its interactions

PS 2: Motion and stability: Forces and interactions

PS 3: Energy

PS 4: Waves and their applications in technologies for information transfer

Life Sciences

LS 1: From molecules to organisms: Structures and processes

LS 2: Ecosystems: Interactions, energy, and dynamics

LS 3: Heredity: Inheritance and variation of traits

LS 4: Biological Evolution: Unity and diversity

Earth and Space Sciences

ESS 1: Earth's place in the universe

ESS 2: Earth's systems

ESS 3: Earth and human activity

Engineering, Technology, and the Applications of Science

ETS 1: Engineering design

ETS 2: Links among engineering, technology, science, and society

[1] Nation Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concept, and Core Ideas.* Washington DC. The National Academies Press.

Decisions by the Committee for the First Draft

1. The Career and College Readiness Statement will guide the writing of standards and benchmarks. This consideration led the committee to emphasize science and engineering skills, called practices in these standards.
2. Standards will be written as anchor standards (statements that span the K-12 grade range), and will be based on the Framework's Science and Engineering Practices. Where appropriate, separate anchor standards will be written for both the science and the engineering aspects of a practice.
3. Benchmarks will be written to reflect the integration of the three dimensions.
4. Benchmarks for grades K-5 will include core ideas from physical science, life science, and earth and space science at each grade.
5. Benchmarks for grades 6-8 will primarily have core ideas from physical science at grade 6, life science at grade 7, and earth and space science at grade 8.
6. Benchmarks for grades 9 – 12 will be organized by physics, chemistry, life science, and earth and space science.
7. The Standards Committee will delay, until the second draft, the full consideration of the following areas called for in the Assumptions:
    a. Contributions of Minnesota American Indian tribes and communities
    b. Technology and Information literacy Standards
    c. Computer science concepts and skills
    d. Environmental literacy
    e. Alignment with Minnesota Mathematics and ELA/literacy standards
    f. Full attention to issues of diversity and equity
    g. Balancing the specificity of the standards and benchmarks ("grain size")
8. The Standards Committee will plan to add the following to the benchmarks in later drafts: further clarifications, connections to local contexts, and/or examples. There will be additional benchmarks in some areas, especially chemistry and physics. The physics and chemistry benchmarks that are required of all students will be identified in later drafts.

    It is important to note that the standards and benchmarks do not direct or imply a particular combination of Practices, Crosscutting Concepts and Core Ideas that should be taught together. Instruction and curriculum about a core idea should utilize multiple practices and crosscutting concepts, which are woven together to help students understand the core idea and gain proficiency in engaging in practices and using the crosscutting concepts. It is likely that coherent curriculum units will target combinations of benchmarks, rather than single benchmarks.

Career and College Readiness Statement

Research[1] states that the majority of jobs and careers demand a set of skills whose foundation can be developed in the science classroom. Therefore, science instruction should provide students the skills that will prepare them for post-secondary education, potential careers, knowledge and appreciation of cultural diversity, and lifelong learning. These skills include communication, collaboration, critical thinking, creativity, adaptability, resilience and problem solving, which should be learned along with the concepts and practices of science and engineering.

School systems should ensure that all students, regardless of geographic location, socioeconomic status, race, disability, gender, national origin, native language, and religion, have access to rigorous science instruction, and materials and equipment that are relevant to a student's environment and culture. Science education should cultivate broadly applicable knowledge and practices that will prepare students to be conscientious, informed, and productive members of society, able to make evidence-based decisions.

[1] Nation Research Council. (2012) A Framework for K-12 Science Education: Practices, Crosscutting Concept, and Core Ideas. Washington DC. The National Academies Press.

Reviewing the First Draft

In reviewing and providing feedback, the following questions should be kept in mind:

1. How well will the standards and benchmarks encourage improved science and engineering teaching and learning?
2. How well does the sequence of practices and core ideas from grade to grade provide student learning?
3. How well do the standards and benchmarks balance broadness and specificity, particularly in light of the Framework's goal to shift science education to greater coherence?

Standards

The eight practices are organized into four strands. Each practice has one or two anchor standards. When the practice has a strong component of engineering, the second standard conveys the engineering idea.

Code: Number = grade.strand.practice.standard.benchmark. For example. _.3.2.1_ = strand 3, practice 2, standard 1. Grade 9 means the grade band 9 – 12

* = related explicitly to engineering

Strand 1: Exploring phenomena or engineering problems

Practice 1: Asking questions and defining problems

Standard 1: _1.1.1_ Students will be able to ask questions of each other about the texts they read, the features of the phenomena they observe and the conclusions they draw.

Standard 2: _1.1.2._ Students will be able to ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications of its solution.*

Practice 3: Planning and carrying out investigations

Standard 1: _.1.3.1._ Students will design and conduct investigations and formulate questions based on observations, organizing and collecting data to make decisions from investigations in the classroom, school laboratory and/or field.

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

Practice 4. Analyzing and interpreting data

Standard 1: _.2.4.1._ Students will be able to represent observations and data in meaningful ways, including graphically and with mathematics that emphasize patterns in the data and relationships among variables in order for others to understand their evidence and their interpretations.

Practice 5. Using mathematics and computational thinking

Standard 1: _2.5.1_ Students will be able to use symbolic representations that can be used to represent data, to predict outcomes, and eventually derive further mathematical or algorithmic relationships that describe or model phenomena.

Strand 3: Developing possible explanations of phenomena or designing solutions to engineering problems

Practice 2. Developing and using models

Standard 1: _.3.2.1._ Students will be able to use diagrams, maps, and other abstract models as tools that enable them to elaborate on their own ideas or findings and present them to others.

Standard 2: _.3.2.2._ Students will be able to use models in engineering situations to identify problems, visualize and test solutions, and communicate about a design's features and effectiveness to others.*

Practice 6. Constructing explanations and designing solutions

Standard 1: _.3.6.1._ Students will be able to apply scientific principles and empirical evidence (primary or secondary) to construct causal explanations of phenomena or identify weaknesses in explanatory accounts developed by themselves or others.

Standard 2: _.3.6.2._ Students will be able to use their understanding of scientific principles and the engineering design process to either construct a device or implement a design solution that meets agreed-on criteria and constraints.*

Strand 4: Communicating reasons, arguments and ideas to others

Practice 7: Arguing from evidence

Standard 1: _.4.7.1._ Students will be able to use evidence to engage in argumentation to compare and evaluate competing ideas and methods, and to answer questions.

Standard 2: _.4.7.2._ Students will be able to use evidence in the process of constructing an argument necessary for advancing and defending a design solution.*

Practice 8: Obtaining, evaluating and communicating information

Standard 1: _.4.8.1._ Students will be able to use scientific resources, observations, evidence and analytical arguments to critically examine and evaluate claims and communicate critical thinking through discussion, and in writing.

Standard 2: _.4.8.2._ Students will be able to use appropriate combinations of sketches, modeling and language to communicate and critique proposed engineering design solutions.*

Benchmarks

Code: Number = grade.strand.practice.standard.benchmark. For example 5.4.3.2.1 = grade 5, strand 4, practice 3, standard 2, benchmark 1

The references in parentheses at the end of the benchmark refers to the dimensions on page 2-3. P = Practice, CC = Crosscutting Concept, CI = Core Idea,

* = a benchmark related to engineering

Kindergarten

Strand 1: Exploring phenomena or engineering problems

0.1.1.2.1 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.* (P: 1, CC: 2, CI: ESS3,)

0.1.1.2.2 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.* (P: 1, CC: -, CI: ETS1)

0.1.3.1.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. (P: 3, CC: 2, CI: PS2)

0.1.3.1.2 Make observations to determine the effect of sunlight on Earth's surface. (P: 3, CC 2, CI: PS3)

Strand 2: Looking at data and empirical evidence to understand phenomena or solve problems

0.2.4.1.1 Record and use observations to describe patterns of what plants and animals (including humans) need to survive. (P: 4, CC: 1, CI: LS1)

0.2.4.1.2 Record, use and share observations of local weather conditions to describe patterns over time. (P: 4, CC: 1, CI: ESS2)