Oklahoma Academic Standards for Science Content Framework

Fourth Grade

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OVERVIEW

The Oklahoma Academic Standards for Science describe the specific areas of student learning that are considered the most important for proficiency in the discipline at a particular grade level and provide a basis for the development of local curricula and statewide assessments. The Oklahoma Academic Standards were informed by A *Framework for K-12 Science Education* (National Research Council, 2012), *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), *The Next Generation Science* Standards (2013), and the *Oklahoma Priority Academic Students Skills for Science* (Oklahoma State Department of Education, 2011).

LEARNING PROGRESSIONS

The *Framework for K-12 Science Education* (National Research Council, 2012), emphasizes the need for students to have repeated experiences, in every grade, with increasing sophistication across the grade levels. These opportunities allow students to continually build upon and revise their knowledge and abilities. "The goal is to guide their knowledge toward a more scientifically based and coherent view of the natural sciences and engineering, as well as of the ways in which they are pursued and their results can be used." (NRC, A *Framework for K-12 Science Education*, 2012)

THREE DIMENSIONS OF SCIENCE INSTRUCTION

The Oklahoma Academic Standards for Science are designed to address the rich and complex nature of science learning: the processes of thinking about, analyzing, and using science and engineering information, the fundamental concepts that are relevant to all subject areas, and the content that is unique to individual subject areas.

In the standards, three dimensions are referred to as:

1. **Science and Engineering Practices**: They represent the major practices that scientists and engineers use, practices that require both skill and knowledge.
2. **Disciplinary Core Ideas**: There are three major domains; Physical Science, Life Science, and Earth and Space Science.
3. **Crosscutting Concepts**: These connect ideas across all science disciplines. This is how Scientists and Engineers think.

When students have learning experiences that include each dimension in the context of the others, they are able to fully develop the skills and understandings associated with real science.

THREE DIMENSIONAL LEARNING

DIMENSION 1: SCIENCE AND ENGINEERING PRACTICES

Dimension 1 describes (1) the major practices that scientists employ as they investigate and build models and theories about the world, (2) a key set of engineering practices that engineers use as they design and build systems. Here, we use the term "practices" in place of "skills" to emphasize that engaging in scientific investigation requires both skill and knowledge that is specific to each practice. (NRC, A *Framework for K-12 Science Education*, 2012)

DEMENSION 2: DISCIPLINARY CORE IDEAS

The continuing expansion of scientific knowledge makes it impossible to teach all the ideas related to a given discipline in explicit detail during the K-12 years. We need to ensure we are preparing our students with sufficient core knowledge so that they can later continue to acquire additional information on their own. An education focused on a limited set of ideas and practices in science and engineering should enable students to evaluate and select reliable sources of scientific information, and allow them to continue their development well beyond their K-12 school years as science learners, users of scientific knowledge, and perhaps also as producers of such knowledge. (NRC, A *Framework for K-12 Science Education*, 2012)

DEMSION 3: CROSSCUTTING CONCEPTS

Crosscutting concepts provide a connective structure that supports students' understanding of science as disciplines and that facilitates students' comprehension of the phenomena under study in particular disciplines. The crosscutting concepts also aid in students organizational framework for connecting knowledge from various disciplines into a coherent and scientifically-based view of the world. Explicit reference to the concepts, as well as their emergence in multiple disciplinary contexts, can help students develop a cumulative, coherent, and usable understanding of science and engineering. (NRC, A Framework for K-12 Science Education, 2012)

Table of Contents

Science and Engineering Practices

The Science and Engineering Practices describe the major practices that scientists employ as they investigate and build models and theories about the world and a key set of engineering practices that engineers use as they design and build systems. The term "practice" is used instead of the term "process" to emphasize that scientists and engineers use skill and knowledge simultaneously, not in isolation. The eight science and engineering practices are:

1. **Ask questions and define problems**
2. **Develop and use models**
3. **Plan and conduct investigations**
4. **Analyze and interpret data**
5. **Use mathematical and computational thinking**
6. **Construct explanations and design solutions**
7. **Engage in scientific argument from evidence**
8. **Obtain, evaluate, and communicate information**

Each Performance expectation integrates one of the above Science and Engineering Practices with a Disciplinary Core Idea in Science. The integration of Science and Engineering Practices with science content represents a shift from previous science standards in Oklahoma, giving the learning context and allowing students to utilize scientific reasoning and critical thinking to develop their understanding of science.

Taken from the Oklahoma State Department of Education Science Standard Document

The Engineering Design Process is a simple process that is easy for students to use and understand. This process can be started at any point, move back and forth between steps, or repeat the cycle. Students are engaged in different activities at each point. Here is an overview of each step:

ASK: What is the problem?

RESEARCH: How have others approached it? What are your constraints?

IMAGINE: What are some solutions? Brainstorm ideas. Choose the best one.

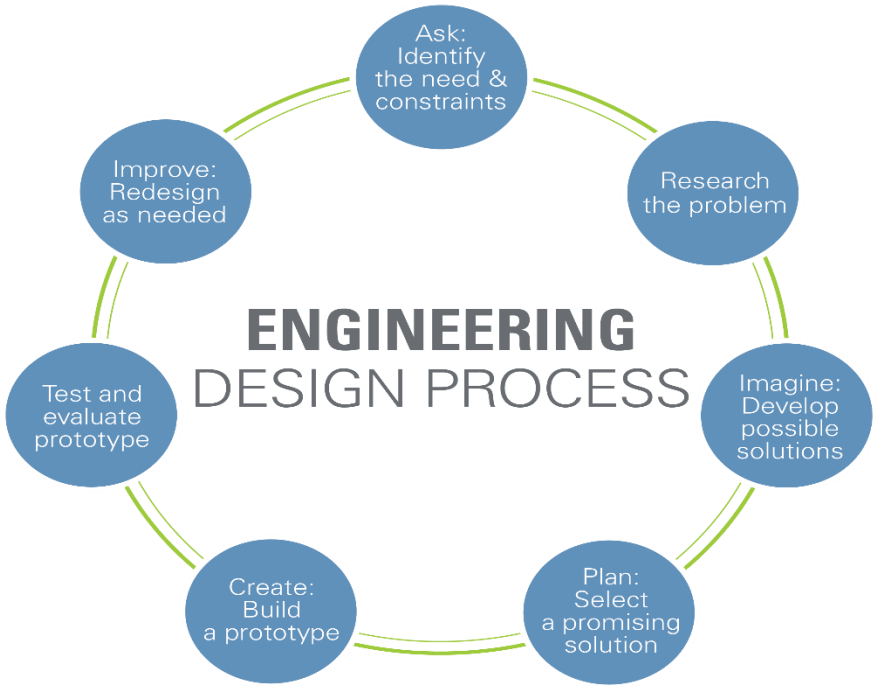
PLAN: Draw a diagram. Make lists of materials you will need.

CREATE: Follow your plan and create something.

TEST: Test it out! Try out the design solution and see if it works.

IMPROVE: What works? What doesn't? What could work better? Modify your design to make it better. Test it out!

Engineering Design Poster



Source:
https://www.teachengineering.org/EDPhandout&2posters_tedl_2015Sep.pdfhttps://www.teachengineering.org/EDPhandout&2posters_tedl_2015Sep.pdf

The 5E Model is an instructional model based on the constructivist model, which states that learners construct or build new ideas off of those they previously had. Each of the 5Es describes a phase of learning and can be used with any age student, including adults. The BSCS 5E Instructional Model lets you think about an integrated instructional unit. The lesson is your basic unit of instruction, but with the new Oklahoma Academic Standards for Science, the 5E Model allows you to translate your lessons into classroom instruction with a sequence of integrated instructional activities.

Figure 4.1. Purposes of the Phases in the BSCS 5E Instructional Model

ENGAGE
- Create interest and stimulate curiosity.
- Provide a meaningful context for learning.
- Raise questions for inquiry and science practices.
- Reveal students' current ideas and beliefs.

EXPLORE
- Provide experience of the phenomenon.
- Examine students' questions to test their ideas.
- Investigate questions and problems.

EXPLAIN
- Introduce concepts and practices that can be used to interpret data and construct explanations.
- Construct multimodal explanations and justify claims in terms based on evidence.
- Compare different explanations generated by students.
- Review current scientific explanations.

ELABORATE
- Use and apply concepts and explanations in new contexts.
- Reconstruct and extend explanations using different modes, such as written language, diagrammatic and graphic modes, and mathematics.

EVALUATE
- Provide an opportunity for students to review and reflect on their understanding and skills.
- Provide evidence for changes to students' understanding, beliefs, and skills.

Source: Adapted from AAS 2008.

Source: Bybee, Rodger W., author. The BSCS 5E Instructional Model : Creating Teachable Moments. Arlington, Virginia :NSTA Press, 2015.

Making Cross-Curricular Connections

Speaking and Listening

***Links to new ELA Standards coming soon**

Math

***Links to new Math Standards coming soon**

Literacy Connections

Unit 1 (Converting Energy) Day Light, Night Light By Franklyn M Bradley, Solar Power By Joseph Sherman, Light: From Sun to Bulbs By Christopher Cooper, Light and Sound By Dr. Mike Glodsmith, Flick a Switch: How Electricity Gets to Homes By Barbara Seuling

Unit 2 (Motion) - Forces: Science All Around Me by Karen Bryant-Mole, Forces and Motion: From Push to Shove by Christopher Cooper, Force and Motion: Laws of Movement by Don Nardo

Unit 3 (Organisms) Ducks Don't Get Wet. Augusta Goldin, Fish Faces. Norbert Wu. Henry Holt and Company, How Do Animals Adapt? Bobbie Kalman

Unit 4 (Information Transfer) Brainstorm! The Stories of Twenty American Kid Inventors. Tom Tucker

Unit 5 (Earth's Features) If You Find a Rock by Peggy Christian, Harcourt, 2000, Rachel: The Story of Rachel Carson by Amyh Ehrlich, Silver Whistle, 2003, The Top of the World: Climbing Mount Everest by Steve Jenkins, Houghton Mifflin, 1999,
Fossils Tell of Long Ago. Aliki

Unit 6 (Human-Environment Interactions) - Oil Spill! By Melvin Berger, Aliens from Earth: When Animals and Plants Invade Other Ecosystems. Mary Batten

Domain Comparison Chart

The Oklahoma Academic Standards (OAS) for Science are divided into 3 Domains. These are Physical Science, Earth and Space Science, and Life Science. These Domains are then further divided into 11 Disciplinary Core Ideas which progress throughout all grade levels. The chart below explains the vertical alignment of the Domains and DCIs for Kindergarten through Fifth Grade.

Domain	Earth And Space			Physical Science				Life Science			
DCI	ESS1	ESS2	ESS3	PS1	PS2	PS3	PS4	LS1	LS2	LS3	LS4
	Earth's Place in the Universe	Earth Systems	Earth and Human Activity	Matter and Its Interactions	Motion and Stability: Force and Interactions	Energy	Waves and Their Applications in Technologies for Information Transfer	From Molecules to Organisms: Structure and Processes	Ecosystems: Interactions, Energy, and Dynamics	Heredity: Inheritance and Variation of Traits	Biological Unity and Diversity
Kindergarten		K	K		K	K		K			
First Grade	1		1				1	1		1	
Second Grade	2	2		2					2		2
Third Grade		3	3		3			3	3	3	3
Fourth Grade	4	4	4			4	4	4			
Fifth Grade	5	5	5	5	5	5		5	5		

Fourth Grade Unit Scope and Sequence

Month	District Unit	Domain	Disciplinary Core Idea (DCI)	Focus Standard(s)	Unit Description
August-September	1	Physical Science	Converting Energy PLTW Module	4-PS3-2 4-PS3-4 4-PS4-1	In this unit, students will make observations and carry out simple investigations whereby they observe phenomenon that allow them to see that energy exists and is transferred within a system. Students will plan and carry out investigations on colliding objects and utilize their observations to begin to explain how energy works in that system. Students should be able to explain using models that energy can be transferred between objects. Students should also plan and carry out investigations on objects that product sound in order to determine a pattern that vibrations accompany sound.
October	2	Physical Science	Motion	4-PS3-1 4-PS3-3	In this unit, students will plan and conduct investigations to provide evidence that the speed of an object is related to the energy of that object. Students will observe objects moving at different speeds and colliding with stationary objects. As students observe the effects of the collisions they will likely begin to ask questions to consider why this is happening and what patterns they see emerge. Students should record their observations and construct an explanation, from observational evidence, that an object with a greater speed has more energy than an object with lesser speed. Finally, students should use a model to communicate that objects with greater energy transfer some of the energy to the object with lesser energy within the system and being to predict outcomes in the changes of speed and energy of objects after they collide.
November-December	3	Life Science	Organisms	4-LS1-1 4-LS1-2 4-LS4-2	In this unit, students will extend their understanding of the structure and function of animal parts to include animal senses as animal senses represent a behavior structure that guide animals and can help them survive. Students will investigate how senses like sight and touch work to collect information. They will create diagrams explaining their understanding of how that information might be transferred and the parts of the system that might be impacting this process.

January-February	**4**	**Physical Science**	**Information Transfer**	**4-PS4-3**	**In this unit, students will discuss different ways to send information to someone and identify patterns in that system. Students will also research digital inventions to discover how they work and should be able to determine that information can be transferred over long distances. Through this research, students should observe that information can be stored for future use and be able to generate a pattern to communicate information. Students could make and use a code for letters to communicate with each other.**
March	**5**	**Earth and Space Science**	**Earth's Features**	**4-ESS1-1** **4-ESS2-1** **4-ESS2-2**	**In this unit students will be given an opportunity to analyze rock formations in order to identify patterns which can be used as evidence to support explanations that Earth's landscapes (surface features) change over time. Students can use the location of fossils in rock layers relative to other rock layers to begin to explain when those rock layers were formed. Students should obtain, record, and interpret data related to the mechanisms that cause changes in land formations over time. Students should also plan and conduct simple investigations to explore the effects variables like wind speed, water movement, freezing and melting, and vegetation of areas have on landforms.**
April-May	**6**	**Earth and Space Science**	**Human Interactions**	**4-ESS3-1** **4-ESS3-2**	**In this unit, students will develop and use models to understand the relationships between the use of resources and the effects on the environment. Students should be able to use evidence to communicate the pros and cons of using different resources for energy. Students should also research and discuss possible solutions that could minimize the impact of these hazards on human life and be able to construct different possible solutions and compare the effectiveness of these solutions.**

OKLAHOMA ACADEMIC STANDARDS

SCIENCE

FRAMEWORK

Grade 4: OVERVIEW

OKLAHOMA STATE DEPARTMENT OF EDUCATION
CHAMPION EXCELLENCE

The Oklahoma State Department of Education is excited to announce the release of the first resources being offered through the Oklahoma Academic Standards Science Frameworks. The Science Frameworks represent curricular resources developed by Oklahoma teachers to help teachers translate standards into classroom practice. The *Framework Overviews* represent how a group of Oklahoma teachers, at a given grade level, might bundle performance expectations/standards found in the Oklahoma Academic Standards for Science.[1] **Bundling** is how teachers would **group performance expectations/standards** for the purpose of developing **instructional units of study.**

Once bundled, the *Science Framework* writers were then charged with completing **four categories of information** that coincided with the bundle of performance expectations/standards. The categories provide insight into how the Science Framework writers collaborated to begin to translate standards into classroom instruction. The guidance provided in the categories does **not** represent a **directive** to teachers, schools or districts for classroom instruction and should not be viewed as such.

The Oklahoma State Department of Education would like to say a special thank you to the Oklahoma educators who participated in developing the Oklahoma Science Framework Overviews and to Quentin Biddy, the project director.

Science Framework Writers

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> "The vision of the Overviews is to provide a resource for teachers that encourages them to embrace the new standards and implement them effectively in their classrooms. The suggestions provided by the frameworks project **do not** have to be implemented exactly as they are written and are **not required** to be a successful teacher, but **serve as a guide** to setting up effective lessons that will help students meet the necessary levels of success in a science classroom." - Oklahoma Science Framework Project Writer

[1] Download the Oklahoma Academic Standards for Science at http://sde.ok.gov/sde/science.

How To Read This Document

Below you will find short descriptions about each of the sections of information provided in this document. If you have questions regarding the *Framework Overviews*, please contact Tiffany Neill at 405-522-3524 or Tiffany.Neill@sde.ok.gov

Science Framework Overview: Sections

In Lay Terms

This section aims at providing a brief introduction to the goals outlined in the Performance Expectation Bundles/grouping of standards.

Three Dimensional Storyline

This section aims at providing a comprehensive instructional storyline of how the three dimensions represented in the Performance Expectation Bundles intertwine to support students engaging in science and engineering practices, crosscutting concepts and disciplinary core ideas. Keep in mind each performance expectation includes one **science and engineering practice**, one **crosscutting concept** and one **disciplinary core idea**. The **color-coding** in this section allows teachers to see where components of these three dimensions appear in the instructional storyline. To find out more about the three dimensions and how they are incorporated into the Oklahoma Academic Standards for Science, review pages 7-8 in the Oklahoma Academic Standards for Science[2] or check out the OKSci PD on Your Plan Module series, Transitioning to the Oklahoma Academic Standards for Science[3].

Lesson Level Performance Expectations

This section aims at providing **scaffolding three-dimensional learning targets** that teachers can design instruction around to meet the end goals of the Performance Expectation(s) represented in the bundles or units of study. Keep in mind the performance expectations represent the things students should know, understand and be able to do to show proficiency at the end of instruction they participate in. A teacher can **utilize** the **Lesson Level Performance Expectations** in each bundle **as a way to develop a series of instruction** to meet the end goals of the performance expectations. For example, a teacher can develop or use a lesson, which may allow students to participate in instruction that covers some of the Lesson Level Performance Expectations, but not all. In this case the teacher would then develop or conduct another lesson that covers other Lesson Level Performance Expectations in the bundle.

Misconceptions

This section aims at providing research-based misconceptions that students frequently have related to the science concepts (disciplinary core ideas) embedded in the Performance Expectation Bundles along with matching correct conceptions.

[2] Download the Oklahoma Academic Standards for Science at http://sde.ok.gov/sde/science.
[3] Access the OKSci PD on Your Plan Modules at: https://www.evernote.com/l/AUXXlQC11VZDeLmUkOMPpjhKeJjqS-R8gww

Bundle: Converting Energy

4-PS3-2
Students who demonstrate understanding can:
Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-4
Students who demonstrate understanding can:
Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
4-PS4-1
Students who demonstrate understanding can:
Develop a model of waves to describe patterns in terms of amplitude and wavelength and to show that waves can cause objects to move.

In Lay Terms

Energy can be observed in a variety of situations (motion of objects, transfer of sound, light, heat, electric currents, and motion of waves). By observing these different types of energy, we can see that energy is transferred and can be converted from one form to another. Through observations of waves we see patterns in wave amplitude and wavelength.

Three Dimensional Storyline

Energy can be observed all around us. Energy is present and can be observed through moving objects and through observing how sound, light, and heat are transmitted.

In this bundle of performance expectations, students can make observations and carry out simple investigations whereby they observe phenomenon that allow them to see that energy exists and is transferred within a system. Students can plan and carry out investigations on colliding objects and utilize their observations to begin to explain how energy works in that system. For example, when two basketballs are rolled directly at each other, the system includes the two basketballs, the push by the people rolling the basketballs and the air around the basketballs. Students should be able to explain using models that energy can be transferred between objects. Students can also plan and carry out investigations on objects that produce sound in order to determine a pattern that vibrations accompany sound. Investigations related to light, heat and electrical currents can add to the collection of observational data related to energy. If given the opportunity to explore energy in a variety of situations (motion, sound, light, heat, electrical currents), students should be able to explain how energy exists in each of those situations. Students should also be able to make connections among the situations and identify a pattern, that energy is transferred in each of those situations.

As students have observed that energy can be transferred between objects, they can observe that the transfer of energy involves waves, which have measurable features such as amplitude and wavelength. Students can observe and measure how waves move objects up and down or forward and backward. As students analyze the movement of waves, they can make a model of a wave. Through this model, students will see the patterns in amplitude and wavelengths of waves.

Lesson level Performance Expectations

- Students can make observations of objects that produce forms of energy (sound, light, heat, and electrical currents).
- Students can plan and carry out investigations to discover how energy is transferred by sound, light, heat and electrical currents.
- Students can provide evidence that energy can be transferred from one place to another.
- Students can create a model to explain transfer of energy using either sound, light, heat, or electrical currents.
- Students can apply scientific ideas to observations and show how energy can be converted from one form to another.
- Students can observe waves and the motion of an object on the wave.
- Students can observe patterns in waves as they travel in the amplitude and the wavelength of the waves.
- Students can make a model of a wave.
- Students can provide evidence that waves cause objects to move as they transfer energy to objects.

Misconceptions	Accurate Concept
1. Energy can be created.	1. Energy cannot be created or destroyed only transferred or converted from one form to another.
2. There is no relationship between matter and energy.	2. Energy can affect matter.
3. If energy is conserved, why are we running out of it?	3. Energy and fuel/energy sources are not the same.

References

- AAAS Science Assessment
  - (Kruger, 1990; Lovrude, 2004; Papadouris et al., 2008)
  - (AAAS Project 2061, n.d.)
- http://www.nsta.org/elementaryschool/connections/201209AppropriateTopics-ElementaryStudentScienceMisconceptions.pdf
- http://www.nsta.org/elementaryschool/connections/201209AppropriateTopics-ElementaryStudentScienceMisconceptions.pdf)

Bundle: Motion

4-PS3-1
Students who demonstrate understanding can:
Use evidence to construct an explanation relating the speed of an object to the energy of that object.

4-PS3-3
Students who demonstrate understanding can:
Ask questions and predict outcomes about the changes in energy that occur when objects collide.

In Lay Terms

The speed of an object is related to the energy it possess. Objects moving faster possess more energy than objects moving slower. The energy of objects when they collide with each other can be predicted.

Three Dimensional Storyline

In this bundle of performance expectations, students can plan and conduct investigations to provide evidence that the speed of an object is related to the energy of that object. To assist student in gathering this evidence, teachers can support students in observing objects moving at different speeds and colliding with stationary objects. As students observe the effects of the collisions, they will likely begin to ask questions or consider why this is happening and what patterns they see emerge. Students can be given an opportunities to answer these questions by being prompted to think about the *inputs* and *outputs* that are in the system the objects are in. For example, if a ball collides with another ball, something probably pushed at least one ball it get it moving in the first place. There was energy being transferred in the system from the person who pushed the ball, to the ball being pushed, then to the colliding ball. As students record their observations about colliding objects, they can attempt to develop a sketch model or a mental model about what is causing the colliding objects to move they way they do. Students can construct an explanation, from observational evidence, that an object with a greater speed has more energy than an object with lesser speed.

Students should make observations of different objects colliding. As students observe objects colliding, they should ask questions about their observations. Students should be able to explain that objects speed up or slow down after a collision. Students can use evidence to predict that the object with greater speed slow down after a collision, and the object with lesser speed move faster after a collision. Students can use a model to communicate that objects with greater energy transfer some of the energy to the object with lesser energy within the system. Students can begin to predict outcomes in the changes of speed and energy of objects after a collision.

Lesson Level Performance Expectations

- Students can make observations of objects moving at different speeds colliding with a stationary object.
- Students can plan and conduct investigations in order to record data about the effects of moving objects at different speeds when colliding with a stationary object.
- Students can analyze the data and construct an explanation relating the speed of an object to the energy of that object.
- Students can make observations of moving objects colliding with other moving objects of different speeds.
- Students can ask questions about the changes in speed they observe as objects collide.
- Students can record and analyze data of the changing speeds of moving objects after they collide.
- Students can interpret the data to understand that when objects collide energy is transferred from one object to another.
- Students can predict outcomes of the changes in energy that occur when objects collide.

Misconceptions

1. Energy is not transferred from one object to another unless those objects are in direct contact with each other.
2. An object has energy within it that is used up as the object moves.
3. A lighter object has more motion energy than a heavier object because lighter objects move faster than heavier objects.
4. The motion energy of an object depends on its size.
5. The motion energy of an object does not depend on speed (the motion energy of an object does not increase as the speed increases).

Accurate Concept

- Energy can be transferred between objects even at a distance.
- Energy is transferred between objects within a system. Energy cannot be created or destroyed.
- Lighter objects require less energy to move than heavy objects.
- The motion of an object is dependent on the amount of force applied to it.
- The motion energy (kinetic energy) of an object increases as it travels faster.

References

- AAAS Project 2061, n.d.
- Brook & Driver, 1984; Kesidou & Duit, 1993; Loverude, 2004; Stead, 1980
- Kruger, 1990

Bundle: Organisms

4-LS1-1
Students who demonstrate understanding can:
Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4-LS1-2
Students who demonstrate understanding can:
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.

4-PS4-2
Students who demonstrate understanding can:
Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

In Lay Terms

Plants have structures like thorns, stems, and roots, and animals have structures like heart, stomach and lungs that support survival, growth, behavior and reproduction.

Animals also have structures that aid them with receiving and processing information through their senses and responding to that information in different ways. One sense that aids animals in processing information is the sense of sight. Sight occurs when light reflects from objects and enters the eye, allowing the objects to be seen.

Three Dimensional Storyline

Plants and animals have many structures or parts that students can observe. When observing plants and animal parts students can also observe how plant or animal parts interact with things around them and begin to make claims for how those parts play a role in the ability of the organism to survive and grow. For example, thorns on a plant can prevent animals from eating the plant. Therefore the plant can better survive because it has thorns.

In this bundle of performance expectations, students can extend their understanding of the structure and function of animal parts to include animal senses as animal senses represent a behavior structure that guide animals' actions and can help them survive. As students investigate how senses like sight and touch work to collect information, they can create diagrams explaining their understanding of how that information might be transferred within an animal's body. Student diagrams should include the process of information transfer and the parts of the system that might be impacting this process. For example, the nervous system transfers information about pain from the nerves to the brain. **Keep in mind at this age students are**

not expected to understand detailed mechanisms by which the brain stores and recalls information or the detailed mechanisms for how sensory receptors function. Students can gather information about how plants can collect and transfer information leading to a response.

One sense that students can focus on in this bundle is sight. As students communicate their understanding about how information is collected, transferred and responded to by an organism, students can analyze the mechanisms involved in sight and develop a model to understand how this sense works in more detail. Students should be able to explain that light reflecting from objects enters into the eye causing sensory receptors in the eye to send signals to the brain that are interpreted as images resulting in the objects being seen. Students can collect observational data that leads them to this conclusion by examining a variety of objects in dark and light settings. If given a variety of opportunities to investigate how visible objects are in light and dark settings, students can draw conclusions that objects in the dark cannot be seen and that light is required for sight to occur. Students can then begin to make the claim that objects can be seen when light reflects from its surface and enters the eye. Students can display their understanding of this through model diagrams.

Lesson Level Performance Expectations

- . Students can identify internal and external structures of plants and animals.
- Students can construct an argument with supporting evidence that structures of plants and animals support their survival, growth, behavior, and reproduction.
- Students can illustrate with a model the information that animals receive through senses.
- Students can describe how information from senses are processed by organisms and cause a response from the organism.
- Students can use a model to describe different ways that animals respond to information they receive.
- Students can use a model to describe how animals are able to use their senses and memories to guide their actions.
- Students can use a model to describe how objects are seen by the eye when light reflects off of them.
- Students can use a model to describe how objects are not seen by the eye when light is not present to reflect off of objects.
- Students can construct an argument that sight aids organisms in survival, growth, behavior, and reproduction.

Misconceptions

1. Only shiny objects that I can see myself in reflect light.
2. Only metals and water reflect light.
3. Everything reflects light but only if it is in the Sun.
4. Light reflects off things if the angle is correct.
5. Our eyes produce light so we can see things.
6. Living objects can change to meet their survival needs.
7. The eye is the only organ for sight and the brain is only for thinking.

Accurate Concept

1-4. All objects reflect light to some degree.
5. Eyes only receive light input they do not produce light.
6. Traits are developed across generations in response to environmental demands.
7. The eye and the brain work together for vision to occur.

References

- http://www.nsta.org/elementaryschool/connections/201404Schleigh.pdf
- www.mechatronics-mec.org/.../revisedlist**misconceptions**9_08.doc
- www.weebly.com/.../common_**misconceptions**_in_primary_school

Bundle: Information Transfer

4-PS4-3

Students who demonstrate understanding can:

Generate and compare multiple solutions that use patterns to transfer information.

In Lay Terms

Throughout history, people have used many different means for communicating information. Today many different devices are used to transfer information from one person to another over long distances. We receive different forms of information through these different devices. Telescopes communicate information about the universe. Cell phones and computers help us transfer information to each other instantly or through stored information for use at a later time. These devices use patterns to transfer information.

Three Dimensional Storyline

. Communication can occur in many ways. At various times throughout history, different codes have been created and used to meet different needs, such as Morse code with telegraphs, QR code with smartphones, and binary code with computers. To explore this idea, students can discuss different ways to send information to someone and identify patterns in that system. For example, Zip Codes and Area Codes follow patterns and give information to people using them about where another person lives. Technology devices, such as computers, receive and decode information digitally to change a signal from data to voice and voice back to data. Students should be able to research digital inventions to discover how they work.

Through their research, students should determine that information can be transferred over long distances. Some examples might include, verbal communication is transferred through phones from state to state, written communication is transferred through computers using email, and visual communication is transferred through televisions and computers over long distances. Students should also observe that information can be stored for future use. Examples of this include, information transferred through computers can be stored in the computer and recovered at a later time, information transferred through the television can be stored for later viewer using a DVR, and information transferred through a cell phone can be recorded on the phone through the voice recorder or text messages as well as email. Students should be able to generate a pattern to communicate information. Students could make and use a code for letters to communicate with each other.

Lesson Level Performance Expectations

- Students can evaluate and compare different communication methods.
- Students can analyze data to understand how information is transmitted over long distances in one form and converted by a device to be used by people.
- Students can develop a model to explain how computers or cell phones, can receive and decode information.
- Students can use evidence to explain how communication devices transmit data.
- Students can generate a pattern that could communicate information.

Misconceptions

1. All waves travel the same way.
2. Sounds can be produced without material objects.
3. In telephones, sounds are carried through the wires.
4. Waves involve the movement of matter.

Accurate Concept

1. Waves can vary.
2. For sound to be produced, vibrations must be produced by matter. Sound requires a medium to travel through.
3. Phones convert sounds to electrical signals and back to sounds.
4. Waves transfer energy.

References

- http://www.usc.edu/org/cosee-west/Dec0410/wave_misconceptions.pdf
- http://www.physicsclassroom.com/mop/m12/sl1details.cfm

Bundle: Earth's Features

4-ESS1-1

Students who demonstrate understanding can:

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

4-ESS2-1

Students who demonstrate understanding can:

Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.

4-ESS2-2

Students who demonstrate understanding can:

Analyze and interpret data from maps to describe patterns of Earth's features.

In Lay Terms

Earth's surface features have changed and continue to change over time. Water, ice, wind, and vegetation can affect the how fast weathering and erosion occur. As rocks and land formations erode, we are able to see into the rock formations, which helps explain how the landscape had changed over time. Rock formations can be examined to identify patterns in rock layers and fossils found in those rock layers. By looking at maps and identifying changes in the landscape from these maps, students should identify patterns.

Three Dimensional Storyline

In this bundle of performance expectations, students should be given the opportunity to analyze rock formations in order to identify patterns which can be used as evidence to support explanations that Earth's landscapes (surface features) change over time. Students can use the location of fossils in rock layers relative to other rock layers to begin to explain when those rock layers were formed. For example, if students see a layer of shell fossils above a layer of plant fossils, the student can use this evidence to create an explanation that the area where this rock formation was found was land at one time and was then covered with water for a period of time.

This bundle allows students to obtain, record, and interpret data related to the mechanisms that cause changes in land formations over time. Teachers can support students in setting up a variety of investigations that allow them to collect data showcasing the factors that cause weathering and erosion to occur. Through this, students can identify the effects water, ice, wind, living organisms and vegetation might have on landforms. Students can also plan and conduct simple investigations to explore the effects variables like wind speed, water movement, freezing and melting, and vegetation of areas have on landforms. For example, the teacher could use a container of soil with and without vegetation to help students tests these variables. When students understand that landforms change over time and the factors that cause those changes, it can facilitate natural connections to allow students to analyze patterns of Earth's features in order to construct explanations about how Earth's surface has changed over time.

The locations of mountain ranges, deep ocean trenches, earthquakes and volcanoes occur in patterns. Students should be given the opportunity to interpret and evaluate maps to determine and analyze these patterns. Students will interpret maps to determine where earthquakes, volcanoes, mountain chains, and other land and water features occur on Earth. As students locate these earth features they can support an explanation that those features caused the changes in the earth in the different areas.

Lesson Level Performance Expectations

- Students can analyze data to determine that patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.
- Students can use evidence to explain that the presence and location of certain fossil types indicate the order in which rock layers were formed.
- Students can collect data to explain that natural occurrences such as rain, wind, ice, and gravity etc. break rocks, soils, and sediments into smaller pieces.
- Students can develop and use a model to show that rain, wind, ice, and gravity move rocks, soils, and sediments around from place to place on Earth's surface.
- Students can conduct investigations that show rainfall, wind, or gravity helps to shape the land and affects the types of living things found in a region.
- Students can analyze data found in maps to determine that the locations of landforms such as mountain ranges, ocean floor structures, and volcanoes occur in patterns.
- Students can analyze and interpret data to determine that most earthquakes and volcanoes often occur along the boundaries between continents and oceans.
- Students can use information from maps to develop a model that shows that mountain chains normally form inside continents or near the edges of continents.
- Students can obtain and evaluate information from maps to help locate the different land and water features of Earth.

Misconceptions

1. Wind and water cannot wear away the solid rock of a mountain.
2. Landforms can change in size, but not by the motion of wind and water.
3. Landforms look similar today as they did many millions of years ago. For example, a river on earth today hasn't changed over time.
4. Wind can wear away the solid rock of mountains only a small amount (feet or inches) over millions of years, not thousands of feet.
5. Wind can make a valley deeper by only a small amount (feet or inches) over millions of years.
6. Water can wear away only a small amount of a mountain's height (feet or inches) over millions of years.
7. It takes rain a long time to wear away solid rock, even very small amounts that you cannot see.
8. Water can wear down the solid rock of a river valley only a small amount (feet or inches) over millions of years.
9. Wind can only wear down solid rock over long time periods. Changes are not happening over short time periods (i.e., a day or a year).
10. Moving water can only wear down solid rock over long time periods. Changes are not happening over short time periods (i.e., a day or a year).
11. Moving water can only change the surface of the earth over long time periods. Changes are not happening over short time periods (i.e., a day or a year).
12. Wind is wearing away the solid rock of valleys today but did not wear away the solid rock of valleys in the past.

Accurate Concept

1-8. The surface of the earth is changed as rock material is broken, carried, and dropped in new locations. Small changes to the surface of the earth caused by wind and water can add up to large changes over long periods of time (i.e., over thousands to millions of years).

13. Wind wore away the solid rock of valleys in the past but is not wearing away the solid rock of valleys today.
14. Wind and water only change the surface of the earth during rare events, such as huge storms.
15. It only takes hundreds of years for wind and water to wear away the solid rock of a mountain (bedrock) so that the mountain is almost flat.

References

- **AAAS Science Assessment**
  - AAAS Project 2061, n.d.
  - Dove, 1998; Trend, 1998

Bundle: Human Environment Interactions

4-ESS3-1

Students who demonstrate understanding can:

Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their uses affect the environment.

4-ESS3-2

Students who demonstrate understanding can:

Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

In Lay Terms

All of the energy and fuels that humans use come from natural resources. Some of these resources are renewable and can be used over or can be replaced, while other resources are non-renewable and are limited and cannot be replaced or reused. When humans use resources they in turn affect the environment in different ways. Just as humans can affect the Earth by using resources, the Earth can affect human life through natural disasters. Humans can use natural resources to take steps to reduce the impacts that natural disaster can have on humans.

Three Dimensional Storyline

Earth is composed of many different sources of energy. Some of these sources are renewable, such as wind and sunlight (solar) and some are non-renewable, such as natural gas, coal, and oil. Some resources, like trees, are renewable, but can sometimes be used faster than they can be replaced. Using these resources affects the environment in many different ways, both positive ways and negative ways. For example, burning fossil fuels pollutes the atmosphere, while using renewable resources can reduce the amount fossil fuels are used and result in less pollutants entering the atmosphere. Students should obtain and evaluate information about different resources available and how using those resources can affect the environment. Students should develop and use models to understand the relationships between the use of resources and the effects on the environment. Students should be able to use evidence to communicate the pros and cons of using different resources for energy.

Just as humans impact the Earth by using resources, the Earth also impacts human life. Natural disasters such as hurricanes and tornadoes can have a tremendous effect on human life; however, humans can design solutions to reduce the impact these natural disasters have on humans and human societies. Students should research and discuss possible solutions that could minimize the impact of these hazards on human life. Students should be able to construct different possible solutions and compare the effectiveness of these solutions.

Lesson Level Performance Expectations

- Students can use a model to explain that energy and fuel are derived from natural resources.
- Students can distinguish between renewable and non-renewable resources.
- Students can use evidence to explain what renewable and non-renewable resources.
- Students can explain that using natural resources can affect the environment in different ways.
- Students can construct an argument for the use of both renewable and non-renewable resources.
- Students can explain using evidence how Earth processes, such as natural disasters, impact humans.
- Students can explore ways to minimize the impact to humans by Earth processes.
- Students can construct and compare the effectiveness of multiple solutions designed to reduce the impact of natural Earth processes on humans.

Misconceptions

1. Ecosystems change little over time.
2. Except for a few major changes due to large volcanoes that have erupted or meteorites that have struck the earth, environmental conditions have stayed the same throughout the history of the earth.
3. If we run out of oil and gas we will just find more.
4. Earth's resources are not finite-there is an endless supply of water, petroleum, and mineral resources. All we have to do is explore for them.

Accurate Concept

1. Ecosystems change as a result of natural hazards, environmental changes, and human activity.
2. Environmental conditions are dynamic and have changed over the course of Earth's history.
3. Fossil fuels are a limited and finite resource.
4. Some of Earth's resources are renewable, however most are non-renewable and finite or cannot be renewed at the rate they are being consumes.

References

- http://beyondpenguins.ehe.osu.edu/issue/tundra-life-in-the-polar-extremes/common-misconceptions-about-biomes-and-ecosystems
- AAAS Science Assessment; AAAS Project 2061, n.d. http://hub.mspnet.org/media/data/MiTEP_List_of_Common_Geoscience_Misconceptions.pdf?media_000000007297.pdf

Resource Guide

Teacher Resources

Professional Development Resources

Content Refresher Energy: There are two basic categories of energy: potential energy and kinetic energy. Potential energy is the energy of position. Kinetic energy is the energy of motion. Many other forms of energy, such as light energy, sound energy, and electrical energy, are forms of potential and/or kinetic energy. For example, chemical energy is potential energy that is stored in the chemical bonds that hold compounds together. Chemical energy is released when glow sticks are bent.

Video: Science in Focus: Energy

Content Refresher-Motion: • A change of position is called motion. • A change in motion means starting or stopping, speeding up or slowing down, or moving in a different direction. • Speed is a change in position over a period of time.

Content Refresher-Earth & Space: Star patterns appear to translate (slide) across the sky nightly (and from season to season) without changing their shape or distance from one another. • Students need to differentiate between the motion of rotation (the spinning of a planet or moon on its axis) and revolution (one complete trip of a planet around the sun).

Student Resources

Scholastic Study Jams: Motion

Scholastic Study Jams: Rocks/Minerals

Vocabulary

Energy	Light	Sound	Wavelength	Heat	Pitch
Frequency	Amplitude	Speed	Motion	Force	Minerals
Rocks	Soil	Classify	Sedimentary	Igneous	metamorphic
Mohr's Hardness Scale	Weathering	Erosion	ecosystem	Survive	Grow
Structure	Digital inventions	Information transfer			

Vertical Alignment

Earth and Space Science-Third Grade

3-ESS2-1 Students who demonstrate understanding can: **Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.**	**3-ESS2-2** Students who demonstrate understanding can: **Obtain and combine information to describe climates in different regions of the world.**
3-ESS3-1 Students who demonstrate understanding can: **Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.**	

Physical Science-Third Grade

3-PS2-1 Students who demonstrate understanding can: **Plan and conduct investigations on the effects of balanced and unbalanced forces on the motion of an object.**	**3-PS2-2** Students who demonstrate understanding can: **Make observations and/or measurements of the object's motion to provide evidence that a pattern can be used to predict future motion.**
3-PS2-3 Students who demonstrate understanding can: **Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.**	**3-PS2-4** Students who demonstrate understanding can: **Define a simple design problem that can be solved by applying scientific ideas about magnets.**

Life Science-Third Grade

3-LS1-1 *Students who demonstrate understanding can*: **Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction and death.**	**3-LS2-1** Students who demonstrate understanding can: **Construct an argument that some animals form groups that help members survive.**
3-LS3-1 *Students who demonstrate understanding can:* **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.**	**3-LS3-2** *Students who demonstrate understanding can:* **Use evidence to support the explanation that traits can be influenced by the environments.**
3-LS4-1 Students who demonstrate understanding: **Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.**	**3-LS4-2** Students who demonstrate understanding can: **Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving and reproducing.**
3-LS4-3 Students who demonstrate understanding can: **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.**	**3-LS4-4** Students who demonstrate understanding can: **Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.**

Earth and Space Science-Fifth Grade

5-ESS1-1 Students who demonstrate understanding can: **Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.**	**5-ESS1-2** Students who demonstrate understanding can: **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.**
5-ESS2-1 Students who demonstrate understanding can: **Develop a model to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.**	5-ESS2-2 Students who demonstrate understanding can: **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.**
5-ESS3-1 *Students who demonstrate understanding can:* **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.**	

Physical Science-Fifth Grade

5-PS1-1 *Students who demonstrate understanding can:* **Develop a model to describe that matter is made of particles too small to be seen.**	**5-PS1-2** *Students who demonstrate understanding can:* **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.**
5-PS1-3 Students who demonstrate understanding can: **Make observations and measurements to identify materials based on their properties.**	5-PS1-4 Students who demonstrate understanding can: **Conduct an investigation to determine whether the mixing of two or more substances results in new substances.**
5-PS2-1 Students who demonstrate understanding can: **Support an argument that the gravitational force exerted by the Earth is directed down.**	**5-PS3-1** *Students who demonstrate understanding can:* **Use models to describe that energy in animal's food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.**

Life Science-Fifth Grade

5-LS1-1 *Students who demonstrate understanding can:* **Support an argument that plants get the materials they need for growth chiefly from air and water.**	**5-LS2-1** *Students who demonstrate understanding can:* **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.**
5-LS2-2 *Students who demonstrate understanding can:* **Use models to explain factors that upset stability of local ecosystems.**	