Science Standard-Specific Supports

Grade 4

Revised October 2022

Contents

Science Standard-Specific Supports

Overview

The West Virginia College- and Career-Readiness Standards for Science[1] identify what students should know and be able to do at the end of science instruction. Each standard represents the integration of three "dimensions" of science education: practices of scientists and engineers, core science content, and science connecting concepts. As such, both student learning and assessment around the standards should be "three dimensional." The Science Standard-Specific Supports in this document are intended to show what it looks like for students to fully satisfy the intent of the standard.

The Science Standard-Specific Supports are adapted from the Evidence Statements of the Next Generation Science Standards (NGSS)[2], created when West Virginia was a lead state during the NGSS writing process, and the Framework for K-12 Science Instruction[3], created prior to the development of the NGSS. For more information on the Evidence Statements, please refer to them in their original form.

Purpose

The Science Standard-Specific Supports were designed to articulate how students can use the practices of scientists and engineers to demonstrate their understanding of the core science content through the lens of the science connecting concepts, and thus, demonstrate proficiency on each standard. The Science Standard-Specific Supports do this by clarifying:

- how the three dimensions could be assessed together, rather than in independent units;
- the underlying knowledge required for each core science content;
- the detailed approaches to the practices of scientists and engineers; and
- how science connecting concepts might be used to deepen content- and practice-driven learning.

The Science Standard-Specific Supports are not intended to be used as curriculum or limit or dictate instruction.

Structure

The practices of scientists and engineers are used as the organizing structure for the Science Standard-Specific Supports. However, this does not mean that the practices are more important than the other dimensions. The practices of scientists and engineers form the activities through which students demonstrate understanding of the science content. The proper integration of the practices makes students' thinking visible.

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[1] *West Virginia College- and Career-Readiness Standards for Science* (Policy 2520.3C) https://apps.sos.wv.gov/adlaw/csr/readfile.aspx?DocId=54673&Format=PDF

[2] NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.

[3] National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press.

How to Use the Science Standard-Specific Supports

- For instruction:
  - The Science Standard-Specific Supports can be used to aid instructional design, but it is crucial to recognize there are numerous pathways educators may use throughout the sequence of lessons and units to allow students to ultimately be prepared to demonstrate mastery of the standards.
- For assessment:
  - The Science Standard-Specific Supports can be used to inform the development of formative and summative assessments by the classroom educator.

Although supports are listed individually for each standard, this does not indicate that they should be measured individually, or that standards should be taught or assessed individually. Best practices in classroom instruction should be focused on helping students build towards several standards at one time because many concepts and practices are interrelated.

Limitations of the Science Standard-Specific Supports

The science standard-specific supports cannot do the following:

- Provide or prescribe the contexts through which the standards may be taught or assessed.
- Be the rubrics on which levels of student success would be measured.
- Identify the sequence of instruction or assessment.
- Put limits on student learning or student coursework.
- Replace lesson plans or assessment items.
- Serve as complete scoring rubrics.

Science - Grade 4 Introduction

Fourth Grade Science standards build on the study of physics and geology. Through a progressive rigorous, integrated approach, the inquiry-based program of study provides students opportunities to demonstrate scientific literacy in the fields of Physical Science, Life Science, and Earth and Space Science focusing on the connecting concepts of science: systems, changes, and models. The content develops basic problem-solving skills through observing, experimenting, and concluding. Students will engage in hands-on activities at least 50% of the instructional time as they develop and demonstrate conceptual understandings along with research and laboratory skills described in the standards and indicators for science. Engineering, Technology, and the Application of Science standards are integrated throughout instruction as students define problems and design solutions related to the course standards and indicators for science. Fourth Grade Science intentionally supports developmental and academic growth. Standards followed by an asterisk (*) denote the integration of traditional science content with an engineering practice.

Within the evidence statements, the words “description” or “describe” followed by an asterisk indicate those descriptions given by students could include but are not limited to written, oral, pictorial, and kinesthetic descriptions unless otherwise specified.

College- and Career-Readiness Indicators for Science Grades 3-5

<table>
<tr><th colspan="2">College- and Career-Readiness Indicators for Science</th></tr>
<tr><td colspan="2" align="center">Grades 3-5</td></tr>
<tr><th colspan="2">Nature of Science</th></tr>
<tr><td colspan="2">• Scientific knowledge is simultaneously reliable and subject to change based on empirical evidence and interpretation.
• Scientific knowledge is obtained through a combination of observations of the natural world and inferences based on those observations.
• Science is a creative human endeavor which is influenced by social and cultural biases.
• A primary goal of science is the formation of theories and laws. Theories are inferred explanations of some aspect of the natural world based on successfully tested information from evidence and evaluated phenomena. Laws describe relationships among what has been observed in the natural world.
• Scientific investigations use a variety of methods to address questions about the natural and material world.</td></tr>
<tr><th>Practices of Scientists and Engineers</th><th>Science Connecting Concepts</th></tr>
<tr><td>• Asking questions and defining problems
• Developing and using models
• Planning and carrying out investigations
• Analyzing and interpreting data
• Using mathematical and computational thinking
• Constructing explanations and designing solutions
• Engaging in argument from evidence
• Obtaining, evaluating, and communicating information</td><td>• Observing patterns
• Investigating and explaining cause and effect
• Recognizing scale, proportion, and quantity
• Defining systems and system models
• Tracking energy and matter flows, into, out of, and within systems to understand system behavior
• Determining the relationships between structure and function
• Studying stability and change</td></tr>
<tr><th>Science Literacy</th><th>Science Lab Safety</th></tr>
<tr><td>• Utilizing and connecting ideas among informational (factual) scientific texts
• Integrating and applying information presented in various media formats when writing and speaking
• Citing evidence to support scientific claims
• Comparing and contrasting sets of data
• Building and appropriately using science domain vocabulary and phrases
• Interpreting and applying visually expressed information (e.g., flowchart, diagram, model, graph, or table)</td><td>• Requiring lab safety training and archiving signed student safety contracts including medical conditions
• Wearing proper protective equipment as needed (e.g., goggles, apron, and gloves)
• Requiring grade-appropriate lab equipment operation and safety training
• Storing and disposing of chemical/biological materials properly
• Following ethical classroom use of living organisms</td></tr>
</table>

Physical Science

Topic: Energy

S.4.1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]

Practices of Scientists and Engineers	Core Science Content
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Students will use evidence (e.g., measurements, observations, patterns) to construct an explanation.	Definitions of Energy The faster a given object is moving, the more energy it possesses.
Science Connecting Concepts	
Energy and Matter Energy can be transferred in various ways and between objects.	

Observable features of the student performance by the end of the course:

1) Articulating the explanation of phenomena
   a) Students articulate a statement that relates the given phenomenon to a scientific idea, including that the speed of a given object is related to the energy of the object (e.g., the faster an object is moving, the more energy it possesses).
   b) Students use the evidence and reasoning to construct an explanation for the phenomenon.
2) Evidence
   a) Students identify and describe* the relevant given evidence for the explanation, including:
      i) The relative speed of the object (e.g., faster vs. slower objects).
      ii) Qualitative indicators of the amount of energy of the object, as determined by a transfer of energy from that object (e.g., more or less sound produced in a collision, more or less heat produced when objects rub together, relative speed of a ball that was stationary following a collision with a moving object, more or less distance a stationary object is moved).
3) Reasoning
   a) Students use reasoning to connect the evidence to support an explanation for the phenomenon. In the explanation, students describe* a chain of reasoning that includes:
      i) Motion can indicate the energy of an object.
      ii) The faster a given object is moving, the more observable impact it can have on another object (e.g., a fast-moving ball striking something (a gong, a wall) makes more noise than does the same ball moving slowly and striking the same thing).
      iii) The observable impact of a moving object interacting with its surroundings reflects how much energy was able to be transferred between objects and therefore relates to the energy of the moving object.
      iv) Because faster objects have a larger impact on their surroundings than objects moving more slowly, they have more energy due to motion (e.g., a fast-moving ball striking a gong makes more noise than a slow-moving ball doing the same thing because it has more energy that can be transferred to the gong, producing more sound).
      v) Therefore, the speed of an object is related to the energy of the object.

S.4.2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Practices of Scientists and Engineers	Core Science Content
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Students will make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	**Definitions of Energy** Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **Conservation of Energy and Energy Transfer** Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Light also transfers energy from place to place. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.
Science Connecting Concepts	
Energy and Matter Energy can be transferred in various ways and between objects.	

Observable features of the student performance by the end of the course:

1) Identifying the phenomenon under investigation
    a) From the given investigation plan, students describe* the phenomenon under investigation, which includes the following ideas:
        i) The transfer of energy, including:
            (1) Collisions between objects.
            (2) Light traveling from one place to another.
            (3) Electric currents producing motion, sound, heat, or light.
            (4) Sound traveling from one place to another.
            (5) Heat passing from one object to another.
            (6) Motion, sound, heat, and light causing a different type of energy to be observed after an interaction (e.g., in a collision between two objects, one object may slow down or stop, the other object may speed up, and the objects and surrounding air may be heated; a specific sound may cause the movement of an object; the energy associated with the motion of an object, via an electrical current, may be used to turn on a light).
    b) Students describe* the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon, including the idea that energy can be transferred from place to place by:
        i) Moving objects.
        ii) Sound.
        iii) Light.
        iv) Heat.
        v) Electric currents.
2) Identifying the evidence to address the purpose of the investigation
    a) From the given investigation plan, students describe* the data to be collected that will serve as the basis for evidence, including:
        i) The motion and collision of objects before and after an interaction (e.g., when a given object is moving fast, it can move another object farther than when the same object is moving more slowly).

        ii) The relative presence of sound, light, or heat (including in the surrounding air) before and after an interaction (e.g. shining a light on an object can increase the temperature of the object; a sound can move an object).
        iii) The presence of electric currents flowing through wires causally linking one form of energy output (e.g., a moving object) to another form of energy output (e.g., another moving object; turning on a light bulb).
    b) Students describe* how their observations will address the purpose of the investigation, including how the observations will provide evidence that energy, in the form of light, sound, heat, and motion, can be transferred from place to place by sound, light, heat, or electric currents (e.g., in a system in which the motion of an object generates an observable electrical current to turn on a light, energy (from the motion of an object) must be transferred to another place (energy in the form of the light bulb) via the electrical current, because the motion doesn't cause the light bulb to light up if the wire is not completing a circuit between them; when a light is directed at an object, energy (in the form of light) must be transferred from the source of the light to its destination and can be observed in the form of heat, because if the light is blocked, the object isn't warmed.
3) Planning the investigation
    a) From the given investigation plan, students identify and describe* how the data will be observed and recorded, including the tools and methods for collecting data on:
        i) The motion and collision of objects, including any sound or heat producing the motion/collision, or produced by the motion/collision.
        ii) The presence of energy in the form of sound, light, or heat in one place as a result of sound, light, or heat in a different place.
        iii) The presence of electric currents in wires and the presence of energy (in the form of sound, light, heat, or motion resulting from the flow of electric currents through a device).
    b) Students describe* the number of trials, controlled variables, and experimental set up.
4) Collecting the data
    a) Students make and record observations according to the given investigation plan to provide evidence that:
        i) Energy is present whenever there are moving objects, sound, light, or heat.
        ii) That energy has been transferred from place to place (e.g., a bulb in a circuit is not lit until a switch is closed and it lights, indicating that energy is transferred through electric current in a wire to light the bulb; a stationary ball is struck by a moving ball, causing the stationary ball to move and the moving ball to slow down, indicating that energy has been transferred from the moving ball to the stationary one).

S.4.3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Students will ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.</td><td rowspan="3">Definitions of Energy
Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
Conservation of Energy and Energy Transfer
Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
Relationship Between Energy and Forces
When objects collide, the contact forces transfer energy so as to change the objects’ motions.</td></tr>
<tr><th>Science Connecting Concepts</th></tr>
<tr><td>Energy and Matter
Energy can be transferred in various ways and between objects.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Addressing phenomena of the natural world
   a) Students ask questions about the changes in energy that occur when objects collide, the answers to which would clarify:
      i) A qualitative measure of energy (e.g., relative motion, relative speed, relative brightness) of the object before the collision.
      ii) The mechanism of energy transfer during the collision, including:
         (1) The transfer of energy by contact forces between colliding objects that results in a change in the motion of the objects.
         (2) The transfer of energy to the surrounding air when objects collide resulting in sound and heat.
   b) Students predict reasonable outcomes about the changes in energy that occur after objects collide, based on patterns linking object collision and energy transfer between objects and the surrounding air.
2) Identifying the scientific nature of the question
   a) Students ask questions that can be investigated within the scope of the classroom or an outdoor environment.

S.4.4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

Practices of Scientists and Engineers	Core Science Content
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Students will apply scientific ideas to solve design problems.	**Conservation of Energy and Energy Transfer** Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.
Science Connecting Concepts	
Energy and Matter Energy can be transferred in various ways and between objects. **Influence of Engineering, Technology, and Science on Society and the Natural World** Engineers improve existing technologies or develop new ones. **Science is a Human Endeavor** Most scientists and engineers work in teams. Science affects everyday life.	**Energy in Chemical Processes and Everyday Life** The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. **Defining Engineering Problems** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria).

Observable features of the student performance by the end of the course:

1) Using scientific knowledge to generate design solutions
   a) Given a problem to solve, students collaboratively design a solution that converts energy from one form to another. In the design, students:
      i) Specify the initial and final forms of energy (e.g., electrical energy, motion, light).
      ii) Identify the device by which the energy will be transformed (e.g., a light bulb to convert electrical energy into light energy, a motor to convert electrical energy into energy of motion).
2) Describing* criteria and constraints, including quantification when appropriate
   a) Students describe* the given criteria and constraints of the design, which include:
      i) Criteria:
         (1) The initial and final forms of energy.
         (2) Description* of how the solution functions to transfer energy from one form to another.
      ii) Constraints:
         (1) The materials available for the construction of the device.
         (2) Safety considerations.
3) Evaluating potential solutions
   a) Students evaluate the proposed solution according to how well it meets the specified criteria and constraints of the problem.
4) Modifying the design solution
   a) Students test the device and use the results of the test to address problems in the design or improve its functioning.

Topic: Waves: Waves and Information

S.4.5. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></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. Students will develop a model using an analogy, example, or abstract representation to describe a scientific principle.
Scientific Knowledge is Based on Empirical Evidence
Science findings are based on recognizing patterns.</td><td rowspan="3">Wave Properties
Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).</td></tr>
<tr><th>Science Connecting Concepts</th></tr>
<tr><td>Patterns
Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Components of the model
   a) Students develop a model (e.g., diagrams, analogies, examples, abstract representations, physical models) to make sense of a phenomenon that involves wave behavior. In the model, students identify the relevant components, including:
      i) Waves.
      ii) Wave amplitude.
      iii) Wavelength.
      iv) Motion of objects.
2) Relationships
   a) Students identify and describe* the relevant relationships between components of the model, including:
      i) Waves can be described* in terms of patterns of repeating amplitude and wavelength (e.g., in a water wave there is a repeating pattern of water being higher and then lower than the baseline level of the water).
      ii) Waves can cause an object to move.
      iii) The motion of objects varies with the amplitude and wavelength of the wave carrying it.
3) Connections
   a) Students use the model to describe*:
      i) The patterns in the relationships between a wave passing, the net motion of the wave, and the motion of an object caused by the wave as it passes.
      ii) How waves may be initiated (e.g., by disturbing surface water or shaking a rope or spring).
      iii) The repeating pattern produced as a wave is propagated.
   b) Students use the model to describe* that waves of the same type can vary in terms of amplitude and wavelength and describe* how this might affect the motion, caused by a wave, of an object.
   c) Students identify similarities and differences in patterns underlying waves and use these patterns to describe* simple relationships involving wave amplitude, wavelength, and the motion of an object (e.g., when the amplitude increases, the object moves more).

S.4.6. Generate and compare multiple solutions that use patterns to transfer information.* [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Students will generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.</td><td rowspan="3">Information Technologies and Instrumentation
Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information (convert it from digitized form to voice) and vice versa.

Optimizing the Design Solution
Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.</td></tr>
<tr><td>Science Connecting Concepts</td></tr>
<tr><td>Patterns
Similarities and differences in patterns can be used to sort and classify designed products.
Interdependence of Science, Engineering, and Technology
Knowledge of relevant scientific concepts and research findings is important in engineering.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Using scientific knowledge to generate design solutions
    a) Students generate at least two design solutions, for a given problem, that use patterns to transmit a given piece of information (e.g., picture, message). Students describe* how the design solution is based on:
        i) Knowledge of digitized information transfer (e.g., information can be converted from a sound wave into a digital signal such as patterns of 1s and 0s and vice versa; visual or verbal messages can be encoded in patterns of flashes of light to be decoded by someone else across the room).
        ii) Ways that high-tech devices convert and transmit information (e.g., cell phones convert sound waves into digital signals, so they can be transmitted long distances, and then converted back into sound waves; a picture or message can be encoded using light signals to transmit the information over a long distance).
2) Describing* criteria and constraints, including quantification when appropriate
    a) Students describe* the given criteria for the design solutions, including the accuracy of the final transmitted information and that digitized information (patterns) transfer is used.
    b) Students describe* the given constraints of the design solutions, including:
        i) The distance over which information is transmitted.
        ii) Safety considerations.
        iii) Materials available.
3) Evaluating potential solutions
    a) Students compare the proposed solutions based on how well each meets the criteria and constraints.
    b) Students identify similarities and differences in the types of patterns used in the solutions to determine whether some ways of transmitting information are more effective than others at addressing the problem.

Life Science

Topic: Structure, Function, and Information Processing

S.4.7. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

Practices of Scientists and Engineers	Core Science Content
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. Students will develop a model to describe phenomena.	Electromagnetic Radiation An object can be seen when light reflected from its surface enters the eyes.
Science Connecting Concepts	
Cause and Effect Cause and effect relationships are routinely identified.	

Observable features of the student performance by the end of the course:

1) Components of the model
   a) Students develop a model to make sense of a phenomenon involving the relationship between light reflection and visibility of objects. In the model, students identify the relevant components, including:
      i) Light (including the light source).
      ii) Objects.
      iii) The path that light follows.
      iv) The eye.
2) Relationships
   a) Students identify and describe* causal relationships between the components, including:
      i) Light enters the eye, allowing objects to be seen.
      ii) Light reflects off of objects, and then can travel and enter the eye.
      iii) Objects can be seen only if light follows a path between a light source, the object, and the eye.
3) Connections
   a) Students use the model to describe* that in order to see objects that do not produce their own light, light must reflect off the object and into the eye.
   b) Students use the model to describe* the effects of the following on seeing an object:
      i) Removing, blocking, or changing the light source (e.g., a dimmer light).
      ii) Closing the eye.
      iii) Changing the path of the light (e.g., using mirrors to direct the path of light to allow the visualization of a previously unseen object or to change the position in which the object can be seen, using an opaque or translucent barrier between 1) the light source and the object or 2) the object and the eye to change the path light follows and the visualization of the object).

S.4.8. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Engaging in Argument from Evidence
Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Students will construct an argument with evidence, data, and/or a model.</td><td rowspan="3">Structure and Function
Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.</td></tr>
<tr><th>Science Connecting Concepts</th></tr>
<tr><td>Systems and System Models
A system can be described in terms of its components and their interactions.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Supported claims
   a) Students make a claim to be supported about a phenomenon. In the claim, students include the idea that plants and animals have internal and external structures that function together as part of a system to support survival, growth, behavior, and reproduction.
2) Identifying scientific evidence
   a) Students describe* the given evidence, including:
      i) The internal and external structures of selected plants and animals.
      ii) The primary functions of those structures.
3) Evaluating and critiquing evidence
   a) Students determine the strengths and weaknesses of the evidence, including whether the evidence is relevant and sufficient to support a claim about the role of internal and external structures of plants and animals in supporting survival, growth, behavior, and/or reproduction.
4) Reasoning and synthesis
   a) Students use reasoning to connect the relevant and appropriate evidence and construct an argument that includes the idea that plants and animals have structures that, together, support survival, growth, behavior, and/or reproduction. Students describe* a chain of reasoning that includes:
      i) Internal and external structures serve specific functions within plants and animals (e.g., the heart pumps blood to the body, thorns discourage predators).
      ii) The functions of internal and external structures can support survival, growth, behavior, and/or reproduction in plants and animals (e.g., the heart pumps blood throughout the body, which allows the entire body access to oxygen and nutrients; thorns prevent predation, which allows the plant to grow and reproduce).
      iii) Different structures work together as part of a system to support survival, growth, behavior, and/or reproduction (e.g., the heart works with the lungs to carry oxygenated blood throughout the system; thorns protect the plant, allowing reproduction via stamens and pollen to occur).

S.4.9. 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. [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></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. Students will use a model to test interactions concerning the functioning of a natural system.</td><td rowspan="3">Information Processing
Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.</td></tr>
<tr><td>Science Connecting Concepts</td></tr>
<tr><td>Systems and System Models
A system can be described in terms of its components and their interactions.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Components of the model
   a) From a given model, students identify and describe* the relevant components for testing interactions concerning the functioning of a given natural system, including:
      i) Different types of information about the surroundings (e.g., sound, light, odor, temperature).
      ii) Sense receptors able to detect different types of information from the environment.
      iii) Brain.
      iv) Animals' actions.
2) Relationships
   a) Students describe* the relationships between components in the model, including:
      i) Different types of sense receptors detect specific types of information within the environment.
      ii) Sense receptors send information about the surroundings to the brain.
      iii) Information that is transmitted to the brain by sense receptors can be processed immediately as perception of the environment and/or stored as memories.
      iv) Immediate perceptions or memories processed by the brain influence an animal's action or responses to features in the environment.
3) Connections
   a) Students use the model to describe* that:
      i) Information in the environment interacts with animal behavioral output via interactions mediated by the brain.
      ii) Different types of sensory information are relayed to the brain via different sensory receptors, allowing experiences to be perceived, stored as memories, and influence behavior (e.g., an animal sees a brown, rotten fruit and smells a bad odor — this sensory information allows the animal to use information about other fruits that appear to be rotting to make decisions about what to eat; an animal sees a red fruit and a green fruit — after eating them both, the animal learns that the red fruit is sweet and the green fruit is bitter and then uses this sensory information, perceived and stored as memories, to guide fruit selection next time).
      iii) Sensory input, the brain, and behavioral output are all parts of a system that allow animals to engage in appropriate behaviors.
   b) Students use the model to test interactions involving sensory perception and its influence on animal behavior within a natural system, including interactions between:
      i) Information in the environment.
      ii) Different types of sense receptors.
      iii) Perception and memory of sensory information.
      iv) Animal behavior.

Earth and Space Science

Topic: Earth's Systems: Processes that Shape the Earth

S.4.10. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]

Practices of Scientists and Engineers	Core Science Content
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Students will identify the evidence that supports particular points in an explanation.	The History of Planet Earth Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.
Science Connecting Concepts	
Patterns Patterns can be used as evidence to support an explanation. Scientific Knowledge Assumes an Order and Consistency in Natural Systems Science assumes consistent patterns in natural systems.	

Observable features of the student performance by the end of the course:

1) Articulating the explanation of phenomena
   a) Students identify the given explanation for a phenomenon, which includes a statement about the idea that landscapes change over time.
   b) From the given explanation, students identify the specific aspects of the explanation they are supporting with evidence.
2) Evidence
   a) Students identify the evidence relevant to supporting the explanation, including local and regional patterns in the following:
      i) Different rock layers found in an area (e.g., rock layers taken from the same location show marine fossils in some layers and land fossils in other layers).
      ii) Ordering of rock layers (e.g., layer with marine fossils is found below layer with land fossils).
      iii) Presence of particular fossils (e.g., shells, land plants) in specific rock layers.
      iv) The occurrence of events (e.g., earthquakes) due to Earth forces.
3) Reasoning
   a) Students use reasoning to connect the evidence to support particular points of the explanation, including the identification of a specific pattern of rock layers and fossils (e.g., a rock layer containing shells and fish below a rock layer containing fossils of land animals and plants is a pattern indicating that, at one point, the landscape had been covered by water and later it was dry land). Students describe* reasoning for how the evidence supports particular points of the explanation, including:
      i) Specific rock layers in the same location show specific fossil patterns (e.g., some lower rock layers have marine fossils, while some higher rock layers have fossils of land plants).
      ii) Since lower layers were formed first then covered by upper layers, this pattern indicates that the landscape of the area was transformed into the landscape indicated by the upper

layer (e.g., lower marine fossils indicate that, at one point, the landscape was covered by water, and upper land fossils indicate that later the landscape was dry land).

iii) Irregularities in the patterns of rock layers indicate disruptions due to Earth forces (e.g., a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock).

S.4.11. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.]

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Analyzing and Interpreting Data
Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Students will analyze and interpret data to make sense of phenomena using logical reasoning.</td><td rowspan="3">Evidence of Common Ancestry and Diversity
Some kinds of plants and animals that once lived on Earth are no longer found anywhere. Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.</td></tr>
<tr><td>Science Connecting Concepts</td></tr>
<tr><td>Scale, Proportion, and Quantity
Observable phenomena exist from very short to very long time periods.
Scientific Knowledge Assumes an Order and Consistency in Natural Systems
Science assumes consistent patterns in natural systems.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Organizing data
   a) Students use graphical displays (e.g., table, chart, graph) to organize the given data, including data about:
      i) Fossils of animals (e.g., information on type, size, type of land on which it was found).
      ii) Fossils of plants (e.g., information on type, size, type of land on which it was found).
      iii) The relative ages of fossils (e.g., from a very long time ago).
      iv) Existence of modern counterparts to the fossilized plants and animals and information on where they currently live.
2) Identifying relationships
   a) Students identify and describe* relationships in the data, including:
      i) That fossils represent plants and animals that lived long ago.
      ii) The relationships between the fossils of organisms and the environments in which they lived (e.g., marine organisms, like fish, must have lived in water environments).
      iii) The relationships between types of fossils (e.g., those of marine animals) and the current environments where similar organisms are found.
      iv) That some fossils represent organisms that lived long ago and have no modern counterparts.
      v) The relationships between fossils of organisms that lived long ago and their modern counterparts.
      vi) The relationships between existing animals and the environments in which they currently live.

3) Interpreting data
   a) Students describe* that:
      i) Fossils provide evidence of organisms that lived long ago but have become extinct (e.g., dinosaurs, mammoths, other organisms that have no clear modern counterpart).
      ii) Features of fossils provide evidence of organisms that lived long ago and of what types of environments those organisms must have lived in (e.g., fossilized seashells indicate shelled organisms that lived in aquatic environments).
      iii) By comparing data about where fossils are found and what those environments are like, fossilized plants and animals can be used to provide evidence that some environments look very different now than they did a long time ago (e.g., fossilized seashells found on land that is now dry suggest that the area in which those fossils were found used to be aquatic; tropical plant fossils found in Antarctica, where tropical plants cannot live today, suggests that the area used to be tropical).

S.4.12. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]

Practices of Scientists and Engineers	Core Science Content
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Students will make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. **Biogeology** Living things affect the physical characteristics of their regions.
Science Connecting Concepts	
Cause and Effect Cause and effect relationships are routinely identified, tested, and used to explain change.	

Observable features of the student performance by the end of the course:

1) Identifying the phenomenon under investigation
   a) From the given investigation plan, students identify the phenomenon under investigation, which includes the following idea: the effects of weathering or the rate of erosion of Earth's materials.
   b) From the given investigation plan, students identify the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon.
2) Identifying the evidence to address the purpose of the investigation
   a) From the given investigation plan, students describe* the data to be collected that will serve as the basis for evidence.
   b) From the given investigation plan, students describe* the evidence needed, based on observations and/or measurements made during the investigation, including:
      i) The change in the relative steepness of slope of the area (e.g., no slope, slight slope, steep slope).
      ii) The kind of weathering or erosion to which the Earth material is exposed.

iii) The change in the shape of Earth materials as the result of weathering or the rate of erosion by one of the following:
(1) Motion of water.
(2) Ice (including melting and freezing processes).
(3) Wind (speed and direction).
(4) Vegetation.
c) Students describe* how the data to be collected will serve as evidence to address the purpose of the investigation, including to help identify cause and effect relationships between weathering or erosion, and Earth materials.

3) Planning the investigation
a) From the given investigation plan, students describe* how the data will be collected, including:
i) The relative speed of the flow of air or water.
ii) The number of cycles of freezing and thawing.
iii) The number and types of plants growing in the Earth material.
iv) The relative amount of soil or sediment transported by erosion.
v) The number or size of rocks transported by erosion.
vi) The breakdown of materials by weathering (e.g., ease of breaking before or after weathering, size/number of rocks broken down).
b) Students describe* the controlled variables, including:
i) Those variables that affect the movement of water (e.g., flow speed, volume, slope).
ii) Those variables that affect the movement of air.
iii) The water temperature and forms of matter (e.g., freezing, melting, room temperature).
iv) The presence or absence of plants growing in or on the Earth material.

4) Collecting the data
a) Students make and record observations according to the given investigation plan to provide evidence for the effects of weathering or the rate of erosion on Earth materials (e.g., rocks, soils, and sediment).

S.4.13. Analyze and interpret data from maps to describe patterns of Earth's features. [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

Practices of Scientists and Engineers	Core Science Content
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Students will analyze and interpret data to make sense of phenomena using logical reasoning.	**Plate Tectonics and Large-Scale System Interactions** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.
Science Connecting Concepts	
Patterns Patterns can be used as evidence to support an explanation.	

Observable features of the student performance by the end of the course:

1) Organizing data
   a) Students organize data using graphical displays (e.g., table, chart, graph) from maps of Earth's features (e.g., locations of mountains, continental boundaries, volcanoes, earthquakes, deep ocean trenches, ocean floor structures).
2) Identifying relationships
   a) Students identify patterns in the location of Earth features, including the locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes. These relationships include:
      i) Volcanoes and earthquakes occur in bands that are often along the boundaries between continents and oceans.
      ii) Major mountain chains form inside continents or near their edges.
3) Interpreting data
   a) Students use logical reasoning based on the organized data to make sense of and describe* a phenomenon. In their description*, students include that Earth features occur in patterns that reflect information about how they are formed or occur (e.g., mountain ranges tend to occur on the edges of continents or inside them, the Pacific Ocean is surrounded by a ring of volcanoes, all continents are surrounded by water [assume Europe and Asia are identified as Eurasia]).

Engineering, Technology, and Applications of Science

Topic: Engineering Design

S.4.14. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Asking Questions and Defining Problems
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Students will define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.</td><td rowspan="3">Defining and Delimiting Engineering Problems
Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.</td></tr>
<tr><td>Science Connecting Concepts</td></tr>
<tr><td>Influence of Science, Engineering, and Technology on Society and the Natural World
People’s needs and wants change over time, as do their demands for new and improved technologies.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Identifying the problem to be solved
   a) Students use given scientific information and information about a situation or phenomenon to define a simple design problem that includes responding to a need or want.
   b) The problem students define is one that can be solved with the development of a new or improved object, tool, process, or system.
   c) Students describe* that people’s needs and wants change over time.
2) Defining the boundaries of the system
   a) Students define the limits within which the problem will be addressed, which includes addressing something people want and need at the current time.
3) Defining the criteria and constraints
   a) Based on the situation people want to change, students specify criteria (required features) of a successful solution.
   b) Students describe* the constraints or limitations on their design, which may include:
      i) Cost.
      ii) Materials.
      iii) Time.

S.4.15. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Students will generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.</td><td rowspan="3">Developing Possible Solutions
Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.</td></tr>
<tr><td>Science Connecting Concepts</td></tr>
<tr><td>Influence of Science, Engineering, and Technology on Society and the Natural World
Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.</td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Using scientific knowledge to generate design solutions
   a) Students use grade-appropriate information from research about a given problem, including the causes and effects of the problem and relevant scientific information.
   b) Students generate at least two possible solutions to the problem based on scientific information and understanding of the problem.
   c) Students specify how each design solution solves the problem.
   d) Students share ideas and findings with others about design solutions to generate a variety of possible solutions.
   e) Students describe* the necessary steps for designing a solution to a problem, including conducting research and communicating with others throughout the design process to improve the design [note: emphasis is on what is necessary for designing solutions, not on a step-wise process].
2) Describing* criteria and constraints, including quantification when appropriate
   a) Students describe*:
      i) The given criteria (required features) and constraints (limits) for the solutions, including increasing benefits, decreasing risks/costs, and meeting societal demands as appropriate.
      ii) How the criteria and constraints will be used to generate and test the design solutions.
3) Evaluating potential solutions
   a) Students test each solution under a range of likely conditions and gather data to determine how well the solutions meet the criteria and constraints of the problem.
   b) Students use the collected data to compare solutions based on how well each solution meets the criteria and constraints of the problem.

S.4.16. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

<table>
<tr><th>Practices of Scientists and Engineers</th><th>Core Science Content</th></tr>
<tr><td>Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Students will plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.</td><td rowspan="3">Developing Possible Solutions
Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.

Optimizing the Design Solution
Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.</td></tr>
<tr><td>Science Connecting Concepts</td></tr>
<tr><td></td></tr>
</table>

Observable features of the student performance by the end of the course:

1) Identifying the purpose of the investigation
   a) Students describe* the purpose of the investigation, which includes finding possible failure points or difficulties to identify aspects of a model or prototype that can be improved.
2) Identifying the evidence to be address the purpose of the investigation
   a) Students describe* the evidence to be collected, including:
      i) How well the model/prototype performs against the given criteria and constraints.
      ii) Specific aspects of the prototype or model that do not meet one or more of the criteria or constraints (i.e., failure points or difficulties).
      iii) Aspects of the model/prototype that can be improved to better meet the criteria and constraints.
   b) Students describe* how the evidence is relevant to the purpose of the investigation.
3) Planning the investigation
   a) Students create a plan for the investigation that describes* different tests for each aspect of the criteria and constraints. For each aspect, students describe*:
      i) The specific criterion or constraint to be used.
      ii) What is to be changed in each trial (the independent variable).
      iii) The outcome (dependent variable) that will be measured to determine success.
      iv) What tools and methods are to be used for collecting data.
      v) What is to be kept the same from trial to trial to ensure a fair test.
4) Collecting the data
   a) Students carry out the investigation, collecting and recording data according to the developed plan.

David L. Roach
West Virginia Superintendent of Schools