2022 Oregon Science Standards

K-12 Science Education

Adopted: June 2022

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K-12 Science Education for Every Student: The Vision

A K–12 Framework Science Education (National Research Council, 2012) is a compilation of science education research identifying critical topics and best practices for youth to learn science that centers students' cultures, interests, and identities as they make sense of their world. The Framework highlights how "all science learning can be understood as a cultural accomplishment." Research shows that a cultural perspective can transform learning experiences to be more engaging and meaningful for learners. This is a fundamental shift from **learning about** a science topic, **to figuring out** why or how something happens. These instructional sequences are more coherent when students investigate compelling natural phenomena (in science) or work on meaningful design problems (in engineering) by engaging in science and engineering practices.

> "Equity in science education requires that all students are provided with equitable opportunities to learn science and become engaged in science and engineering practices; with access to quality space, equipment, and teachers to support and motivate that learning and engagement; and adequate time spent on science. In addition, the issue of connecting to students' interests and experiences is particularly important for broadening participation in science." (NRC, 2012).

Figure 1

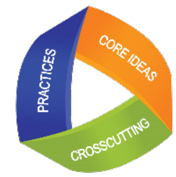
From the research publication of the Framework, the Next Generation Science Standards were developed in partnership with the coordination of 26 states, including Oregon, along with critical partners in science, science education, higher education, and industry. As part of the development process, the standards underwent multiple reviews, including two public drafts, allowing all who have a stake in science education an opportunity to inform the development of the standards. This included input from over 50,000 educators. In 2014, and again in 2022, based on the recommendation from the Oregon Science Standards Advisory Panels, **the Oregon State Board of Education adopted the NGSS as Oregon's K-12 Science Standards**.

There is no doubt that science - and therefore, **science education - is central to the lives of every community member**. Never before has our world been so complex and scientific literacy so critical to making sense of it all. Science is also at the heart of each community's ability to continue innovating, leading, and creating jobs for the future. That's why **all students** - regardless of whether they pursue college or STEM careers - **should have access to a high-quality K-12 science education**. (nextgenscience.org, 2013).

For more information on Next Generation Science Standards (NGSS) and supporting resources, please visit the NextGenScience website.

Three Dimensional Learning: Putting it Together

A K–12 Framework Science Education (National Research Council, 2012) describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard. These three dimensions, **science and engineering practices**, **crosscutting concepts**, and the **disciplinary core ideas**, make up distinct but equally important components of what students should know and be able to demonstrate. The three dimensions are:



Dimension 1: Science and Engineering Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. *A Framework for K-12 Science Education* uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also the knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening instruction involving engineering will clarify for students the relevance of science, technology, engineering, and mathematics (the four STEM fields) to everyday life.

- ***Asking Questions and Defining Problems***
  A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.

- ***Developing and Using Models***
  A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

- ***Planning and Carrying Out Investigations***
  Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

- ***Analyzing and Interpreting Data***
  Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results.

- ***Using Mathematics and Computational Thinking***
  In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing

simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships.

- ***Constructing Explanations and Designing Solutions***
  The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

- ***Engaging in Argument from Evidence***
  Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem.

- ***Obtaining, Evaluating, and Communicating Information***
  Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change.

A Framework for K-12 Science Education emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

- ***Patterns***
  Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

- ***Cause and Effect: Mechanism and Explanation***
  Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

- ***Scale, Proportion, and Quantity***
  In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

- ***Systems and System Models***
  Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

❖ ***Energy and Matter: Flows, Cycles, and Conservation***

Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

❖ ***Structure and Function***

The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

❖ ***Stability and Change***

For natural and built systems alike, conditions of stability and factors that control rates of change are critical elements to consider and understand.

Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction, and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four main core ideas (domains) and their subtopics: the earth and space sciences; engineering, technology and applications of science; the life sciences; and the physical sciences.

❖ ***Earth & Space Science***

- ESS1 Earth's Place in the Universe
- ESS2 Earth's Systems
- ESS3 Earth and Human Activity

❖ ***Engineering, Technology, and the Application of Science***

- ETS1 Engineering Design
- ETS2 Links Among Engineering, Technology, Science, and Society

❖ ***Life Science***

- 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

❖ ***Physical Science***

- PS1 Matter and Its Interactions
- PS2 Motion and Stability: Forces and Interactions
- PS3 Energy
- PS4 Waves and Their Applications in Technologies for Information Transfer

Integration of K-12 Climate Change Education^

The adopted 2022 Oregon Science Standards include the foundational understanding of weather, climate, and human impacts on natural resources in Kindergarten through Grade 5. The standards also specifically identify global climate change and human impact on earth's system as a disciplinary core idea in middle school and high school.

With the adoption of the 2022 Oregon Science Standards, there are continual opportunities to elevate climate change education across grade levels and between disciplinary core ideas. This will provide learning progressions for students to make sense of the complex nature of climate change and learn the skills to develop and deploy solutions. A caret or up arrow (^) was added to those K-12 science standards that have proximal connections to climate change and human impact on earth's system. These standards were identified by utilizing a research analysis conducted by MADE CLEAR through a National Science Foundation Grant that could further support climate change education. For more information on climate change education and supporting resources, please visit the STEM Teaching Tools – Climate Learning website.

^ This performance expectation references a proximal connection to climate change and the disciplinary core ideas: Earth's Systems and Earth and Human Activity.

Integration of Engineering Design*

The NGSS represents a commitment to integrate engineering design into the structure of science education by raising engineering design to the same level as scientific inquiry when teaching science disciplines at all levels, from kindergarten to twelfth grade. It affirms the value of teaching engineering ideas, particularly engineering design, to young students.

The inclusion of engineering design within the fabric of the NGSS has profound opportunities for all students to acquire engineering design practices and concepts alongside the practices and concepts of science. The core idea of engineering design includes three component ideas:

- **Defining** and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success and constraints or limits.
- **Designing solutions** to engineering problems begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.
- **Optimizing** the design solution involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

It is important to point out that these component ideas do not always follow in order, any more than do the "steps" of scientific inquiry. At any stage, a problem solver can redefine the problem or generate new solutions to replace an idea that is just not working out. An asterisk (*****) was added to those K-12 science standards that have engineering design embedded within either the science and engineering practices or as a disciplinary core idea. For more information on engineering design and supporting resources, please visit Appendix I – Engineering Design in the NGSS.

***** This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.

Grade 2 Science Standards

Earth & Space Science

2.ESS1 Earth's Place in the Universe

2.ESS1.1 **Use observations from several sources to provide evidence that Earth events can occur quickly or slowly.^** [Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.] [Assessment Boundary: Assessment does not include quantitative measurements of timescales.]

2.ESS2 Earth's Systems

2.ESS2.1 **Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*^** [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.][Assessment Boundary: Assessment does not include explicit naming of hydrosphere, biosphere, atmosphere, and geosphere.]

2.ESS2.2 **Develop a model to represent the shapes and kinds of land and bodies of water in an area.** [Clarification Statement: Examples of model could include a map identifying components of specific bodies of water (e.g. creek, ocean, lake, river) and shapes of land describing their relationship (e.g. playground, park, hill).][Assessment Boundary: Assessment does not include quantitative scaling in models.]

2.ESS2.3 **Obtain information to identify where water is found on Earth and that it can be solid or liquid.** [Clarification Statement: Emphasis is on having students identify reliable sources (e.g texts, digital media, observation) to identify patterns where water is found as a solid or liquid source.][Assessment Boundary: Assessment does not include relative amounts of saltwater and freshwater on Earth.]

Engineering, Technology, and the Application of Science

2.ETS1 Engineering Design

2.ETS1.1 **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.** [Clarification Statement: Identifying a problem or need is necessary before designing a solution. For example, students can describe desired features or tools to solve a simple problem.][Assessment Boundary: Assessment does not include information regarding constraints (restraints or limitations).]

2.ETS1.2 **Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.** [Clarification Statement: Solutions or designs can be addressed in stages before describing the overall plan or design.][Assessment Boundary: Assessment is limited to the development of a single, simple solution illustrated by a sketch, drawing, or physical model.]

2.ETS1.3 **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.** [Clarification Statement: Observations and measurements are collected and information is displayed to compare the performance of two objects. Students test solutions and collect data to identify the strengths and weaknesses of each object. Objects could feature shape, thickness, strength, speed, etc.][Assessment Boundary: Assessment is limited to sharing observations about the strengths and weaknesses of the analyzed data. Students will not be asked to propose an improved design based on the analyzed data.]

Life Science

2.LS2 Ecosystems: Interactions, Energy, and Dynamics

2.LS2.1 **Plan and conduct an investigation to determine if plants need sunlight and water to grow.** [Clarification Statement: Plants depend on air, water, light, and minerals (in the soil) to grow. Examples of an investigation could include plant growth with different amounts of sunlight or water.] [Assessment Boundary: Assessment is limited to testing one variable at a time. Assessment is limited to the effects of sunlight and water on plant growth.]

2.LS2.2 **Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*** [Clarification Statement: Examples of dispersing seeds or pollinating plants could include a simple model that describes plants and animals disperse seeds or pollinate plants (i.e squirrel cheek pouches that transport seeds or pollen that sticks to bees fuzzy body). Simple models could be a simple sketch, drawing, or physical model to communicate the relationship between structure and function.] [Assessment Boundary: Assessment does not include food webs or the health of ecosystems.]

2.LS4 Biological Evolution: Unity and Diversity

2.LS4.1 **Make observations of plants and animals to compare the diversity of life in different habitats.** [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

Physical Science

2.PS1 Matter and Its Interactions

2.PS1.1 **Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.][Assessment Boundary: Assessment is limited to classification by observable properties and does not include Moh's hardness scale or identification of materials based on their properties.]

2.PS1.2 **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.]

2.PS1.3 **Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.** [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.][Assessment Boundary: Assessment is limited to objects large enough to be seen without magnification or advanced technology.]

2.PS1.4 **Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.** [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.][Assessment Boundary: Assessment does not include conservation of mass or the mixing of substances to form new substances.]

*****This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.

^This performance expectation references a proximal connection to climate change and the disciplinary core ideas: Earth's Systems and Earth and Human Activity.