STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

Draft 2020 New Jersey Student Learning Standards – Science Introduction

Science

Scientific and technological advances have proliferated and now permeate most aspects of life in the 21st century. It is increasingly important that all members of our society develop an understanding of scientific and engineering concepts and processes. Learning how to construct scientific explanations and how to design evidence-based solutions provides students with tools to think critically about personal and societal issues and needs. Students can then contribute meaningfully to decision-making processes, such as discussions about humans' impact on the natural environment, new approaches to health care, and innovative solutions to local and global problems.

Mission

All students will possess an understanding of scientific concepts and processes required for personal decision-making, participation in civic life, and preparation for careers in STEM fields (for those that chose).

Vision

Prepare students to become scientifically literate individuals who can effectively:

- Apply scientific thinking, skills, and understanding to real-world phenomena and problems;
- Engage in systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned;
- Conduct investigations, solve problems, and engage in discussions;
- Discuss open-ended questions that focus on the strength of the evidence used to generate claims;
- Read and evaluate multiple sources, including science-related magazine and journal articles and web-based resources to gain knowledge about current and past science problems and solutions and develop well-reasoned claims; and
- Communicate ideas through journal articles, reports, posters, and media presentations that explain and argue.

Spirit and Intent

The New Jersey Student Learning Standards for Science (NJSLS-S) describe the expectations for what students should know and be able to do as well as promote three-dimensional science instruction across the three science domains (i.e., physical sciences, life science, earth and space sciences.) From the earliest grades, the expectation is that students will engage in learning experiences that enable them to investigate phenomena, design solutions to problems, make sense of evidence to construct arguments, and critique and discuss those arguments (in appropriate ways relative to their grade level).

The foundation of the NJSLS-S reflects three dimensions — science and engineering practices, disciplinary core ideas, and crosscutting concepts. The performance expectations are derived from the interplay of these three dimensions. It is essential that these three components are integrated in all learning experiences. Within each standard document, the three dimensions are intentionally presented as integrated components to foster sensemaking and designing solutions to problems. Because the NJSLS-S is built on the notions of coherence and contextuality, each of the science and engineering practices and crosscutting concepts appear multiple times across topics and at every grade level. Additionally, the three dimensions should be an integral part of every curriculum unit and should not be taught in isolation.

Three Dimensions of NJSLS-S

The performance expectations reflect the three dimensions and describe what students should know and be able to. In layman's terms, they are "the standards." They are written as statements that can be used to guide assessment and allow for flexibility in the way that students are able to demonstrate proficiency.

The example below is provided to illustrate the interconnected nature of the NJSLS-S components.

Disciplinary Core Ideas and Performance Expectations

Disciplinary Core Idea	Performance Expectation
Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

Science and Engineering Practices

Developing and Using Models	Develop and use a model to describe phenomena.

Crosscutting Concepts

Scale, Proportion, and Quantity	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Becoming familiar with the science practices and crosscutting concepts is a critically important first step in designing learning experiences reflective of the three dimensions. A description of each of the science and engineering practices and the cross-cutting concepts can be found in the next sections.

Further, for students to develop proficiency of the NJSLS-S, they will need to engage in learning experiences that are *meaningful, cumulative,* and *progressive*. Learning experiences designed to *meaningful* go beyond reading about science concepts and provide opportunities for students to be active learners and make sense of ideas. *Cumulative* learning experiences provide opportunities for students to use and build on ideas that they have learned in previous units. *Progressive* learning experiences provide multiple occasions for students to engage in ways that enable them to improve their construction of explanations and solutions over time by iteratively assessing them, elaborating on them, and holding them up to critique and evidence.

Scientific and Engineering Practices

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 works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.

Both scientists and engineers also ask questions to clarify the ideas of others.

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.

Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

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. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

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.

Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems.

Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions

The products of science are explanations and the 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.

The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations 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. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.

Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

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; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

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.

Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and design.

Disciplinary Core Ideas

Disciplinary Core Ideas in Physical Science

PS1: Matter and Its Interactions

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS1.C: Nuclear Processes

PS2: Motion and Stability: Forces and Interactions

- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- PS2.C: Stability and Instability in Physical Systems

PS3: Energy

- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- PS3.D: Energy in Chemical Processes and Everyday Life

PS4: Waves and Their Applications in Technologies for Information Transfer

- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

Disciplinary Core Ideas in Life Science

LS1: From Molecules to Organisms: Structures and Processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms
- LS1.C: Organization for Matter and Energy Flow in Organisms
- LS1.D: Information Processing

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS2.D: Social Interactions and Group Behavior

LS3: Heredity: Inheritance and Variation of Traits

- LS3.A: Inheritance of Traits
- LS3.B: Variation of Traits

LS4: Biological Evolution: Unity and Diversity

- LS4.A: Evidence of Common Ancestry and Diversity
- LS4.B: Natural Selection
- LS4.C: Adaptation
- LS4.D: Biodiversity and Humans

Disciplinary Core Ideas

Disciplinary Core Ideas in Earth and Space Science

ESS1: Earth's Place in the Universe

- ESS1.A: The Universe and Its Stars
- ESS1.B: Earth and the Solar System
- ESS1.C: The History of Planet Earth

ESS2: Earth's Systems

- ESS2.A: Earth Materials and Systems
- ESS2.B: Plate Tectonics and Large-Scale System Interactions
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and Climate
- ESS2.E: Biogeology

ESS3: Earth and Human Activity

- ESS3.A: Natural Resources
- ESS3.B: Natural Hazards
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

Disciplinary Core Ideas in Engineering, Technology, and the Application of Science

ETS1: Engineering Design

- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

ETS2: Links Among Engineering, Technology, Science, and Society

- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Crosscutting Concepts

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 determinants of rates of change or evolution of a system are critical elements of study. Standards in Action

Standards in Action: Climate Change

Earth's climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities. Global climate change has already resulted in a wide range of impacts across New Jersey and many sectors of its economy. The addition of academic standards that focus on climate change is important so that all students will have a basic understanding of the climate system, including the natural and human-caused factors that affect it. The underpinnings of climate change span across physical, life, as well as Earth and space sciences. The goal is for students understand climate science as a way to inform decisions that improve quality of life for themselves, their community, and globally and to know how engineering solutions can allow us to mitigate impacts, adapt practices, and build resilient systems.

The topic of climate change can easily be integrated in science classes without losing the big picture ideas. At each grade level in which systems thinking, managing uncertainty, and building arguments based on multiple lines of data are included, there are opportunities for students to develop essential knowledge and skills that will help them understand the impacts of climate change on humans, animals, and the environment. For example, in

help them understand the impacts of climate change on humans, animals, and the environment. For example, in the earlies grades, students can use data from firsthand investigations of the school yard habitat to justify recommendations for design improvements to the school yard habitat for plants, animals, and humans. In the middle grades, students use resources from NJ Department of Environmental Protection, NOAA, and NASA to inform their actions as they engage in designing, testing, and modifying an engineered solution to mitigate the impact of climate change on their community. In high school, students can construct models they develop of a proposed solution to mitigate the negative health effects of unusually high summer temperatures resulting from heat islands in cities across the globe and share in the appropriate setting.

Structure of the NJSLS-S Documents

The performance expectations are the organizing structure for the NJSLS-S documents found below. In grades kindergarten through five, performance expectations are described by individual grades. In grades 6 through 12, the performance expectations are described as middle school (MS), grades 6-8, and high school (HS), grades 9 through 12.

As illustrated in Figure 1 (below), every document has four sections:

1. Title (e.g., Earth and Human Activity)
2. Performance expectation
3. Foundation box (science and engineering practice(s), disciplinary core idea(s), and crosscutting concept (s) that relate specifically to the performance expectation)
4. Connection box (connections to other disciplinary concepts at grade level, at grade levels above and below, and specific English language arts and mathematics standards that are relevant)

More information regarding the foundation and connection boxes can be found in the next section.

1. Title (e.g., Earth and Human Activity)

2. Performance Expectation(s) and code (e.g., 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: none available for this performance expectation.]

3. Science and Engineering Practices	3. Disciplinary Core Ideas	3. Crosscutting Concepts

4. Connections to:

- related disciplinary concepts at the same grade level
- related disciplinary concepts for grades above and below that grade level
- to related New Jersey Student Learning Standards for Mathematics and English Language Arts

Figure 1: Structure of a NJSLS-S document

Note about the Clarification Statement and Assessment Boundary (in red): frequently, a Clarification Statement and an Assessment Boundary are listed after the performance expectation. The Clarification Statement provides real-world examples that reflect the performance expectations. The Assessment Boundary is intended to inform statewide assessment item writers and educators about what is "out of bounds" on statewide science assessments at the end of grades 5, 8, and 11.

Coding of Performance Expectation

Every performance expectation is labeled with a specific alpha numeric code. The code summarizes important information. See Figure 2 below. The first number within the code reflects the grade or grade band. The letters are an abbreviation of the component idea from which the performance expectations are derived. PS1 is shorthand for Matter and its Interactions (see Disciplinary Core Ideas table on page 4). Finally, the number at the end of each code indicates the order in which the performance expectation appears in the NJSLS-S.

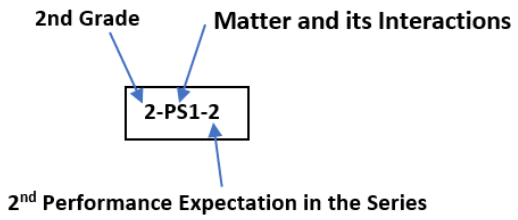

Figure 2: Coding of performance expectations

Foundation Boxes

The foundation boxes provide information about the specific science and engineering practice(s), disciplinary core idea(s), and crosscutting concept(s) that were used to write the performance expectation.

Science and Engineering Practices (SEP)

The blue box on the left (see Figure 1) includes the science and engineering practices used to construct the performance expectation(s.) These statements 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.

Disciplinary Core Ideas (DCI)

The orange box in the middle includes statements about the most essential ideas in the major science disciplines that all students should understand during 13 years of school. Including these detailed statements are very helpful in "unpacking" the disciplinary core ideas and sub-ideas.

Crosscutting Concepts (CCC)

The green box includes statements which apply to one or more of the performance expectations. 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.

Aspects of the Nature of Science relevant to the performance expectation(s) are also listed in this box, as are the Interdependence of Science and Engineering, and the influence of Engineering, Technology, and Science on

society and the natural world. Although these are not crosscutting concepts in the same sense as the others, they are best taught and assessed in the context of specific science ideas and are therefore also listed in this box.

Connection Boxes

Three connection boxes, below the foundation boxes, are designed to support a coherent curriculum by showing how the performance expectations in each standard connect to other performance expectations in science, as well as to New Jersey Student Learning Standards in English language arts and mathematics. The three boxes include:

Connections to other disciplinary core ideas in this grade level

This box contains the names of disciplinary core ideas that have related disciplinary core ideas at the same grade level. For example, both Physical Science and Life Science performance expectations contain core ideas related to photosynthesis and could be taught in relation to one another.

Articulation of disciplinary core ideas across grade levels

This box contains the names of disciplinary core ideas that either:

1) provide a foundation for student understanding of the core ideas in this performance expectation (usually at prior grade levels); or
2) build on the foundation provided by the core ideas in this performance expectations (usually at subsequent grade levels).

New Jersey Student Learning Standards Connections

This box contains the coding and names of pre- requisite or connected NJSLS in mathematics and English language arts that align to the performance expectations. For example, performance expectations that require student use of exponential notation will align to the corresponding NJSLS mathematics standards. An effort has been made to ensure that the mathematical skills that students need for science were taught in a previous year where possible. Italicized performance expectation names indicate that the NJSLS standard is not pre-requisite knowledge but could be connected to that performance expectation.

New Jersey Statutes and Administrative Code Summary

Dissection Law

N.J.S.A. 18A:35-4.25 and N.J.S.A. 18A:35-4.24 authorizes parents or guardians to assert the right of their children to refuse to dissect, vivisect, incubate, capture or otherwise harm or destroy animals or any parts thereof as part of a course of instruction.

Amistad Law

N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Holocaust Law

N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further

emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law

N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards.

N.J.S.A.18A:35-4.36 A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35. When adopting instructional materials for use in the schools of the district, a board of education shall adopt inclusive instructional materials that portray the cultural and economic diversity of society including the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, where appropriate.

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