2022 Oregon Science Standards

K-12 Science Education

Adopted: June 2022

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Table of Contents

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).

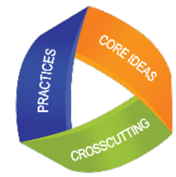
Figure 1

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 3 Science Standards

Earth & Space Science

3.ESS2 Earth's Systems

3.ESS2.1 **Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.^** [Clarification Statement: Examples of data at this grade level could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs.]

3.ESS2.2 **Obtain and combine information to describe climates in different regions of the world.** [Clarification Statement: Examples of different regions could include equatorial, polar, coastal, and midcontinental.][Assessment Boundary: Assessment does not include complex interactions that cause weather patterns and climate or identify the role of the water cycle in weather.]

3.ESS3 Earth and Human Activity

3.ESS3.1 **Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.***^** [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.][Assessment Boundary: Assessment does not include types (hurricane, tornado, tropical storm) of names of storms (Hurricane Andrew), jet streams, or El Nino or La Nina weather patterns.]

Engineering, Technology, and the Application of Science

3.ETS1 Engineering Design

3.ETS1.1 **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.** [Clarification Statement: A design problem must be identified before solutions are developed. Solutions or designs identify the criteria for success and identify limitations and constraints.][Assessment Boundary: Assessment does not include limitations or criteria based on specific process or system boundaries (e.g. limitations of scientific principles or long-term societal and environmental impacts).]

3.ETS1.2 **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.** [Clarification Statement: Emphasis is on researching a problem prior to designing a solution, plan for testing to evaluate how well it will perform under a range of likely conditions using scientific knowledge and communicating the design process.][Assessment Boundary: Assessment is limited to the design process and modeling.]

3.ETS1.3 **Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.** [Clarification Statement: Emphasis is on identifying the purpose of the investigation and specific evidence to collect, testing one criteria or constraint at a time, and record the data accordingly.][Assessment Boundary: Assessment is limited to proposing different solutions based on evidence collected and to determine which is best based on the criteria and the constraints.]

Life Science

3.LS1 From Molecules to Organisms: Structures and Processes

3.LS1.1 **Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.** [Clarification Statement: Changes organisms go through during their life form a pattern.][Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.]

3.LS2 Ecosystems: Interactions, Energy, and Dynamics

3.LS2.1 **Construct an argument that some animals form groups that help members survive.** [Clarification Statement: Emphasis is on how being part of a group helps animals obtain food, defend themselves, and cope with changes, and does not cover how group behavior evolved as a result of a survival advantage.][Assessment Boundary: Assessment does not include evolution of group behavior, altruism, and signaling behaviors.]

3.LS3 Heredity: Inheritance and Variation of Traits

3.LS3.1 **Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.** [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.][Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.]

3.LS3.2 **Use evidence to support the explanation that traits can be influenced by the environment.** [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.][Assessment Boundary: Assessment is limited to physical traits and does not include genetic factors.]

3.LS4 Biological Evolution: Unity and Diversity

3.LS4.1 **Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.** [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.]

3.LS4.2 **Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.** [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.][Assessment Boundary: Assessment does not include patterns of genetic inheritance.]

3.LS4.3 **Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.^** [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.][Assessment Boundary: Assessment does not include multi-generational shifts in population traits due to natural selection.]

3-LS4-4 **Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.^** [Clarification Statement: Examples of environmental changes could include global climate change, changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change.]

Physical Science

3.PS2 *Motion and Stability: Force and Interactions*

3.PS2.1 **Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]

3.PS2.2 **Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.** [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [Assessment Boundary: Assessment does not include technical terms such as period and frequency.]

3.PS2.3 **Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.** [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paper clips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]

3.PS2.4 **Define a simple design problem that can be solved by applying scientific ideas about magnets.*** [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.][Assessment Boundary: Assessment does not include electromagnetism.]

*****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.