



# ARKANSAS

## K-12 SCIENCE STANDARDS

EDUCATION FOR A NEW GENERATION

**Grades 5-8**

**Learning Progressions and Standards Overviews**

**2015**

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**Grade 5 Learning Progression by Topic**

Grade 5			
EARTH and SPACE SCIENCES	PHYSICAL SCIENCES		LIFE SCIENCES
Earth's Systems	Space Systems	Structure and Properties of Matter	Matter and Energy in Organisms and Ecosystems
5-ESS2-1	5-PS2-1	5-PS1-1	5-PS3-1
5-ESS2-2	5-ESS1-1	5-PS 1-2 <b>AR</b>	5-LS1-1
5-ESS3-1	5-ESS1-2	5-PS1-3	5-LS2-1
		5-PS1-4 <b>AR</b>	
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 5-ETS1-1, 5-ETS1-2, 5-ETS1-3			

Arkansas Clarification Statement/Assessment Boundary (**AR**)

**Grade 5 Learning Progression by Disciplinary Core Idea**

Grade 5							
EARTH and SPACE SCIENCES			PHYSICAL SCIENCES			LIFE SCIENCES	
Earth's Place in the Universe	Earth's Systems	Earth and Human Activity	Matter and its Interactions	Motion and Stability: Forces and Interactions	Energy	From Molecules to Organisms: Structures and Processes	Ecosystems: Interactions, Energy, and Dynamics
5-ESS1-1	5-ESS2-1	5-ESS3-1	5-PS1-1	5-PS2-1	5-PS3-1	5-LS1-1	5-LS2-1
5-ESS1-2	5-ESS2-2		5-PS1-2AR				
			5-PS1-3				
			5-PS1-4AR				
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 5-ETS1-1, 5-ETS1-2, 5-ETS1-3							

Arkansas Clarification Statement/Assessment Boundary (AR)

## **Grade Five Standards Overview**

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

### **Science and Engineering Practices**

Students are expected to demonstrate grade-appropriate proficiency in

- developing and using models,
- planning and carrying out investigations,
- analyzing and interpreting data,
- using mathematics and computational thinking,
- engaging in argument from evidence, and
- obtaining, evaluating, and communicating information.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

### **Crosscutting Concepts**

Students are expected to demonstrate grade-appropriate understanding of

- patterns,
- cause and effect,
- scale, proportion, and quantity,
- energy and matter,
- systems and systems models, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

### **Disciplinary Core Ideas**

Students are expected to continually build on and revise their knowledge of

- PS1 - Matter and Its Interactions,
- PS2 - Motion and Stability: Forces and Interactions,
- PS3 - Energy,
- LS1 - Molecules to Organisms: Structures and Processes,
- LS2 - Ecosystems: Interactions, Energy, and Dynamics,
- ESS1 - Earth's Place in the Universe,
- ESS2 - Earth's Systems,
- ESS3 - Earth and Human Activity, and
- ETS1- Engineering Design in a 3-5 developmental learning progression.

### **Physical Sciences (PS)**

The (PS) performance expectations in fifth grade help students formulate answers to the questions, “Can new substances be created by combining other substances?” and “When matter changes, does its weight change?” Fifth grade students are expected to be able to describe that matter is made of particles too small to be seen through the development of a model. Students determine whether the mixing of two or more substances results in new substances. Students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved.

### **Life Sciences (LS)**

The (LS) performance expectations in fifth grade help students explore the questions, “Where does the energy in food come from?” and “What is it used for?” Students develop an understanding of the idea that plants get the materials they need for growth chiefly from air and water. Using models, students can describe the movement of matter among plants, animals, decomposers, and the environment and that energy in animals’ food was once energy from the sun.

### **Earth and Space Sciences (ESS)**

The (ESS) performance expectations in fifth grade help students investigate the questions, “How much water can be found in different places on Earth?”, “How does matter cycle through ecosystems?”, and “How do lengths and directions of shadows or relative lengths of day and night change from day to day, and how does the appearance of some stars change in different seasons?” Students are expected to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. Through the development of a model, fifth grade students describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. Students describe and graph data to provide evidence about the distribution of water on Earth.

### **Engineering, Technology, and Applications of Science (ETS)**

Engineering design performance expectations in the earliest grades introduce students to problems as situations that people want to change. With increased maturity students in third through fifth grade are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems** involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits. In this grade range the additional step of specifying criteria and constraints.
- **Designing solutions to engineering problems** begins with generating a number of different possible solutions, and then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem. In this grade range students generate several alternative solutions and compare them systematically to see which best meet the criteria and constraints of the problem.
- **Optimizing the engineering design** involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important. In this grade range students build and test models or prototypes using controlled experiments in which only one variable is changed from trial to trial while all other variables are kept the same.

By the end of fifth grade students should be able to achieve all three performance expectations (5-ETS1-1, 5-ETS1-2, 5-ETS1-3) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve simple problems, use visual or physical representations to convey solutions, and compare different solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

**Grade 6 Learning Progression by Topic**

Grade 6					
PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES		
Energy	Structure, Function, and Information Processing	Growth, Development, and Reproduction of Organisms	Earth's Systems	Human Impacts	Weather and Climate
6-PS3-3 <sup>AR</sup>	6-LS1-1	6-LS1-4	6-ESS2-4	6-ESS3-3	6-ESS2-5
6-PS3-4	6-LS1-2	6-LS1-5		6-ESS3-4	6-ESS2-6
6-PS3-5 <sup>AR</sup>	6-LS1-3	6-LS3-2			6-ESS3-5
	6-LS1-8				
<p align="center">ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE                      Engineering Design                      6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4</p>					

Arkansas Clarification Statement (<sup>AR</sup>)

**Grade 6 Learning Progression by Disciplinary Core Idea**

Grade 6				
PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES	
Energy	From Molecules to Organisms: Structures and Processes	Heredity: Inheritance and Variation of Traits	Earth's Systems	Earth and Human Activity
6-PS3-3	6-LS1-1	6-LS3-2	6-ESS2-4	6-ESS3-3
6-PS3-4	6-LS1-2		6-ESS2-5	6-ESS3-4
6-PS3-5 <b>AR</b>	6-LS1-3		6-ESS2-6	6-ESS3-5
	6-LS1-4			
	6-LS1-5			
	6-LS1-8			
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4				

Arkansas Clarification Statement (**AR**)

## **Grade Six Standards Overview**

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

### **Science and Engineering Practices**

Students are expected to demonstrate grade-appropriate proficiency in

- analyzing and interpreting data,
- developing and using models,
- constructing explanations and designing solutions,
- engaging in argument from evidence,
- obtaining, evaluating, and communicating information,
- using mathematics and computational thinking, and
- planning and carrying out investigations.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

### **Crosscutting Concepts**

Students are expected to demonstrate grade-appropriate understanding of

- cause and effect,
- scale, proportion and quantity,
- structure and function,
- systems and system models,
- stability and change,
- patterns, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

### **Disciplinary Core Ideas**

Students are expected to continually build on and revise their knowledge of

- PS3- Energy,
- LS1- Molecules to Organisms: Structures and Processes,
- LS3- Heredity: Inheritance and Variation of Traits,
- ESS2- Earth's Systems,
- ESS3- Earth and Human Activity, and
- ETS1- Engineering Design in a 6-8 developmental learning progression.

### **Physical Sciences (PS)**

The (PS) performance expectations in sixth grade help students formulate answers to the question, "How can energy be transferred from one object or system to another?" Students are expected to develop understanding of energy and energy transfer.

### **Life Sciences (LS)**

The (LS) performance expectations in sixth grade help students explore the questions, "How do the structures of organisms contribute to life's functions?", "How can one explain the ways cells contribute to the function of living organisms?", and "How do organisms grow, develop, and reproduce?" Students are expected to develop understanding of structure, function, and information processing as well as growth, development, and reproduction.

### **Earth and Space Sciences (ESS)**

The (ESS) performance expectations help students investigate the questions, "How is water cycled on Earth?", "How have human activity of land, energy, and water resources impacted Earth's systems?", and "How are complex weather systems related to the sun's energy and the force of gravity?" Students are expected to develop understanding of Earth systems, weather and climate, and consequences of human activity.

### **Engineering, Technology, and Applications of Science (ETS)**

Engineering design performance expectations in middle school continue to engage students in numerous design experiences. The goal at this level is to define problems more precisely, conduct a more thorough process for choosing the best solution, and optimize the final design.

Students are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems with precision** involves thinking more deeply than is expected in the earlier grades about the needs a problem is intended to address or the goals a design is intended to reach. Students now are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.
- **Designing solutions to engineering problems is a two stage process** in middle school of evaluating the different ideas that have been proposed by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions. Then designers combine the best ideas into a new solution that may be better than any of the preliminary ideas.
- **Optimizing the engineering design** involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle multiple times in order to reach the best possible result.

In the sixth grade students begin to develop the ability to achieve all four performance expectations (6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve problems, use visual or physical representations to convey solutions, and optimize solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

**Grade 7 Learning Progression by Topic**

Grade 7						
PHISICAL SCIENCES		LIFE SCIENCES		EARTH and SPACES SCIENCES		
Structures and Properties of Matter	Chemical Reactions	Interdependent Relationships in Ecosystems	Matter and Energy in Organisms and Ecosystems	Earth's Systems	History of Earth	Human Impacts
7-PS1-1	7-PS1-2 <sup>AR</sup>	7-LS2-2	7-LS1-6	7-ESS2-1 <sup>AR</sup>	7-ESS2-2	7-ESS3-2
7-PS1-3	7-PS1-5	7-LS2-5	7-LS1-7	7-ESS3-1	7-ESS2-3	
7-PS1-4	7-PS1-6 <sup>AR</sup>		7-LS2-1			
			7-LS2-3			
			7-LS2-4			
<b>ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE</b> Engineering Design 7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4						

Arkansas Clarification Statement (<sup>AR</sup>)

**Grade 7 Learning Progression by Disciplinary Core Idea**

Grade 7				
PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES	
Matter and Its Interactions	From Molecules to Organisms: Structures and Processes	Ecosystems: Interactions, Energy, and Dynamics	Earth's Systems	Earth and Human Activity
7-PS1-1	7-LS1-6	7-LS2-1	7-ESS2-1 <b>AR</b>	7-ESS3-1
7-PS1-2 <b>AR</b>	7-LS1-7	7-LS2-2	7-ESS2-2	7-ESS3-2
7-PS1-3		7-LS2-3	7-ESS2-3	
7-PS1-4		7-LS2-4		
7-PS1-5		7-LS2-5		
7-PS1-6 <b>AR</b>				
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4				

Arkansas Clarification Statement (**AR**)

## **Grade Seven Standards Overview**

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

### **Science and Engineering Practices**

Students are expected to demonstrate grade-appropriate proficiency in

- analyzing and interpreting data,
- developing and using models,
- constructing explanations and designing solutions,
- engaging in argument from evidence,
- obtaining, evaluating, and communicating information,
- using mathematics and computational thinking, and
- planning and carrying out investigations.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

### **Crosscutting Concepts**

Students are expected to demonstrate grade-appropriate understanding of

- cause and effect,
- scale, proportion and quantity,
- structure and function,
- systems and system models,
- stability and change,
- patterns, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

### **Disciplinary Core Ideas**

Students are expected to continually build on and revise their knowledge of

- PS1 - Matter and Its Interactions,
- LS1 - Molecules to Organisms: Structures and Processes,
- LS2 - Ecosystems: Interactions, Energy, and Dynamics,
- ESS2 - Earth's Systems,
- ESS3 - Earth and Human Activity, and
- ETS1 - Engineering Design in a 6-8 developmental learning progression.

### **Physical Sciences (PS)**

The (PS) performance expectations in seventh grade help students formulate answers to the questions, “How can particles combine to produce substances with different properties?”, “What stays the same and what changes in a chemical reaction?”, and “What happens when new materials are formed?” Students are expected to develop understanding of the structures and properties of matter and chemical reactions.

### **Life Sciences (LS)**

The (LS) performance expectations in seventh grade help students explore the questions, “How does matter and energy move through an ecosystem?” and “How do organisms interact with other organisms in the physical environment to obtain energy?” Students are expected to develop understanding of interdependent relationships in ecosystems and matter and energy in organisms and ecosystems.

### **Earth and Space Sciences (ESS)**

The (ESS) performance expectations in seventh grade help students investigate the questions, “How has Earth developed and changed over time?”, and “How have humans been able to forecast catastrophic events and mitigate their effects?” Students are expected to develop understanding of Earth systems, history of the Earth, and human impacts.

### Engineering, Technology, and Applications of Science (ETS)

Engineering design performance expectations in middle school continue to engage students in numerous design experiences. The goal at this level is to define problems more precisely, conduct a more thorough process for choosing the best solution, and optimize the final design. Students are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems with precision** involves thinking more deeply than is expected in the earlier grades about the needs a problem is intended to address or the goals a design is intended to reach. Students now are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.
- **Designing solutions to engineering problems is a two stage process** in middle school of evaluating the different ideas that have been proposed by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions. Then designers combine the best ideas into a new solution that may be better than any of the preliminary ideas.
- **Optimizing the engineering design** involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle multiple times in order to reach the best possible result.

In the seventh grade students are still developing the ability to achieve all four performance expectations (7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve problems, use visual or physical representations to convey solutions, and optimize solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

**Grade 8 Learning Progression by Topic**

Grade 8						
PHYSICAL SCIENCES			EARTH and SPACE SCIENCES		LIFE SCIENCES	
Waves and Electromagnetic Radiation	Forces and Interactions	Energy	Space Systems	History of Earth	Growth, Development, and Reproduction of Organisms	Natural Selection and Adaptations
8-PS4-1	8-PS2-1	8-PS3-1 <b>AR</b>	8-ESS1-1	8-ESS1-4	8-LS3-1	8-LS4-1
8-PS4-2	8-PS2-2	8-PS3-2	8-ESS1-2		8-LS4-5	8-LS4-2
8-PS4-3	8-PS2-3		8-ESS1-3			8-LS4-3
	8-PS2-4					8-LS4-4
	8-PS2-5					8-LS4-6
<b>ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE</b> Engineering Design 8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4						

Arkansas Clarification Statement (**AR**)

**Grade 8 Learning Progression by Disciplinary Core Idea**

Grade 8					
PHYSICAL SCIENCES			EARTH and SPACE SCIENCES	LIFE SCIENCES	
Waves and Their Applications in Technologies for Information Transfer	Motion and Stability: Forces and Interactions	Energy	Earth's Place in the Universe	Heredity: Inheritance and Variation of Traits	Natural Selection and Adaptations
8-PS4-1	8-PS2-1	8-PS3-1	8-ESS1-1	8-LS3-1	8-LS4-1
8-PS4-2	8-PS2-2	8-PS3-2	8-ESS1-2		8-LS4-2
8-PS4-3	8-PS2-3		8-ESS1-3		8-LS4-3
	8-PS2-4		8-ESS1-4		8-LS4-4
	8-PS2-5				8-LS4-5
					8-LS4-6
<b>ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE</b> Engineering Design 8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4					

## **Grade Eight Standards Overview**

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

### **Science and Engineering Practices**

Students are expected to demonstrate grade-appropriate proficiency in

- analyzing and interpreting data,
- developing and using models,
- constructing explanations and designing solutions,
- engaging in argument from evidence,
- obtaining, evaluating, and communicating information,
- using mathematics and computational thinking, and
- planning and carrying out investigations.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

### **Crosscutting Concepts**

Students are expected to demonstrate grade-appropriate understanding of

- cause and effect,
- scale, proportion and quantity,
- structure and function,
- systems and system models,
- stability and change,
- patterns, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

### **Disciplinary Core Ideas**

Students are expected to continually build on and revise their knowledge of

- PS2 - Motion and Stability: Forces and Interactions,
- PS3 - Energy,
- PS4 - Waves and Their Applications in Technologies for Information Transfer,
- LS3 - Heredity: Inheritance and Variation of Traits,
- LS4 - Biological Evolution: Unity and Diversity,
- ESS1 - Earth's Place in the Universe,
- ESS3 - Earth and Human Activity, and
- ETS1 - Engineering Design in a 6-8 developmental learning progression.

### **Physical Sciences (PS)**

The (PS) performance expectations in eighth grade help students formulate answers to the questions, “What are the characteristic properties of waves and how can they be used?”, “How can Newton’s Third Law of Motion be used to explain the movement of objects?”, “How can one describe interactions between objects and within systems of objects?”, and “How can the total change of energy in any system be equal to the total energy transferred into or out of the system?” Students are expected to develop understanding of waves and electromagnetic radiation, forces and interactions, and energy.

### **Life Sciences (LS)**

The (LS) performance expectations in eighth grade help students explore the questions, “How does genetic variation among organisms in a species affect survival and reproduction?”, “What are the ethical responsibilities related to selective breeding?”, and “How does the environment influence genetic traits in populations over multiple generations?” Students are expected to develop understanding of natural selection and adaptation, and growth, development, and reproduction.

### **Earth and Space Science (ESS)**

The (ESS) performance expectations in eighth grade help students investigate the questions, “How have instruments and technology allowed us to explore objects in the solar system and obtain data to support the theories of the origin and evolution of the universe?” and “How can models be used to explain cyclic patterns of eclipses, tides, and seasons?” Students are expected to develop understanding of space systems, history of Earth, and human impacts.

### Engineering, Technology, and Applications of Science (ETS)

Engineering design performance expectations in middle school continue to engage students in numerous design experiences. The goal at this level is to define problems more precisely, conduct a more thorough process for choosing the best solution, and optimize the final design. Students are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems with precision** involves thinking more deeply than is expected in the earlier grades about the needs a problem is intended to address or the goals a design is intended to reach. Students now are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.
- **Designing solutions to engineering problems is a two stage process** in middle school of evaluating the different ideas that have been proposed by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions. Then designers combine the best ideas into a new solution that may be better than any of the preliminary ideas.
- **Optimizing the engineering design** involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle multiple times in order to reach the best possible result.

By the end of the eighth grade students should be able to achieve all four performance expectations (8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve problems, use visual or physical representations to convey solutions, and optimize solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

#### Reference:

NGSS Lead States, (2013). *Next Generation Science Standards: For States, By States*. Washington, D.C.: The National Academies Press.