
Grades Pre-K–2: Overview of Science and Engineering Practices

The development of science and engineering practices begins very early, even as babies and young children inquire about and explore how the world works. Formal education should advance students' development of the skills necessary to engage in scientific inquiry and engineering design. These are the skills that provide the foundation for the scientific and technical reasoning that is so critical to success in civic life, postsecondary education, and careers. Inclusion of science and engineering practices in standards only speaks to the types of performances students should be able to demonstrate at the end of instruction at a particular grade; the standards do not limit what educators and students should or can be engaged in through a well-rounded curriculum.

Pre-K through grade 2 standards integrate all eight science and engineering practices. Pre-K standards ask students to demonstrate an ability to ask questions, set up simple investigations, analyze evidence, observations, and data for patterns, and use evidence to explain or develop ideas about how phenomena work. Kindergarten standards call for students to show further development of investigation and communication skills, as well as application of science concepts to designing solutions to problems, and to now use information obtained from text and media sources. Grade 1 standards call for students to continue developing investigation skills, including their ability to pose scientific questions as well as their ability to analyze observations and data and to effectively use informational sources. Grade 1 standards also call for students to demonstrate their ability to craft scientific explanations using evidence from a variety of sources. Grade 2 standards call for students to use models in a scientific context and further their skills in a number of the practices, including investigations, data analysis, designing solutions, argumentation, and use of informational sources.

Some examples of specific skills students should develop in these grades:

1. Raise questions about how different types of environments provide homes for living things; ask and/or identify questions that can be answered by an investigation.
2. Use a model to compare how plants and animals depend on their surroundings; develop and/or use a model to represent amounts, relationships, and/or patterns in the natural world; distinguish between a model and the actual object and/or process the model represents.
3. Conduct an investigation of light and shadows; plan and conduct an investigation collaboratively to produce data to answer a question; make observations and/or relative measurements to collect data that can be used to make comparisons.
4. Analyze data to identify relationships among seasonal patterns of change; use observations to describe patterns and/or relationships in the natural world and to answer scientific questions.
5. Decide when to use qualitative vs. quantitative information; use counting and numbers to describe patterns in the natural world.
6. Use information from observations to construct an evidence-based account of nature.
7. Construct an argument with evidence for how plants and animals can change the environment; distinguish between opinions and evidence in one's own explanations; listen actively to others to indicate agreement or disagreement based on evidence.

8. Obtain information to compare ways that parents and their offspring behave to survive; obtain information using various texts, text features, or other media to answer a question.

While presented as distinct skill sets, the eight practices intentionally overlap and interconnect. Skills such as those outlined above should be reflected in curricula and instruction that engage students in an integrated use of the practices. See the Science and Engineering Practices Progression Matrix (Appendix I) for more information, including particular skills for students in grades pre-K–2.

Pre-Kindergarten

The World Around Me

Pre-K students focus on experiencing and making observations of the world around them. They are beginning to learn about their own environment as they observe plants and animals, the Moon and the Sun, and the daily weather. They experience their world through their senses and body parts and begin to recognize that animals also use their senses and body parts to meet their basic needs. They investigate pitch and volume, shadow and light, liquids and solids, and how things move. They sort materials by simple observable properties such as texture and color. They share their understanding of these concepts through discussion as they develop their language and quantitative skills. Pre-K students build awareness of the wide variety of natural phenomena and processes in the world around them.

Pre-K: Earth and Space Sciences

ESS1. Earth's Place in the Universe

PreK-ESS1-1(MA). Demonstrate awareness that the Moon can be seen in the daytime and at night, and of the different apparent shapes of the Moon over a month.

Clarification Statement:

- The names of moon phases or sequencing of moon phases is not expected.

PreK-ESS1-2(MA). Observe and use evidence to describe that the Sun is in different places in the sky during the day.

ESS2. Earth's Systems

PreK-ESS2-1(MA). Raise questions and engage in discussions about how different types of local environments (including water) provide homes for different kinds of living things.

PreK-ESS2-2(MA). Observe and classify non-living materials, natural and human made, in the local environment.

PreK-ESS2-3(MA). Explore and describe different places water is found in the local environment.

PreK-ESS2-4(MA). Use simple instruments to collect and record data on elements of daily weather, including sun or clouds, wind, snow or rain, and higher or lower temperature.

PreK-ESS2-5(MA). Describe how local weather changes from day to day and over the seasons and recognize patterns in those changes.

Clarification Statement:

- Descriptions of the weather can include sunny, cloudy, rainy, warm, windy, and snowy.

PreK-ESS2-6(MA). Provide examples of the impact of weather on living things.

Clarification Statement:

- Make connections between the weather and what they wear and can do and the weather and the needs of plants and animals for water and shelter.

ESS3. Earth and Human Activity

PreK-ESS3-1(MA). Engage in discussion and raise questions using examples about local resources (including soil and water) humans use to meet their needs.

PreK-ESS3-2(MA). Observe and discuss the impact of people's activities on the local environment.

Pre-K: Life Science

LS1. From Molecules to Organisms: Structures and Processes

PreK-LS1-1(MA). Compare, using descriptions and drawings, the external body parts of animals (including humans) and plants and explain functions of some of the observable body parts.

Clarification Statement:

- Examples can include comparison of humans and horses: humans have two legs and horses four, but both use legs to move.

PreK-LS1-2(MA). Explain that most animals have five senses they use to gather information about the world around them.

PreK-LS1-3(MA). Use their five senses in their exploration and play to gather information.

LS2. Ecosystems: Interactions, Energy, and Dynamics

PreK-LS2-1(MA). Use evidence from animals and plants to define several characteristics of living things that distinguish them from non-living things.

PreK-LS2-2(MA). Using evidence from the local environment, explain how familiar plants and animals meet their needs where they live.

Clarification Statements:

- Basic needs include water, food, air, shelter, and, for most plants, light.
- Examples of evidence can include squirrels gathering nuts for the winter and plants growing in the presence of sun and water.
- The local environment includes the area around the student's school, home, or adjacent community.

PreK-LS2-3(MA). Give examples from the local environment of how animals and plants are dependent on one another to meet their basic needs.

LS3. Variation of Traits

PreK-LS3-1(MA). Use observations to explain that young plants and animals are like but not exactly like their parents.

Clarification Statement:

- Examples of observations include puppies that look similar but not exactly the same as their parents.

PreK-LS3-2(MA). Use observations to recognize differences and similarities among themselves and their friends.

Pre-K: Physical Sciences

PS1. Matter and Its Interactions

PreK-PS1-1(MA). Raise questions and investigate the differences between liquids and solids and develop awareness that a liquid can become a solid and vice versa.

PreK-PS1-2(MA). Investigate natural and human-made objects to describe, compare, sort, and classify objects based on observable physical characteristics, uses, and whether something is manufactured or occurs in nature.

PreK-PS1-3(MA). Differentiate between the properties of an object and those of the material of which it is made.

PreK-PS1-4(MA). Recognize through investigation that physical objects and materials can change under different circumstances.

Clarification Statement:

- Changes include building up or breaking apart, mixing, dissolving, and changing state.

PS2. Motion and Stability: Forces and Interactions

PreK-PS2-1(MA). Using evidence, discuss ideas about what is making something move the way it does and how some movements can be controlled.

PreK-PS2-2(MA). Through experience, develop awareness of factors that influence whether things stand or fall.

Clarification Statement:

- Examples of factors in children’s construction play include using a broad foundation when building, considering the strength of materials, and using balanced weight distribution in a block building.

PS4. Waves and Their Applications in Technologies for Information Transfer

PreK-PS4-1(MA). Investigate sounds made by different objects and materials and discuss explanations about what is causing the sounds. Through play and investigations, identify ways to manipulate different objects and materials that make sound to change volume and pitch.

PreK-PS4-2(MA). Connect daily experiences and investigations to demonstrate the relationships between the size and shape of shadows, the objects creating the shadow, and the light source.

Kindergarten

Reasons for Change

In kindergarten, students build on early experiences observing the world around them as they continue to make observations that are more quantitative in nature and help them identify why some changes occur. Students begin to learn to use these observations as evidence to support a claim through growing language skills. They learn that all animals and plants need food, water, and air to grow and thrive and that the fundamental difference between plants and animals is a plant's ability to make its own food. Students build their quantitative knowledge of temperature in relation to the weather and its effect on different kinds of materials. They observe that the amount of sunlight shining on a surface causes a temperature change and they design a structure to reduce the warming effects of sunlight. They investigate motions of objects by changing the strength and direction of pushes and pulls. They provide examples of plants and animals that can change their environment through their interactions with it. In kindergarten science, students begin to identify reasons for changes in some common phenomena.

Kindergarten: Earth and Space Sciences

ESS2. Earth's Systems

K-ESS2-1. Use and share quantitative observations of local weather conditions to describe patterns over time.

Clarification Statements:

- Examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month, and relative temperature.
- Quantitative observations should be limited to whole numbers.

K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment.

Clarification Statement:

- Examples of plants and animals changing their environment could include a squirrel digging holes in the ground and tree roots that break concrete.

ESS3. Earth and Human Activity

K-ESS3-2. Obtain and use information about weather forecasting to prepare for, and respond to, different types of local weather.

K-ESS3-3. Communicate solutions to reduce the amount of natural resources an individual uses.*

Clarification Statement:

- Examples of solutions could include reusing paper to reduce the number of trees cut down and recycling cans and bottles to reduce the amount of plastic or metal used.

[K-ESS3-1 from NGSS is not included.]

Kindergarten: Life Science

LS1. From Molecules to Organisms: Structures and Processes

K-LS1-1. Observe and communicate that animals (including humans) and plants need food, water, and air to survive. Animals get food from plants or other animals. Plants make their own food and need light to live and grow.

K-LS1-2(MA). Recognize that all plants and animals grow and change over time.

Kindergarten: Physical Science

PS1. Matter and Its Interactions

K-PS1-1(MA). Investigate and communicate the idea that different kinds of materials can be solid or liquid depending on temperature.

Clarification Statements:

- Materials chosen must exhibit solid and liquid states in a reasonable temperature range for kindergarten students (e.g., 0–80°F), such as water, crayons, or glue sticks.
- Only a qualitative description of temperature, such as hot, warm, and cool, is expected.

PS2. Motion and Stability: Forces and interactions

K-PS2-1. Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

Clarification Statements:

- Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.
- Comparisons should be on different relative strengths or different directions, not both at the same time.
- Non-contact pushes or pulls such as those produced by magnets are not expected.

[K-PS2-2 from NGSS is not included.]

PS3. Energy

K-PS3-1. Make observations to determine that sunlight warms materials on Earth's surface.

Clarification Statements:

- Examples of materials on Earth's surface could include sand, soil, rocks, and water.
- Measures of temperature should be limited to relative measures such as warmer/cooler.

K-PS3-2. Use tools and materials to design and build a model of a structure that will reduce the warming effect of sunlight on an area.*