



2022 Oregon Science Standards

K-12 Science Education

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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.

Kindergarten Science Standards

Earth & Space Science

K.ESS2 Earth's Systems

- K.ESS2.1 Use and share observations of local weather conditions to describe patterns over time.**[^]
 [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.]
- K.ESS2.2 Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.**[^] [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.][Assessment Boundary: Assessment is limited to a single example of a plant or animal per item or task.]

K.ESS3 Earth and Human Activity

- K.ESS3.1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.** [Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas; and, grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.][Assessment Boundary: Modeling is limited to describing the relationship and does not include patterns of structure and function to show how needs are met. Impact on the environment is beyond the standard.]
- K.ESS3.2 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.**^{*^} [Clarification Statement: Emphasis is on local forms of severe weather and preparation efforts to respond to weather events that sometimes happen more often in some regions or locations.][Assessment Boundary: Assessment focuses on a particular region at a particular time to describe weather and notice patterns, including severe weather events.]
- K.ESS3.3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.**^{*^} [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.][Assessment Boundary: Assessment focuses on the ability to choose solutions and communicate ways to reduce the impact(s) on land, water, and air, and other living things. Communication can be written, oral, drawings, modeling, or other ways that are comprehensible to others.]

Engineering, Technology, and the Application of Science

K.ETS1 Engineering Design

- K.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).]
- K.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.]
- K.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

K.LS1 From Molecules to Organisms: Structures and Processes

- K.LS1.1** Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.][Assessment Boundary: Assessment is limited to patterns of light, food, or water as sources of matter and energy needed for growth. The process of photosynthesis is beyond the standard at this grade level.]

Physical Science

K.PS2 Motion and Stability: Forces and Interactions

- K.PS2.1** 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. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.][Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]

K.PS2.2 Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

K.PS3 Energy

K.PS3.1 Make observations to determine the effect of sunlight on Earth's surface. ^ [Clarification Statement: Examples of Earth's surface could include sand, soil, rocks, and water] [Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler.]

K.PS3.2 Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*^ [Clarification Statement: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.][Assessment Boundary: Assessment does not include information about how light travels or mechanisms of solar radiation.]

*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.

