

DEPT. OF EDUCATION AND
EARLY DEVELOPMENT



K-12 Science Standards for Alaska

Science Standards for Alaska

Introduction

Science and technology have been essential to the people for Alaska in its past, its present, and will be increasingly important in the future. Providing a firm foundation in science education for all students in Alaska is a bright opportunity and essential challenge. The State's science standards provide the foundation for defining what students should know and be able to do in terms of scientific knowledge and skills.

Development Process

In October of 2017, the Alaska Department of Education and Early Development (DEED) began a statewide application process to identify teachers, principals, curriculum directors, science specialists, and other qualified individuals to serve as writers and reviewers and aid in the creation of new science standards for the State of Alaska.

Out of the pool of applicants, 15 diverse professionals were selected based upon merit, to serve on the science content standards Writing Committee. An additional 15 individuals were chosen to review the writing committee's recommendations.

The Writing Committee was provided with the following charge:

- The Writing Committee will identify and review influential sets of science content standards (e.g., Next Generation Science Standards; standards for the NAEP, PISA, and TIMSS assessments; science standards from College Board and ACT; standards from other leading states; science standards from leading textbook publishers; and past science standards such as AAAS' Project 2061).
- The Writing Committee will identify, modify, write, and compile a recommended set of science content standards drawing on its members' expertise and review of relevant materials. Ideally, the Writing Committee will produce a set of content standards to guide curriculum and instruction in the state. In addition, the Writing Committee will provide recommendations regarding the state summative assessment in science.
- The Writing Committee will receive feedback from the Review Committee. Following review, the Writing Committee will make appropriate changes. The Writing Committee will send its recommended set of science content standards to the Alaska Department of Education and Early Development, which will review and send to the State Board.

In April of 2018, the first meeting of the Writing Committee was held in Anchorage. From this review, the team decided to use the Next Generation Science Standards (NGSS) as a basis for Science Standards for Alaska due to its three-dimensional design, and focus on science for all students. The three-dimensional design provides students with a context for the content of science, how science knowledge is acquired and understood, and how the individual sciences are connected through concepts that have universal meaning across disciplines.

It was the committee’s decision to shape the Science Standards for Alaska around the NGSS, with a strong focus on relevance to Alaskan students and allow educators the flexibility to determine the best way to help students meet the standards, based on local needs.

Following the first meeting, Writing Committee suggestions were sent to Reviewers for questions and comments. The Writing Committee met again in June of 2018 to discuss reviewers’ input and revise the standards based on the feedback received.

Subsequently the Writing Committee’s revisions went back to the Review Committee for a second round of review. The Reviewers’ comments were again presented to the Writing Committee in October of 2018.

In October of 2018, the Writing Committee met again, reviewed comments of the Review Team, and finalized recommendations regarding the Science Standards for Alaska, to be submitted to the Alaska Board of Education for review and adoption.

Relation of the Science Standards for Alaska and the NGSS

The Science Standards for Alaska are largely the same as the NGSS. The Writing Committee strongly supported the general architecture and approach of the NGSS, and made no changes to the scientific content. The revisions made by the Writing Committee included:

- Adding many examples of how the standards could be made more relevant for students in Alaska by showing applications of scientific principles and skills in an Alaskan context
- Rephrasing several content standards statements to make them clearer and/or more age-appropriate
- Fewer than a handful of NGSS content standards were combined, moved to a different grade, or deleted.

The Science Standards for Alaska contain two main parts: Performance Expectations and Foundational Statements. These are also found in the NGSS. In addition, the NGSS standards have a third part, called “Connections” that provide information for how the science content standards are related to each other and to other widely-used content standards in reading, writing, and mathematics. The Writing Committee recommended not incorporating the Connections information as a part of the state-adopted science content standards because such connections are likely to change more rapidly than the science standards. The Writing Committee endorsed DEED providing such information, along with other support materials as supplemental to the actual state science standards.

How to Read the Science Standards for Alaska¹

The Science Standards for Alaska are distinct from prior science standards in three essential ways.

- 1) Performance. Prior standards documents listed what students should “know” or “understand.” These ideas needed to be translated into performances that could be assessed to determine whether or not students met the standard. Different interpretations sometimes resulted in assessments that were not aligned with curriculum and instruction. The Science Standards for Alaska has avoided this difficulty by developing performance expectations that state what students should be able to do in order to demonstrate that they have met the standard, thus providing the same clear and specific targets for curriculum, instruction, and assessment.
- 2) Foundations. Each performance expectation incorporates all three dimensions from the Framework— a science or engineering practice, a disciplinary core idea, and a crosscutting concept. The symbol “∞” indicates foundational statements are continued onto the next page.
- 3) Coherence. Each set of performance expectations lists connections to other ideas within the disciplines of science and engineering, and with Common Core State Standards in Mathematics and English Language Arts.

This chapter describes how these three unique characteristics are embodied in the format of the standards, beginning with the “system architecture.”

The Framework: A Vision For Science K-12

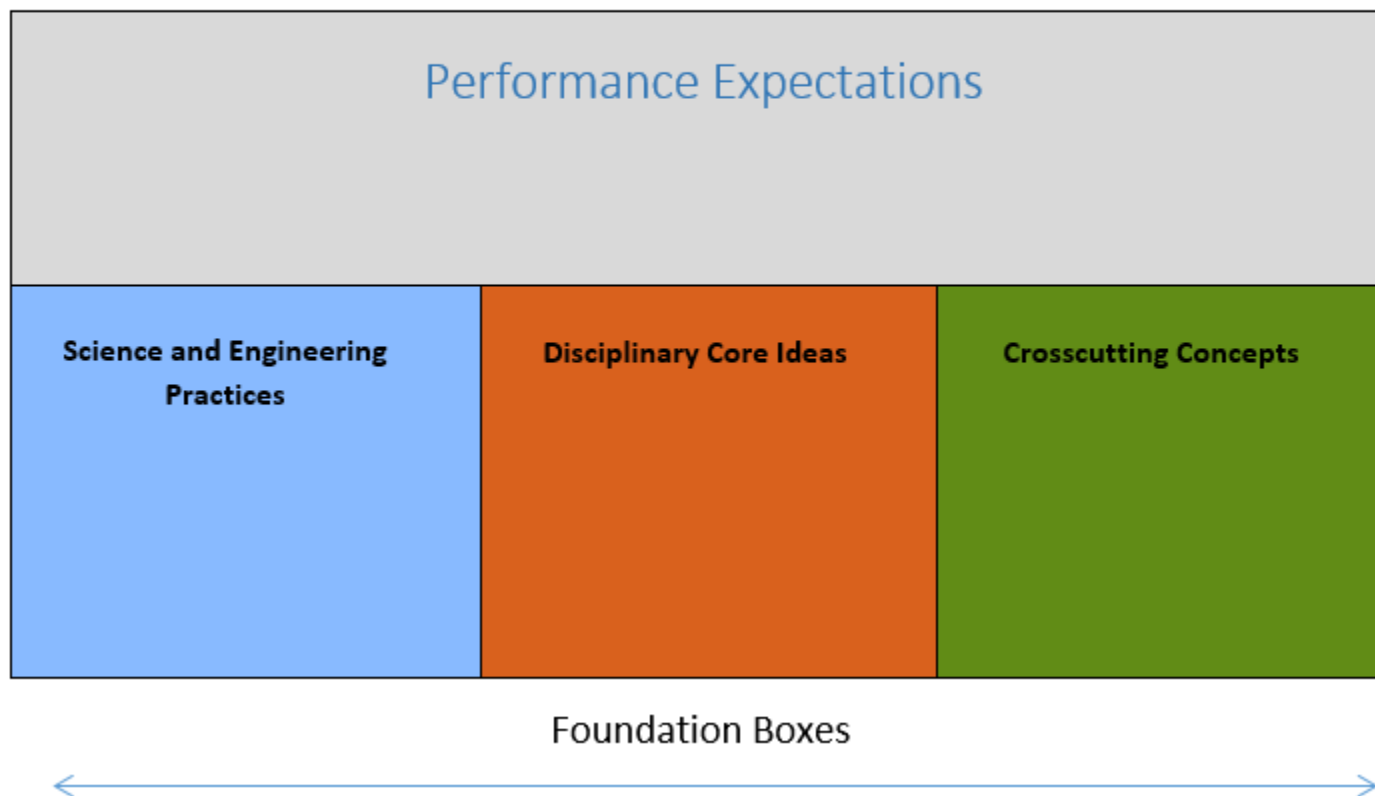
Science, engineering, and technology permeate nearly every facet of modern life and hold the key to solving many of humanity’s most pressing current and future challenges, The United States’ position in the global economy is declining, in part because U.S. workers lack fundamental knowledge in these fields. To address the critical issues of U.S. competitiveness and to better prepare the workforce, *A Framework for K-12 Science Education* proposes a new approach to K-12 science education that will capture students’ interest and provide them with the necessary foundational knowledge in the field.

¹ This section paraphrases and quotes extensively from NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

System Architecture

As shown in the illustration below, each set of performance expectations has a title. Below the title is a box containing the performance expectations. Below that are three foundation boxes, which list (from left to right) the specific science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that were combined to produce the performance expectations (PEs) above. These sections are described in further detail below.

3. Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms



Performance Expectations (PEs)

The Science Standards for Alaska are expressed as Performance Expectations.

Performance Expectations are statements about what students should know and be able to do at the end of instruction. Each performance expectation combines the practices of science and engineering, the disciplinary core ideas, and the cross cutting concepts into a single statement of what is to be assessed. These are the elements of Three Dimensional Learning.

The Performance Expectations in the Science Standards for Alaska are targets for assessment. For students to achieve such performances, they will need regular opportunities to engage in learning that blends all three dimensions of the standards throughout their classroom experiences, from Kindergarten through High School. The performance expectations set the learning goals for students, then students, teachers, and districts decide how to reach those learning targets.

When instruction is consistent with the Framework and the NGSS, students will be actively engaged in the full range of scientific and engineering practices and applying the crosscutting concepts in the context of investigating multiple core ideas.

In three-dimensional learning student work is driven by questions arising from phenomena or by an engineering design problem. Students are supported in connecting their learning across units and courses to build a coherent understanding of science ideas and of the crosscutting concepts.

Students have opportunities to apply their developing science knowledge to explain phenomena or design solutions to real world problems. They interact with others as they conduct investigations; represent data; interpret evidence; gather additional information, and develop explanations, models, and arguments.

The Science Content Standards for Alaska are for all students, and all students are expected to achieve proficiency with respect to all of the performance expectations in the Alaska standards.

The Science Content Standards for Alaska provide a foundation for rigorous advanced courses in science or engineering that some students may choose to take. Students interested in pursuing science further (through Advanced Placement or other advanced courses) should have the opportunity to do so.

In the example below, notice how the performance expectation combines the practices and ideas that students need to learn, while it suggests ways of assessing whether or not third graders have the capabilities and understandings specified in the three foundation boxes.

2-PS1-2

Students who demonstrate understanding can: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*

Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.

Assessment Boundary: Assessment of quantitative measurements is limited to length.

The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze data from tests of an object or tool to determine if it works as intended. 	<p>PS1.A: Structure and Properties of Matter</p> <ul style="list-style-type: none"> Different properties are suited to different purposes. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Simple tests can be designed to gather evidence to support or refute student ideas about causes. <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Engineering, Technology, and Science, on Society and the Natural World</p> <ul style="list-style-type: none"> Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.

As in this example, the performance expectations marked with an asterisk* integrate traditional science content with engineering through a practice or disciplinary core idea. (<https://www.nextgenscience.org>)

As shown in the example, most of the performance expectations are followed by one or two additional statements. These include Clarification Statements, which supply examples or additional clarification to the performance expectations including connections to Alaskan phenomena where applicable; and Assessment Boundary Statements, which specify the limits to large-scale assessment.

The **codes for the performance expectations** were derived from the Framework. As with the titles, the **first digit** indicates a Grade Level from Kindergarten to Grade 5. Middle School and High School Performance Expectations are organized by Grade Bands. Middle School (MS) is Grades 6-8, and High School (HS) is Grades 9-12. The next **alpha-numeric code** specifies the discipline, core idea and sub-idea. All of these codes are shown in the table below, derived from the Framework. Finally, the **number at the end of each code** indicates the order in which that statement appeared as a DCI in the Framework. Connections to the **Nature of Science** concepts can be found in either the practices or crosscutting concepts foundation boxes.

Foundation Boxes

While the performance expectations can stand alone, a more coherent and complete view of what students should be able to do comes when the performance expectations are viewed in tandem with the contents of the foundation boxes that lie just below the performance expectations. These three boxes include the science and engineering practices, disciplinary core ideas, and crosscutting concepts, derived from the Framework, that were used to construct this set of performance expectations.

Science and Engineering Practices (SEPs). The blue box on the left includes just the science and engineering practices used to construct the performance expectations in the box above. These statements are derived from and grouped by the eight categories detailed in the Framework to further explain the science and engineering practices important to emphasize in each grade band. Most sets of performance expectations emphasize only a few of the practice categories; however, all practices are emphasized within a grade band. Teachers should be encouraged to utilize several practices in any instruction, and need not be limited by the performance expectation, which is only intended to guide assessment.

The Science and Engineering Practices include:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using Mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

The “Practices of Science and Engineering” replace the use of science processes or skills, to reflect the knowledge that is specific to each practice, along with particular skills.

Disciplinary Core Ideas (DCIs). The orange foundation box in the middle of the Performance Expectation sample includes statements taken from the Framework about the most essential ideas in the major science disciplines that all students should understand during 13 years of school. Including these detailed statements was very helpful to the NGSS writing team as they analyzed and “unpacked” the disciplinary core ideas and sub-ideas to reach a level that is helpful in describing what each student should understand about each sub-idea at the end of grades 2, 5, 8, and 12. Although they appear in paragraph form in the Framework, here they are bulleted to be certain that each statement is distinct.

The number of core ideas has been reduced in the Science Standards for Alaska to allow a deeper look into each concept and develop a strong foundation of knowledge regarding these ideas. The Framework lists 11 core ideas, four in life science, four in physical science, and three in Earth and Space Science. The core ideas are divided into a total of 39 sub-ideas, and each sub-idea is elaborated in a list of what students should understand about that sub-idea at the end of grades 2, 5, 8, and 12. We have called these grade-specific statements Disciplinary Core Ideas (DCIs).

Science Standards for Alaska Disciplinary Core Ideas	
<p>Physical Sciences</p> <p>PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and their applications in technologies for information transfer</p>	<p>Life Sciences</p> <p>LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, and dynamics LS3: Heredity: Inheritance and variation of traits LS4: Biological evolution: Unity and diversity</p>
<p>Earth and Space Sciences</p> <p>ESS1: Earth’s place in the universe ESS2: Earth’s systems ESS3: Earth and human activity</p>	<p>Engineering, Technology, Applications of Science</p> <p>ETS1: Engineering design</p>

Crosscutting Concepts (CCCs). The green box on the right of the sample Performance Expectation (PE), includes statements derived from the Framework’s list of Crosscutting Concepts, which apply to one or more of the performance expectations in the box above. Most sets of Performance Expectations limit the number of crosscutting concepts so as to focus on those that are readily apparent when considering the Disciplinary Core Ideas. However, all are emphasized within a grade band. Again, the list is not exhaustive nor is it intended to limit instruction.

Using Crosscutting Concepts to Engage Students. In three-dimensional learning, crosscutting concepts are the dimension that provides a scaffold upon which teachers and students can organize the cognitive structures for unifying the science disciplines. The crosscutting concepts are featured as one of the three dimensions in the performance expectations outlining what students should know and be able to do.

The Crosscutting Concepts include big ideas in science such as:

- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and Systems Models
- Energy and Matter
- Structure and Function
- Stability and Change

The Crosscutting Concepts can be used to discuss phenomena, evidence, and questions students develop during investigations or data analysis. Prompts for using the Crosscutting Concepts can be located on this website.