Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)

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Acknowledgments

The Pennsylvania Department of Education (PDE) wishes to first thank the State Board of Education for providing the opportunity to review, revise and provide recommendations on the Science and Technology and Environment and Ecology K-12 standards.

Thanks to the nearly 1,000 individuals across Pennsylvania who attended a stakeholder feedback session, answered a survey or participated in a focus group. You provided valuable content and direction to inform the review, revisions and recommendations for an innovative set of standards to guide science, technology, environment and ecology education in Pennsylvania.

Thanks to the Berks County Intermediate Unit team, led by Dan Richards, for supporting the logistics in gathering stakeholder input during the development of the Landscape Report and in organizing the focus groups.

Thanks to the 74 members of the Content and Steering Committees for lending your valuable expertise and time. Your research, critical feedback and tireless efforts to improve science, technology, environment and ecology education by reviewing, revising and generating recommendations with a focus on equity for every student and teacher in Pennsylvania set a high standard.

Special thanks to the writing committee for volunteering countless hours in a difficult season, through a pandemic and transition to an uncertain school year, to craft a thoughtful set of recommendations to the State Board of Education. Your work will guide and inspire the next generation of educators and learners.

There are several committee members who took on leadership roles of the writing teams. Thanks are due to them for ensuring, in the final months of the committees' work, that the stakeholder input, research, committee discussions and everything that went into the process came to fruition in the form of proposed standards to present to the State Board of Education. Thanks to Carrie Lankford (fourth-grade teacher in Red Lion Area School District) and Brienne May (elementary school special education teacher in Franklin Regional School District) for going above and beyond.

Finally, thanks to the American Institutes for Research (AIR) team. The AIR team has embraced PDE's vision for a stakeholder-driven, research-based process to guide the review, revision and development of recommendations for Pennsylvania's *Academic Standards for Science and Technology* (2002) *and Academic Standards for Environment and Ecology* (2002). This could not have been such a stakeholder-driven and innovative process without AIR's partnership—from authoring the Landscape Report; to facilitating stakeholder sessions, committee meetings and focus groups; to incorporating and adapting to feedback throughout the process.

Thank you to the whole AIR team, in particular:

Dr. Bobbi Newman, Senior Researcher (Project Director)
Beth Ratway, Senior Technical Assistance Consultant (Project Facilitator)
Dr. Teresa Smith Neidorf, Principal Research Scientist (Project Advisor)
Dr. Danielle Ferguson, Researcher and Senior STEM Content Expert
Will (Tad) Johnston, Senior Technical Assistance Consultant specializing in mathematics and science education
Debbie Menard, Research Associate Intern and High School Biology Teacher

Introduction

The *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* guide the elementary-level study of the natural and human-made world through inquiry, problem-solving, critical thinking and authentic exploration. The integration of these disciplines in the elementary standards highlights the interconnectedness of scientific study, the integral relationship between humans and the environment and the importance of integrating the teaching and learning of science, engineering and technology. Presenting the standards for science, environment, ecology, technology and engineering together in a single document makes them more accessible for elementary teachers when developing innovative STEM curricula that integrate related content.

The new Pennsylvania standards are built upon the *National Research Council's (NRC's) A Framework for K-12 Science Education* (*The Framework*). Like *The Framework*, the *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* are based on current research in student learning and take a three-dimensional approach that integrates disciplinary core ideas, practices in science and engineering and crosscutting concepts into a coherent set of expectations for student learning that builds progressively across grades. Together, these elementary school standards and the companion standards for middle and high school—the *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6-12)*—provide the basis for K-12 science education in Pennsylvania.[1]

Pennsylvania's Vision

Businesses and industries are growing in Pennsylvania, and they want skilled and well-educated workers who are prepared for the 21st century economy. Students need to be equipped with the knowledge and skills to enter the workforce and to be successful in a science- and technology-driven global economy.

To best prepare students for the 21st century economy, Pennsylvania aims to establish an equitable and innovative culture so every student can be included in science, engineering, technology, environment and ecology education. The *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* were established on the following foundational beliefs:

- Every student is capable of science, engineering, technological and environmental literacy.
- Science, environment, ecology, technology and engineering can be explored through an integrated and active learning process.
- Iteration and reflection are a critical component of the learning process.

[1] In addition to the standards for science, environment and ecology, separate technology and engineering standards were developed for middle and high school—the *Pennsylvania Technology and Engineering Standards (Grades 6-12)*.

- Success depends upon the partnerships between educators, students, families, postsecondary institutions and providers, legislators, businesses and industries.

These draft standards were developed with this vision in mind with contributions and voices of the stakeholders across the commonwealth.

Development of the Standards

The Pennsylvania State Board of Education directed PDE to begin the process of updating Pennsylvania's *Academic Standards for Science and Technology* (2002) and *Academic Standards for Environment and Ecology* (2002) to align them with current research and best practices. From February through March 2020, 14 stakeholder engagement sessions were held across the state and virtually. Of the more than 960 members of the public who provided input at these sessions, most were elementary and secondary educators, school administrators, postsecondary educators, student teachers, business and industry representatives, community not-for-profit organization representatives, parents and students. Their feedback was captured in a report that summarized the current research and best practices regarding science, environment, ecology, technology and engineering standards (see Ferguson et al., 2020).

In April 2020, PDE solicited applications from interested members of the public to serve on committees to review and revise the standards. Applicants were selected through a multi-reviewer process on the basis of their depth and breadth of expertise in curriculum and standards development, understanding of the existing standards and current research, equity and access in education and meeting the needs of diverse learners and overall education experience. Each selected committee member was approved by the State Board of Education in May 2020.

In June and July, the committees met to review the stakeholder input as well as research-based frameworks and guidelines—such as the National Research Council's (NRC) *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012), North American Association for Environmental Education's (NAAEE) *K–12 Environmental Education: Guidelines for Excellence* (2019), Ecological Society of America's (ESA) *Four-Dimensional Ecology Education (4DEE) Framework* (2018), International Technology and Engineering Educators Association's (ITEEA) *Standards for Technological and Engineering Literacy* (STEL) (2020), International Society for Technology in Education's (ISTE) *ISTE Standards for Students* (2019), National Council for Agricultural Education's (NCAE) *Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards* (2015) and other national and international frameworks. Committee members also conducted close reads to share relevant information from Pennsylvania-specific documents, such as Pennsylvania's *Academic Standards for Science and Technology* (2002) and *Academic Standards for Environment and Ecology* (2002), to inform the development of the revised standards. Committee members collaborated to identify key content within those research-informed frameworks and other key national and international standards in science, environment, ecology, technology, engineering

and agriculture.[2] They sought to identify cross-content connections while adding sustainability, PA Career Ready Skills and other PA-specific contexts.

Over nine full-day convenings, the committee members discussed the essential elements of academic standards. Attention to equity and access surfaced as foundational in the development of the standards. Equity in the context of the standards can be defined as a foundation of knowledge and skills critical for and accessible to all students, as well as "a characteristic of the instructional environment that increases the capacity for everyone to participate in meaningful learning" (Windschitl, Thompson, & Braaten, 2018, p. 12). This begins with standards that are crafted to allow for the individual and personalized experiences, knowledge and skills students bring with them to the classroom.

Following recommendations from current research to ensure equitable opportunities exist for all students and research indicating how students learn best, committee members drafted these revised standards based on the committees' commitment to equity and inclusivity, to open doors to STEM fields for all students. Therefore, the practices embedded in the standards provide an equitable on-ramp for all students as they transition their developing and experience-based notions of the scientific world to conceptions that are scientifically based.

The *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* were also developed in parallel with the *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6-12)*. In this document, as well as in the *Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6-12)*, the organization and presentation of the standards are similar, thus creating a cohesive K-12 integrated approach to science, environment, ecology, technology and engineering education in Pennsylvania.

What Is an Integrated Science, Environment, Ecology, Technology and Engineering Education?

The interconnectedness of the world and its impact on science, environment, ecology, technology and engineering has never been more prominent. Engineering and science are fields critical to innovation, and a commitment through the standards to expose all students to scientific and engineering practices can spark interest in the study of STEM or future STEM careers (National Science Foundation [NSF], 2010). Presenting the standards for science, environment, ecology, technology and engineering together in a single document provides content support in these areas to elementary teachers and makes the standards more accessible when developing innovative STEM curricula that integrate related content.

Understanding the components of ecological systems and their interrelationships with social systems and technologies is vital to the development of STEM-literate citizens. These components incorporate the disciplines of resource management, agricultural diversity, government and the impact of human actions on natural systems. This interaction leads to the

[2] Content and steering committee members reviewed over 30 research-based frameworks, guidelines and Pennsylvania-specific documents, such as the Pennsylvania Environmental Literacy Plan and the 22 Pa. Code Chapter 4 Academic Standards and Assessment.

study of watersheds, threatened and endangered species and pest management and to the development of laws and regulations. Integrating science, environment, ecology, technology and engineering in the science standards encourages integrated teaching across these disciplines. Incorporating environment and ecology standards in a systematic way promotes equity by ensuring that the environment, ecology, technology and engineering are well covered in science courses across grades K-5.

Scientific, Environmental and Technological Literacy in Pennsylvania

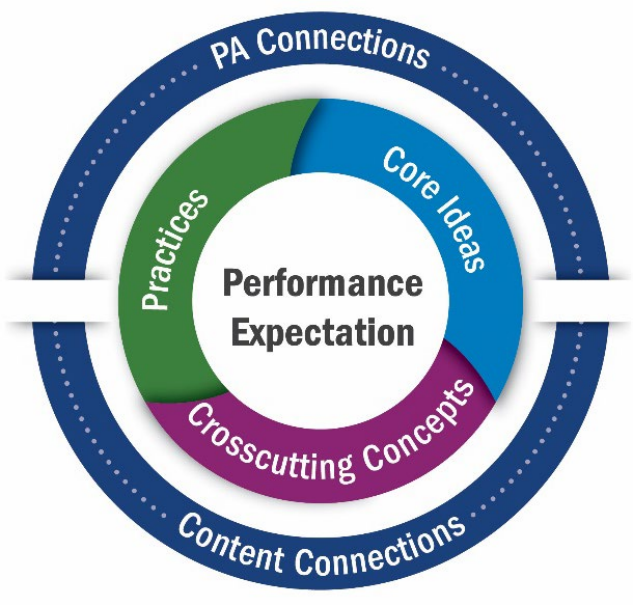

Figure 1. Structure of the Pennsylvania Standards for Integrated Science, Environment, Ecology, Technology and Engineering

Pennsylvania's workforce is continually influenced by the needs of an economy driven by science and technology. To best prepare each of Pennsylvania's 1.7 million students for the future workforce, educators need innovative standards that develop a scientific, environmentally and technologically literate citizenry. "Literacy" requires more than possessing knowledge: literacy requires being able to apply knowledge. A scientifically and environmentally literate person can apply the knowledge, concepts, skills, processes and practices of those fields to real-life situations. This includes engaging in scientific inquiry and applying science concepts and processes to make decisions for oneself, participate in civic and cultural affairs and contribute to society and the economy through one's work (Ashbrook, 2020). Environmental literacy also requires knowledge and understanding of environmental concepts, problems and issues in order to make informed decisions concerning the local and global environment that will improve the well-being of individuals and societies through participation in civic life (NAAEE, 2019). Technological and engineering literacy is "the ability to understand, use, create, and assess the human-designed environment in increasingly sophisticated ways over time" (ITEEA,

2020, p. 161). Technologically literate individuals, in addition to being able to use and understand technology, can apply science knowledge and skills to develop solutions to real-world problems and appreciate the distinctions and relationships between engineering, technology and applications of science.

Structure of the Standards

The *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* are written as grade-specific performance expectations, integrating science, environment, ecology, technology and engineering under unifying Disciplinary Core Ideas. The standards build upon the *National Research Council's (NRC's) A Framework for K-12 Science Education* (*The Framework*) and the *Next Generation Science Standards (NGSS)*. The main dimensions of *The Framework* and the *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* are similar; however, there are aspects that are specific to the *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* (Figure 1). In particular, the *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* include a set of standards for environment and ecology and for technology and engineering to ensure that these disciplines are taught in elementary school. Importantly, the *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* are structured in a way that emphasizes how the core ideas in these two disciplines are connected to those in physical, life, and Earth and spaces sciences to promote an integrated approach to teaching in these areas. The intent is not necessarily to increase the number of topics taught, but to support elementary teachers in helping their students to understand these important connections as they progress across grades K-5.

Like *The Framework*, the *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* are built around three dimensions that are integrated into a set of specific standards at each grade level—Disciplinary Core Ideas (DCIs), Science and Engineering Practices and Crosscutting Concepts—described below.

DCIs reflect essential ideas in science that all students should understand by the end of grade 5. DCIs are included for the major disciplines or domains in the natural sciences, physical sciences, life sciences and Earth and space sciences as well as for environment and ecology and technology and engineering. Standards for the physical, life and Earth and space sciences domains are provided for each grade (K-5). The grade-specific standards in physical, life and Earth and space sciences reflect core ideas in these domains as well as provide practical connections for integrating environment and ecology and technology and engineering, where appropriate. Standards for environment and ecology and for technology and engineering are provided for two grade bands (K-2 and 3-5). Within each of these domains, there is a set of Disciplinary Core Ideas (Core Ideas) that is covered at one or more grade level (Table 1). While all core ideas are reflected across the K-5 standards, not every core idea will be included at every grade level. The standards reflect the knowledge and abilities that students are expected to be able to demonstrate by the end of a particular grade or grade band.

Table 1. Domains and Core Ideas

Domains	Core Ideas
Physical Sciences	• Energy • Matter and Its Interactions • Motion and Stability: Forces and Interactions • Waves and Their Applications in Technologies for Information Transfer
Life Sciences	• From Molecules to Organisms: Structures and Processes • Ecosystems: Interactions, Energy, and Dynamics • Heredity: Inheritance and Variation of Traits • Biological Evolution: Unity and Diversity
Earth and Space Sciences	• Earth's Place in the Universe • Earth's Systems • Earth and Human Activity
Environment and Ecology	• Decision-Making and Action Skills • Personal and Civic Responsibility • Earth's Physical and Living Systems • Human Systems • Environment and Society • Skills for Analyzing and Investigating Environmental Issues

Domains	Core Ideas
Technology and Engineering	• Applying, Maintaining, and Assessing Technological Products and Systems • Core Concepts of Technology and Engineering • Design in Technology and Engineering Education • History of Technology • Impacts of Technology • Influence of Society on Technological Development • Integration of Knowledge, Technologies, and Practices • Nature and Characteristics of Technology and Engineering

Science and Engineering Practices

The Science and Engineering Practices are behaviors that are critical in investigating, modeling and explaining the world, as well as in developing solutions to societal problems. The eight science and engineering practices are:

1. Asking questions and defining problems;
2. Developing and using models;
3. Planning and carrying out investigations;
4. Analyzing and interpreting data;
5. Using mathematics and computational thinking;
6. Constructing explanations and designing solutions;
7. Engaging in argument from evidence; and
8. Obtaining, evaluating and communicating information.

Crosscutting Concepts

The Crosscutting Concepts bridge disciplinary boundaries and unite core ideas in science. The *PA Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* incorporate the seven Crosscutting Concepts of *The Framework*; sustainability is added as an eighth Crosscutting Concept in the PA Integrated *Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)*. Sustainability refers to meeting the needs of the present without compromising the ability of future generations to meet

their needs (Stone & Barlow, 2005, p. xiii). The eight Crosscutting Concepts that appear in the standards are:

1. Patterns;
2. Cause and effect;
3. Scale, proportion and quantity;
4. Systems and system models;
5. Energy and matter;
6. Structure and function;
7. Stability and change; and
8. Sustainability.

Each component of a standard is explained in more detail below. For terms related to the standards, see Appendix A.

Anatomy of a PA Standard

As illustrated below, the standards for each Core Idea are organized in three main sections: (1) performance expectation(s), (2) the foundation boxes and (3) connections. Appendix B provides an example of a completed standard.

Standard Structure

Grade Level or Grade Band: Domain from Earth and space sciences; environment and ecology; life sciences; physical sciences; or technology and engineering

<table>
<tr><td colspan="3">Core Idea:</td></tr>
<tr><td colspan="3">Performance Expectation (PE): Students who demonstrate understanding can:</td></tr>
<tr><td colspan="3">Dimensions</td></tr>
<tr><td>Science and Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td colspan="3">PA Connections: Integration of PA Context and Habits of Mind/PA Career Ready Skills</td></tr>
<tr><td colspan="3">Connections to Other Standards</td></tr>
<tr><td>ELA: PA Core Standards: ELA</td><td>Math: PA Core Standards: Math</td><td>Educational Technology (ISTE Standards for Students)</td></tr>
</table>

Performance Expectations: Below the Core Idea is a box containing a set of performance expectations. Each Core Idea includes one or more performance expectations written as tasks that students at the specified grade level should be able to complete to demonstrate mastery of the content.

The broader performance expectations for environment and ecology and technology and engineering are included as grade bands for grades K-2 and 3-5. These expectations were informed by Pennsylvania's *Academic Standards for Environment and Ecology* (2002), *K–12 Environmental Education: Guidelines for Excellence* (NAAEE 2019)*, Academic Standards for Science and Technology* (2002) and ITEEA *Standards for Technological and Engineering Literacy (STEL),* respectively.

Foundation Boxes: Below the Performance Expectations box are three foundation boxes, which list (from left to right) the specific Science and Engineering Practices, Disciplinary Core Ideas and Crosscutting Concepts.

PA Connections: Below the Foundation boxes are links to possible PA connections that allow for integrated science instruction that leverages local and regional context, as well as connections to the prior *Academic Standards for Science and Technology* (2002), *Academic Standards for Environment and Ecology* (2002), habits of mind and PA Career Ready Skills, as appropriate.

Connections to Other Standards: In addition to the PA connections above, connection boxes are provided for the *PA Core Standards for ELA* and *PA Core Standards for Math, ISTE Standards for Students, North American Association for Environmental Education (NAAEE) K–12 Environmental Education: Guidelines for Excellence* (2019) and the NCAE's *AFNR Content Standards.* These sections are described in further detail below.

How to Use the Standards

Performance Expectations

Performance expectations (PEs) are statements of what students should know and be able to do. Each PE is written to include a practice, idea and crosscutting concept. Each standard includes both the PE(s) and the contents of the three foundation boxes. In Pennsylvania, all students should be held accountable for demonstrating their achievement of all PEs, which are written to allow for multiple means of assessment. Following PEs are clarification statements that provide suggested examples or clarification to the PEs. PEs may also contain assessment boundary statements, which sets limits or parameters to large-scale assessment. However, the PEs are not meant to limit the curriculum, nor are they a set of instructional or assessment tasks.

Foundation Boxes

PEs are the result of the integration of the three dimensions that appear in the foundation boxes. As curriculum and instruction are developed, these dimensions must be taught together. The three dimensions of Science and Engineering Practices, Disciplinary Core Ideas and Crosscutting Concepts should be assessed together. While new in the proposed *Pennsylvania Standards for Integrated Science, Environment, Ecology, Technology and Engineering (Grades K-5)*, the inclusion of an assessment with practices can already be seen across the *PA Core Standards for English Language Arts* and the *PA Core Standards for Mathematics*. For example, in all three content areas, students are expected to make connections and justify their ideas with evidence, comparisons, and investigations; communicate their findings through a variety of mediums; and build a conceptual understanding of the world and their place in it.

Connection Boxes

The connection boxes are included to support curriculum and instruction and, where possible, connect to Pennsylvania's other academic standards and PA Career Ready Skills.

PA Connections: PA connections are provided to leverage opportunities in curriculum and instructional design for students to engage in local and regional phenomena in Pennsylvania. Some connections to *Academic Standards for Environment and Ecology* (2002)[3] appear as associated contexts in the PA Connections boxes. Other PA Connection statements not derived from the 2002 standards are also included where there are opportunities to relate standards to regional and local phenomena. Each standard also includes PA Connections to Career Ready Skills, were appropriate. Educators can use this resource in conjunction with the PA Career Ready Skills Continuum to identify ways to integrate teaching science, environment and ecology, and technology and engineering with related employability skills at any grade level. For the development of the PA connections related to PA Career Ready Skills, see Appendix C.

Connections to Other Standards: Connection boxes are also included to create a more coherent version of the standards by illustrating how each PE connects to state or national documents, including the PA core standards and *ISTE Standards for Students*, The cross-walked standards can be explicitly taught in the context of attaining the related PE. The cross-walked standards are not a complete list of all potential crosswalks. Depending on how standards are used in local curriculum development, additional crosswalks may be identified.

[3] Connections to Pennsylvania's *Academic Standards for Environment and Ecology* (2002) are only included if they are not explicitly covered by the new standards developed based on *The Framework*.

Resources for Integration

The *Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5)* are designed to be used in developing integrated classroom learning experiences and formative and summative assessments. Pennsylvania is fortunate to be rich with environmental learning and nature centers, STEM ecosystems and public libraries and community-based organizations that provide out-of-school time for STEM and environmental education. Environment and ecology and STEM providers across the state are valuable resources to provide age-appropriate lessons, opportunities, expertise and outdoor real-life experiences for Pennsylvania students, so that classroom educators can more easily integrate the standards.

Standards by Grade Level[4] [5]

Kindergarten

Earth and Space Sciences

Earth and Human Activity

1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.
3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Earth's Systems

1. Use observations of local weather conditions to describe patterns over time.
2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

Life Science

From Molecules to Organisms: Structures and Processes

1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

Physical Science

Motion and Stability: Forces and Interactions

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.

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[4] Across grades K-5, all of the core ideas in Table 1 are covered, but not every discipline or core idea is reflected at every grade.

[5] The language of the standards is adapted from, informed by or taken from the: National Research Council (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*; International Society for Technology in Education Standards. (2019) *ISTE standards for students;* International Technology and Engineering Educators Association (ITEEA) (2020) *Standards for Technological and Engineering Literacy* (STEL); NGSS Lead States (2013) *Next generation science standards: For states, by states;* National Council for Agricultural Education (2015) *Agriculture, food and natural resources (AFNR) career cluster content standards;* Pennsylvania State Board of Education (2002) *Academic standards for science and technology;* Pennsylvania Department of Education (2002) *Safety guidelines for elementary and technology education teachers;* Pennsylvania Department of Education (n.d.) *Pennsylvania career ready skills continuum; Pennsylvania Association for Environmental Educators. (September 2015) Pennsylvania environmental literacy plan; Pennsylvania State Board of Education (2002). Academic standards for environment and ecology. North American Association for Environmental Education (2014) State environmental literacy plans: 2014 status report.* North American Association for Environmental Education (2019) *K–12 environmental education: Guidelines for excellence* and other research informed frameworks, guidelines and documents.

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.

Energy

1. Make observations to determine the effect of sunlight on Earth's surface.
2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

Grade 1

Earth and Space Sciences

Earth's Place in the Universe

1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.
2. Make observations at different times of year to relate the amount of daylight to the time of year.

Life Science

From Molecules to Organisms: Structures and Processes

1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

Heredity: Inheritance and Variation of Traits

1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Physical Science

Waves and Their Applications in Technologies for Information Transfer

1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.
3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.
4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Grade 2

Earth and Space Sciences

Earth's Place in the Universe

1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

Earth's Systems

1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.
3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

Life Science

Ecosystems: Interactions, Energy, and Dynamics

1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.
2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Biological Evolution: Unity and Diversity

1. Make observations of plants and animals to compare the diversity of life in different habitats.

Matter and its Interactions

1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
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.
4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Grade 3

Earth and Space Sciences

Earth's Systems

1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
2. Obtain and combine information to describe climates in different regions of the world.

Earth and Human Activity

1. Make a claim supported by evidence about the merit of a design solution that reduces the impacts of a weather-related hazard.

Life Science

From Molecules to Organisms: Structures and Processes

1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

Ecosystems: Interactions, Energy, and Dynamics

1. Construct an argument that some animals have physical and behavioral adaptations that help members survive.

Heredity: Inheritance and Variation of Traits

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.
2. Use evidence to support the explanation that traits can be influenced by the environment.

Biological Evolution: Unity and Diversity

1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
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.
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.
4. Make a claim supported by evidence 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.

Physical Science

Motion and Stability: Forces and Interactions

1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
2. Make and communicate observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
4. Define a simple design problem that can be solved by applying scientific ideas about magnets.

Grade 4

Earth and Space Sciences

Earth's Place in the Universe

1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Earth's Systems

1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
2. Analyze and interpret data from maps to describe patterns of Earth's features.

Earth and Human Activity

1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Life Science

From Molecules to Organisms: Structures and Processes

1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

Physical Science

Waves and Their Applications in Technologies for Information Transfer

1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
3. Generate and compare multiple solutions that use patterns to transfer information.

Energy

1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
2. Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grade 5

Earth and Space Sciences

Earth's Place in the Universe

1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

Earth's Systems

1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Earth and Human Activity

1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

2. Generate and design possible solutions to a current environmental issue, threat, or concern.

Life Science

From Molecules to Organisms: Structures and Processes

1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Ecosystems: Interactions, Energy, and Dynamics

1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Physical Science

Matter and Its Interactions

1. Develop a model to describe that matter is made of particles too small to be seen.
2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.
3. Make and communicate observations and measurements to identify materials based on their properties.
4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
5. Interpret and analyze data and observations to make decisions about how to utilize materials based on their properties.

Motion and Stability: Forces and Interactions

1. Support an argument that the gravitational force exerted by Earth on objects is directed down.

Energy

1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

Standards by Grade Band

Grades K-2: Environment and Ecology

Decision-Making and Action Skills

1. Examine and express their own views on environmental issues.

2. Determine whether action is needed on selected environmental issues and whether they should be involved. They describe their reasoning.
3. Develop an action strategy or design solution for a specific local environmental issue of their choosing.
4. Identify environmental and social consequences of design solutions and civic actions, including their own actions.

Personal and Civic Responsibility

1. Describe their basic rights and responsibilities as members of a community and the importance of these rights and responsibilities in promoting environmental quality and community well-being.
2. Describe how they can realistically and meaningfully contribute to their community and environmental quality.
3. Identify ways in which they are responsible for the environmental and social effects of their actions.

Earth's Physical and Living Systems

1. Describe characteristics of Earth's physical systems, including air, water, and land. They explain how these systems interact with one another and identify changes in the physical environment over time. They provide examples of how physical systems affect living organisms, including humans.
2. Identify basic similarities and differences among a wide variety of living organisms. They explain ways that living organisms, including humans, affect the environment in which they live, and how their environment affects them.

Human Systems

1. Generate examples of how people act, as individuals, as members of a group, and as members of society, toward the environment. They articulate their own beliefs and the beliefs of family and community members about the environment and environmental issues.

2. Identify ways that people express different cultural backgrounds and how these can influence environmental perceptions and activities.

Environment and Society

1. Identify ways that people depend on, change, and are affected by the environment.
2. Describe ways people harvest, re-distribute, and use natural resources.
3. Identify ways that places differ in their physical and human characteristics.
4. Recognize that change is a normal part of individual and societal life.

Skills for Analyzing and Investigating Environmental Issues

1. Identify and investigate issues in their local environment and community.
2. Use their knowledge of how ecological and human systems are interconnected to describe the environmental and social consequences of local environmental issues.
3. Develop plans, including possible design solutions, for addressing selected local environmental issues.
4. Demonstrate openness and receptivity while listening to and working with others who have perspectives about the environment that are different from their own.

Grades K-2: Technology and Engineering

Applying, Maintaining, and Assessing Technological Products and Systems

1. Analyze how things work.
2. Identify and use everyday symbols.
3. Describe qualities of everyday products.

Core Concepts of Technology and Engineering

1. Illustrate how systems have parts or components that work together to accomplish a goal.
2. Safely use tools to complete tasks.
3. Explain that materials are selected for use because they possess desirable properties and characteristics.
4. Develop a plan in order to complete a task.
5. Collaborate effectively as a member of a team.

Design in Technology and Engineering Education

1. Apply design concepts, principles, and processes through play and exploration.
2. Demonstrate that designs have requirements.
3. Explain that design is a response to wants and needs.
4. Discuss that all designs have different characteristics that can be described.
5. Illustrate that there are different solutions to a design and that none are perfect.
6. Demonstrate essential skills of the engineering design process.
7. Apply skills necessary for making in design**.**

History of Technology

1. Discuss how the way people live and work has changed throughout history because of technology.

Impacts of Technology

1. Explain ways that technology helps with everyday tasks.
2. Illustrate helpful and harmful effects of technology.
3. Compare simple technologies to evaluate their impacts.
4. Select ways to reduce, reuse, and recycle resources in daily life.
5. Design new technologies that could improve their daily lives.

Influence of Society on Technological Development

1. Explain the needs and wants of individuals and societies.
2. Explore how technologies are developed to meet individual and societal needs and wants.
3. Investigate the use of technologies in the home and community.

Integration of Knowledge, Technologies, and Practices

1. Apply concepts and skills from technology and engineering activities that reinforce concepts and skills across multiple content areas.
2. Draw connections between technology and human experiences.

Nature and Characteristics of Technology and Engineering

1. Compare the natural world and human-made world.
2. Explain the tools and techniques that people use to help them do things.
3. Demonstrate that creating can be done by anyone.
4. Discuss the roles of scientists, engineers, technologists and others who work with technology.

Grades 3-5: Environment and Ecology

Decision-Making and Action Skills

1. Identify, justify, and clarify their views on environmental issues and alternative ways to address them.
2. Evaluate whether action is needed in specific situations, using environmental, cultural/social, and economic criteria. They decide whether they should be involved in that action.

3. Use their research results to develop action strategies and design solutions at levels consistent with their maturity and preparation. As appropriate, they implement their plans.
4. Analyze the effects of design solutions, their own civic actions, and actions taken by other individuals and groups. They describe the short- and long-term effects of these actions and design solutions in terms of environmental, social, and economic consequences.

Personal and Civic Responsibility

1. Explain the rights and responsibilities of community membership and their role in addressing environmental quality and sustainability.
2. Possess a realistic self-confidence in their effectiveness as community members to make changes in their community that address environmental quality and sustainability.
3. Describe the broad environmental, social, and economic consequences of their personal and group actions and as appropriate, accept responsibility for their actions.

Earth's Physical and Living Systems

1. Describe the physical processes that shape Earth, including weather, climate, plate tectonics, and the hydrologic cycle. They explain how matter cycles and energy flows among the abiotic and biotic components of the environment. They describe how humans affect and are affected by Earth’s physical systems.
2. Describe how living things, including humans, are dependent on their environment and are adapted to live in particular ecosystems under particular environmental conditions. They describe major interactions among organisms and populations of organisms and explain the importance of biodiversity to ecosystem health. They describe how humans affect and are affected by the biosphere.

Human Systems

1. Explain ways that individual traits and group membership or affiliation influence perceptions of and actions toward the environment. They describe how their environmental beliefs and values are shaped by their community and the larger society. They compare their beliefs and values to those held by others in their community.

2. Describe examples of the interconnection between cultural perspectives and the environment.

3. Describe how political systems at varying scales account for, manage, and affect natural resources and environmental quality.

4. Describe how economic systems and economic decision-making influence natural resource use and management as well as environmental and human well-being.

Environment and Society

1. Describe human-caused changes that affect the immediate environment as well as other places, other people, and future times.

2. Explain that uneven geographic distribution of natural resources influences their use and perceived value.

3. Describe the meaning of “place” both close to home and around the world.

4. Explain that human social systems are dynamic and that conflicts sometimes arise over differing and changing viewpoints about the environment and natural resource use and management.

Skills for Analyzing and Investigating Environmental Issues

1. Use primary and secondary sources of information and apply research and analytical skills to investigate environmental issues, beginning in their own community and region.
2. Apply their knowledge of ecological and human processes and systems to describe the short- and long- term consequences of selected environmental issues on sustainability.
3. Identify and develop action strategies, including design solutions, appropriate for addressing a range of environmental issues at community and regional levels. They describe how their action strategies and design solutions might impact environmental quality and other people now and in the future.
4. Demonstrate active listening, tolerance, adaptability, and openness as they work with others to gather a range of perspectives and information.

Grades 3-5: Technology and Engineering

Applying, Maintaining, and Assessing Technological Products and Systems

1. Follow directions to complete a technological task.
2. Use appropriate symbols, numbers and words to communicate key ideas about technological products and systems.
3. Identify why a product or system is not working properly.
4. Examine information to assess the trade-offs of using a product or system.

Core Concepts of Technology and Engineering

1. Describe how a subsystem is a system that operates as a part of another larger system.
2. Illustrate how, when parts of a system are missing, it may not work as planned.

3. Identify the resources needed to get a technical job done, such as people, materials, capital, tools, machines, knowledge, energy, and time.
4. Describe the properties of different materials.
5. Demonstrate how tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.
6. Describe requirements of designing or making a product or system.
7. Create a new product that improves someone's life.

Design in Technology and Engineering Education

1. Illustrate that there are multiple approaches to design.
2. Demonstrate essential skills of the engineering design process.
3. Evaluate designs based on criteria, constraints, and standards.
4. Interpret how good design improves the human condition.
5. Apply universal principles and elements of design.
6. Evaluate the strengths and weaknesses of existing design solutions, including their own solutions.
7. Practice successful design skills.
8. Apply tools, techniques, and materials in a safe manner as part of the design process.

History of Technology

1. Create representations of the tools people made, how they cultivated to provide food, made clothing, and built shelters to protect themselves.

Impacts of Technology

1. Describe the helpful and harmful effects of technology.
2. Judge technologies to determine the best one to use to complete a given task or meet a need.
3. Classify resources used to create technologies as either renewable or nonrenewable.
4. Explain why responsible use of technology requires sustainable management of resources.
5. Predict how certain aspects of their daily lives would be different without given technologies.

Influence of Society on Technological Development

1. Determine factors that influence changes in a society’s technological systems or infrastructure.
2. Explain how technologies are developed or adapted when individual or societal needs and wants change.

Integration of Knowledge, Technologies, and Practices

1. Demonstrate how simple technologies are often combined to form more complex systems.
2. Explain how various relationships can exist between technology and engineering and other content areas.

Nature and Characteristics of Technology and Engineering

1. Compare how things found in nature differ from things that are human-made, noting differences and similarities in how they are produced and used.
2. Describe the unique relationship between science and technology, and how the natural world can contribute to the human-made world to foster innovation.
3. Differentiate between the role of scientists, engineers, technologists, and others in creating and maintaining technological systems.
4. Design solutions by safely using tools, materials, and skills.
5. Explain how solutions to problems are shaped by economic, political, and cultural forces.

References

Ashbrook, P. (2020). Becoming scientifically literate. *Science and Children*, 57(8). Retrieved from https://www.nsta.org/science-and-children/science-and-children-aprilmay-2020/becoming-scientifically-literate

Ecological Society of America. (2018). *The four-dimensional ecology education (4DEE) framework.* Retrieved from https://www.esa.org/4DEE/framework/

Ferguson, D., Neidorf, T., Johnston, W., Ratway, B., and Newman, B. (2020, May). *Science and Technology and Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback*. Washington, DC: American Institutes for Research. Retrieved from https://www.education.pa.gov/Documents/Teachers-Administrators/Curriculum/Science%20Education/PA%20Landscape%20Report.pdf

International Society for Technology in Education Standards. (2019). *ISTE standards for students.* Retrieved from https://www.iste.org/standards

International Technology and Engineering Educators Association. (2020). *Standards for technological and engineering literacy (STEL).* Retrieved from https://www.iteea.org/File.aspx?id=177416&v=90d1fc43

National Council for Agricultural Education. (2015). *Agriculture, food and natural resources (AFNR) career cluster content standards*. Retrieved from https://ffa.app.box.com/s/n6jfkamfof0spttqjvhddzolyevpo3qn/file/294160068843

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press.

National Science Foundation. (2010). *Preparing the next generation of STEM innovators: Identifying and developing our nation's human capital* (Publication No. NSB-10-33). Retrieved from https://www.nsf.gov/nsb/publications/2010/nsb1033.pdf

NGSS Lead States. (2013). *Next generation science standards: For states, by states.* Washington, DC: The National Academies Press. Retrieved from https://www.nextgenscience.org/

North American Association for Environmental Education. (2019). *K–12 environmental education: Guidelines for excellence.* Retrieved from https://cdn.naaee.org/sites/default/files/eepro/products/files/k-12_ee.lr_.pdf

North American Association for Environmental Education. (2014). *State environmental literacy plans: 2014 status report*. Retrieved from https://naaee.org/sites/default/files/2014-selp.2.25.15.a

Pennsylvania Association for Environmental Educators. (2015). *Pennsylvania environmental literacy plan.* Retrieved from https://naaee.org/eepro/resources/pennsylvania-elp

Pennsylvania Department of Education. (n.d.). *Pennsylvania career ready skills continuum.* Retrieved from http://www.education.pa.gov/K-12/CareerReadyPA/CareerReadySkills/Toolkit.

Pennsylvania State Board of Education. (2002). *Academic standards for science and technology*. Retrieved from https://www.stateboard.education.pa.gov/Regulations/AcademicStandards/Pages/default.aspx

Pennsylvania State Board of Education. (2002). *Academic standards for environment and ecology*. Retrieved from https://www.stateboard.education.pa.gov/Regulations/AcademicStandards/Pages/default.aspx

Standards for Technological and Engineering Literacy. (2020). Retrieved from https://www.iteea.org/File.aspx?id=175203&v=61c53622

Stone, M. K., & Barlow, Z. (Eds.). (2005). *Ecological literacy: Educating our children for a sustainable world.* Sierra Club Books.

Windschitl, M., Thompson, J. J., & Braaten, M. L. (2018). *Ambitious science teaching*. Cambridge, MA: Harvard Education Press.

Appendix A. Glossary

A Framework for K-12 Science Education (*The Framework*): The seminal report, created by the National Research Council (NRC), which defines a new way of teaching science, three dimensionally, based on current scientific and educational research.

Assessment Boundary: Specify limits to large-scale assessment; they are not meant to put limits on what can be taught or how it is taught, but to provide guidance to assessment developers.

Clarification Statement: Supply examples or additional clarification and emphasis to the language of the performance expectations.

Coherence: Refers to conceptual building of knowledge and skills over the course of lessons, units or years of instruction. This is in contrast to asking students to learn discrete pieces of content.

Connections boxes: Found as part of the architecture of a standards page, these highlight some of the links between the listed standard, the previous *Academic Standards for Science and Technology* (2002), *Academic Standards for Environment and Ecology* (2002), *PA Core Standards for English Language Arts* (ELA) and *PA Core Standards for Mathematics*, and International Society for Technology (ISTE) *Standards for Stud*ents, as well as the NCAA *Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards*, ITEEA *Standards for Technological and Engineering Literacy (STEL)* and NAAEE *K-12 Environmental Education: Guidelines for Excellence*.

Crosscutting Concepts (CCCs): Previously identified as themes, these are concepts that permeate across the natural and engineered world. They help students make connections between prior experiences and new learning. They help students figure out novel phenomena or design solutions to problems.

Curriculum: As defined for the purpose of this standards document, the curriculum is the blueprint designed to grow students toward achieving a standard over a grade level or band over the course of a semester or year. It is written by local or district personnel. Curriculum includes learning progressions, lesson plans, assessments for learning and teacher guides.

Disciplinary Core Ideas (DCIs): The fundamental ideas that are necessary for understanding a given science discipline. The core ideas all have broad importance within or across science or engineering domains, provide a key tool for understanding or investigating complex ideas and solving problems, relate to societal or personal concerns and can be taught over multiple grade levels at progressive levels of depth and complexity.

Foundation box: Each standard is three-dimensional, integrating elements from a Science and Engineering Practice (SEP), Disciplinary Core Idea (DCI) and Crosscutting Concept (CCC). These elements, which create the foundation for each standard, are listed in foundation boxes underneath the standard in the architecture of the standards.

Habits of mind: Identified as “dispositions” in the *Science and Technology and Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback*

report, these traits are what students should tend to when engaging in science and engineering practices alone and with others. Stakeholder feedback emphasized that students should develop habits of mind regarding science, environment and ecology and technology and engineering. Therefore, the committee created a list of habits of mind that students need in the classroom and in the workforce. Appendix C presents a crosswalk of the committee's habits of mind with Pennsylvania's Career Ready Skills to show the relationships and overlap of each.

Instruction: A teacher's daily plan to implement the curriculum. This may include a lesson plan, formative or summative assessment and differentiation based on the learner's needs.

PA Career Ready Skills: The PA Career Ready Skills are social-emotional learning progressions that support the development of a students' career preparedness. By design, the PA Career Ready Skills reflect priorities to ensure youth are career ready and prepared to meet the demands of the 21st century workforce. The PA Career Ready Skills are grouped into three domains: self-awareness and self-management, establishing and maintaining relationships and social problem-solving skills.

Pennsylvania (PA) connections: Provide opportunities for students to connect standards to local or regional phenomena to increase student engagement. PA connections provide PA-related examples that teachers can use to implement a curriculum designed to master said standard.

Performance Expectations (PEs): Statements of what students should know and be able to do with what they know.

Phenomena: Observable events.

Science and Engineering Practices (SEP): Critical practices that scientists and engineers use to investigate phenomena and solve problems through questioning.

Science and Technology and Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback (Pennsylvania Landscape Report): Commissioned by the Pennsylvania State Board of Education, this report captures the current research and best practices regarding science standards as well as the feedback from 14 stakeholder engagement sessions held across the commonwealth.

Standards: End-of-instruction goals or benchmarks for student proficiency.

Sustainability: A community's ability to "satisfy its needs and aspirations without diminishing the chances of future generations" (Stone & Barlow, 2005, p. xiii).

Three dimensions: The three dimensions are the Science and Engineering Practices ("the Practices" or SEPs), Disciplinary Core Ideas (DCIs) and Crosscutting Concepts (CCCs).

Three-dimensional learning: Developing and using elements of the three dimensions purposefully (i.e., to explain phenomena or design solutions to problems). Lessons and units aligned to the standards should be three-dimensional; that is, they should allow students to actively engage with the practices and apply the crosscutting concepts to deepen their understanding of core ideas across science disciplines while tending to appropriate dispositions.

Appendix B. Example of a Standard

Grade 5: Earth and Space Sciences

<table>
<tr><td colspan="3">Core Idea: Earth’s Systems</td></tr>
<tr><td colspan="3">5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system. Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]</td></tr>
<tr><td colspan="3">5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]</td></tr>
<tr><td>Science and Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
• Develop a model using an example to describe a scientific principle.
Using Mathematics and Computational Thinking
Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.
• Describe and graph quantities such as area and volume to address scientific questions.</td><td><u>Earth and Space Sciences</u>
ESS2.A: Earth Materials and Systems
• Earth’s major systems are the geosphere (solid and molten rock, soil, and sediment), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth’s surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)</td><td>Scale, Proportion, and Quantity
• Standard units are used to measure and describe physical quantities such as weight and volume.
Systems and System Models
• A system can be described in terms of its components and their interactions.
Sustainability
• The needs of the present are met without compromising the ability of future generations to meet their needs.
Natural systems function, remain diverse, and produce everything needed for the ecology to remain in balance.</td></tr>
</table>

Core Idea: Earth's Systems		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	ESS2.C: The Role of Water in Earth's Surface Processes • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **<u>Connections to Environment and Ecology</u>** **Skills for Analyzing and Investigating Environmental Issues** • Apply knowledge of ecological and human processes and systems to describe the short- and long-term consequences of selected environmental issues on sustainability. **Human Systems** • Describe how economic systems and economic decision-making influence natural resource use and management as well as environmental and human well-being. **Environment and Society** • Describe human-caused changes that affect the immediate environment as well as other places, other people, and future times. **Environment and Society** • Explain that uneven geographic distribution of natural resources influences their use and perceived value.	
PA Connections: Habits of Mind/PA Career Ready Skills and PA Context		

Core Idea: Earth's Systems		
Connections to Other Standards		
ELA: CC.1.2.5.G, CC.1.4.5.W, CC.1.5.5.E.	**Math:** MP.2, MP.4, CC.2.3.5.A.1	**ISTE/Ed Tech** 1. Empowered Learner 3. Knowledge Constructor 4. Innovative Designer 5. Computational Thinker 6. Creative Communicator 7. Global Collaborator

Appendix C. Intersection of Pennsylvania's Career Ready Skills, Dispositions and Habits of Mind

Stakeholder engagement sessions captured stakeholder feedback regarding the dispositions that all students should learn and be able to do as a part of a comprehensive K-12 science program. Using the student dispositions recommended by stakeholders, the Pennsylvania Career Ready Skills Continuum and research on habits of mind and the inclusion of dispositions in exemplar academic standards, committee members proposed lists of habits of mind relevant to the academic disciplines and the needs of Pennsylvania learners. Appendix C presents a crosswalk of the committee's habits of mind with Pennsylvania's Career Ready Skills to show the relationships and overlap of each. Educators can use this resource in conjunction with the PA Career Ready Skills Continuum to identify ways to integrate teaching science, environment and ecology and technology and engineering with related employability skills at any grade level.

Habits of Mind/Dispositions Aligned to Pennsylvania Career Ready Skills
Domain of Pennsylvania Career Ready Skills
A. Self-Awareness and Self-Management (Recognize and regulate emotions) *Related employability skills:* Respect, Dependability and Reliability, Communication, Professionalism, Teamwork, Integrity, Business Fundamentals, Adaptability, Initiative, Planning and Organizing
B. Establishing and Maintaining Relationships (Communicate and collaborate amongst diversity) *Related employability skills:* Problem-Solving, Decision Making, Critical Thinking, Integrity, Teamwork, Adaptability, Professionalism, Communication, Respect
C. Social Problem-Solving Skills (Demonstrate empathy and respectful choice) *Related employability skills:* Teamwork, Integrity, Communication, Respect, Customer Focus, Critical Thinking, Professionalism, Reading, Writing, Problem-Solving

PA Career Ready Skills Domains That Align to Each of the Dispositions/Habits of Mind

Science Core Ideas and Practices

Dispositions/ Habits of Mind	Domain A: Self-Awareness and Self-Management	Domain B: Establishing and Maintaining Relationships	Domain C: Social Problem-Solving Skills
Resilience or grit			
Intellectual curiosity			
Empathy			○

Dispositions/ Habits of Mind	Domain A: Self-Awareness and Self-Management	Domain B: Establishing and Maintaining Relationships	Domain C: Social Problem-Solving Skills
Integrity	●	●	●
Self-efficacy			
Adaptability	●	●	
Initiative	●		
Open-minded			
Drive			
Ownership			
Advocate			
Ethical			
Self-awareness/self-management	●		
Establishing and maintaining relationships		●	
Social problem-solving		●	●

Environment and Ecology Core Ideas and Practices

Dispositions/ Habits of Mind	Domain A: Self-Awareness and Self-Management	Domain B: Establishing and Maintaining Relationships	Domain C: Social Problem-Solving Skills
Patience			
Teamwork	●	●	●
Trial and error			
Individual resiliency			
Critical thinking		●	●
Collaboration		●	
Recognizing rights and responsibilities			
Recognizing efficacy and developing agency	●		
Accepting personal responsibility			

Dispositions/ Habits of Mind	Domain A: Self-Awareness and Self-Management	Domain B: Establishing and Maintaining Relationships	Domain C: Social Problem-Solving Skills
Working with flexibility, creativity and openness		●	
Self-awareness/Self-management	●	●	
Establishing and maintaining relationships		●	
Social problem-solving			●

Technology and Engineering Practices

Dispositions/ Habits of Mind	Domain A: Self-Awareness and Self-Management	Domain B: Establishing and Maintaining Relationships	Domain C: Social Problem-Solving Skills
Creativity			
Persistence (goal directed) and perseverance			
Empathy		●	●
Collaboration		●	
Communication	●	●	●
Attention to ethics			
Systems thinking			
Critical thinking		●	●
Self-awareness/Self-management	●	●	
Establishing and maintaining relationships		●	
Social problem-solving			●

The Pennsylvania Career Ready Skills Continuum is available from PDE at: https://www.education.pa.gov/K-12/CareerReadyPA/CareerReadySkills/Toolkit/Pages/Continuum.aspx