Audubon Public Schools

Grade 6: Earth and Space Science

Curriculum Guide

Developed by:

Ms. Natalie Busarello

Mr. Christine Fox

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Course Description

Grade 6: Earth and Space Science

This course covers the Earth and Space science standards for middle school. The course is broken into three units: Earth's place in the universe, Earth’s systems, and Earth & Human Impact. The topics progress from the universe and solar system as a whole to the cycling of Earth’s materials and energy in both weather and geologic processes before exploring human impact on Earth’s systems.

Overview / Progressions

Grade 6: Earth and Space Science

Overview		Earth and Space Sciences	Life Sciences	Physical Sciences
Space Science	**Focus standards (Objectives)**	MS-ESS1-1 MS-ESS1-2 MS-ESS1-3 MS-ESS1-4 MS-ESS2-2 MS-ESS2-3 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	N/A	N/A
Earth Systems	**Focus standards (Objectives)**	MS-ESS2-1 MS-ESS2-4 MS-ESS3-1 MS-ESS2-5 MS-ESS2-6 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	N/A	N/A
Weather and Human Impact	**Focus standards (Objectives)**	MS-ESS3-1 MS-ESS3-2 MS-ESS3-3 MS-ESS3-4 MS-ESS3-5	N/A	N/A

		MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4		

Earth and Space Science	Grade 6	Unit 1 - Earth's Place in the Universe	Trimester 1

<table>
<tr><td colspan="2">Earth and Space Science Unit 1-Earth's Place in the Universe: (35 Instructional Days)
In this unit, students examine the Earth's place in relation to the solar system, the Milky Way galaxy, and the universe. There is a strong emphasis on a systems approach and using models of the solar system to explain the cyclical patterns of eclipses, tides, and seasons. There is also a strong connection to engineering through the instruments and technologies that have allowed us to
Students examine geosciences data in order to understand the processes and events in Earth's history. The crosscutting concepts of patterns, scale, proportion, and quantity and systems and systems models provide a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data. Students are also expected to use these practices to demonstrate understanding of the core ideas.</td></tr>
<tr><td>Overarching Essential Questions</td><td>Overarching Enduring Understandings</td></tr>
<tr><td>• What is Earth's place in the universe?
• What makes up our solar system and what effect does cyclic motion have on the Earth in our solar system?
• How do people figure out the history of changes of Earth over time?</td><td>• Earth exists because of specific motions and changes within our universe over time.
• Cyclic motion and other patterns within the universe help people figure out that Earth and life on Earth have changed through time.
• Geoscience processes have changed the Earth drastically over time and still continue today.</td></tr>
<tr><td colspan="2">Student Learning Objectives</td></tr>
<tr><td>Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]</td><td>MS-ESS1-1</td></tr>
<tr><td>Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds</td><td>MS-ESS1-2</td></tr>
</table>

together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).]	
Analyze and interpret data to determine scale properties of objects in the solar system. *[Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]*	**MS-ESS1-3**
Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. *[Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment **does not include recalling the names of specific periods or epochs** and events within them.]*	**MS-ESS1-4**
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. *[Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]*	**MS-ESS2-2**
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. *[Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]*	**MS-ESS2-3**

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**MS-ETS1-1**
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**

Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-ESS1-1), (MS-ESS1-2) ● Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Asking Questions and Defining Problems** Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ● Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings (MS-ESS1-3) and to provide evidence for phenomena. (MS-ESS2-3, MS-ETS-1-3)	**ESS1.A: The Universe and Its Stars** ● Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.(MS-ESS1-1) ● Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) **ESS1.B: Earth and the Solar System** ● The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.(MS-ESS1-2), (MS-ESS1-3) ● This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1) ● The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.(MS-ESS1-2) **ESS1.C: The History of Planet Earth** ● The geologic time scale interpreted from rock strata	**Patterns** ● Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1) ● Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3) **Scale, Proportion, and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3) **Systems and System Models** ● Models can be used to represent systems and their interactions. (MS-ESS1-2) **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** ● Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-ESS1-3) **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1), (MS-ESS1-2)

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4), (MS-ESS2-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). ● Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4) Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (secondary to MS-ESS2-3) **ESS2.A: Earth Materials and Systems** ● The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ● Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3) **ESS2.C: The Roles of Water in Earth's Surface Processes** ● Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)	● Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3) **Influence of Science, Engineering, and Technology on Society and the Natural World** ● All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) ● The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

	ETS1.A: Defining and Delimiting Engineering Problems • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) • Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the	

	characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

Embedded English Language Arts/Literacy and Mathematics

ELA/Literacy-

RST.6-8.1 - Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3)

RST.6-8.7 - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)

SL.8.5 - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS1-1), (MS-ETS1-4)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2),(MS-ETS1-3)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)

Mathematics-

6.EE.B.6 - Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2)

6.RP.A.1 - Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)

MP.2 - Reason abstractly and quantitatively. (MS-ESS1-3)

MP.4 - Model with mathematics. (MS-ESS1-1), (MS-ESS1-2)

Technology--

8.2.8.D.1 Design and create a product that addresses a real world problem using a design process under specific constraints.

8.2.8.D.3 Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.

Social Studies--

SOC.6.1.8.B.1.b -Analyze the world in spatial terms (e.g., longitude, latitude) using historical maps to determine what led to the exploration of new water and land routes.

Three-Dimensional Teaching and Learning

Using Models and Analyzing Patterns

Students will practice using models of large-scale phenomena (e.g., gravity, orbits) to help make the concepts more tangible. The exploratory nature of this unit will allow for a more broad understanding of the vastness of our Universe and the universal forces, patterns, and processes that affect everything within the Universe. Students will not only understand that studying patterns and changes over time have helped people make sense of the history of our Earth but that these same patterns can help us make logical predictions about the future of our Earth, Solar System, and Universe.

Connections to Mathematics and Social Studies

The scaling of the Solar System activity will help students not only make sense of the vastness of our Solar System, but will also bolster mathematical number sense and proportionality. The first unit will set a basis of understanding for not only the remaining two science units but also for the Social Studies curriculum, which focuses greatly on the first inhabitants of the world, where hunter-gatherers settled, and the affect that geography had on Earth's inhabitants.

Prior Learning

Earth and Space Science-

- Observable patterns can help predict future changes to a system.
- The Solar System is one of many, many solar systems within our Universe, and the Sun is one of many, many stars within our Universe.
- Earth is one of eight planets in our Solar System.
- Gravity is a force of attraction between all things.

Mathematics-

- Basic concept of ratios and fractions.
- Basic concept of large-scale time.
- Understanding of the base ten system, especially on the larger scale (for distances and sizes within the Universe).
- The idea that scaling an object to be larger or smaller will always preserve the proportionality of the object.
- Abstract reasoning and basic number sense.

Part A: What are the major forces that affect the Universe and its movement?

Concepts	Formative Assessment
• Gravity affects all things with mass, and causes major movement such as planetary orbits. Gravity depends on mass and distance of objects.	*Students who understand the concepts are able to:*

• Cyclic motion between planetary bodies creates patterns such as lunar phases, eclipses, and seasons. • Scientists use pictures and data to observe changes in the Universe over time.	• Explain and show that gravity affects all things, using examples on a large and small scale. Students should be able to explain/show how gravity affects the formation of stars and planets. • STEM: Students experiment with center of gravity of different objects in the room. Students can show amd justify that the force of gravity will always be directly toward the center of the Earth, or perpendicular to the ground, no matter how you move the object, based on basic physics concepts. • Use models and data to display how gravity depends on the mass and distance of objects. For example, students should be able to show and explain why the Moon orbits the Earth and not the Sun, as a planet would. • Develop and use models to describe the cyclic motion creating lunar phases, eclipses, and seasons. Students decide which simulation or model used was most helpful and accurate. In journals, students will write a persuasive letter to a teacher in another school persuading him/her to use a specific method of teaching about the lunar phases. The students will decide which method is most helpful and why (computer simulation, hands-on activity with oreos, hands-on activity with flashlights, traditional research, lecture/notes).

Part B: How do scientists conceptualize the size and age of our Solar System?	
Concepts	**Formative Assessment**
• Models are used by scientists to help visualize the massive size of our Solar System and the approximate distances between each planet throughout orbits.	*Students who understand the concepts are able to:* • STEM: Use proportions and ratios to model the Solar System at a smaller scale (such as using paperclips as miles between planets) in the classroom and hallway. Compare

• By observing millions of stars, scientists are able to determine that our Sun is a mid-size star that is approximately 4.5 billion years old. This helps us determine how old our Earth is. • Comparing Earth to the planets around it helps scientists determine how our Earth formed, what the internal makeup of our Earth is, and what potential future our Earth has.	accurate models with inaccurate depictions and discuss the differences. • Draw the life cycle of a stars and logically conclude how old our Sun is, and how much longer it will likely exist. • Categorize planets into terrestrial and Jovian planets and make hypotheses about the Earth if it were to be located in different places in the Solar System.

Part C: How do scientists determine Earth's internal and surface changes over time?	
Concepts	**Formative Assessment**
• Geoscience processes such as volcanoes, earthquakes, tsunamis, and meteor impacts have changed Earth's surface over time. • Plate movement has created both gradual and catastrophic changes on Earth over millions of years. • Rock strata and their corresponding fossils help scientists determine relative ages of land, plants, and animals on Earth.	*Students who understand the concepts are able to:* • Present the causes and effects of several geoscience processes and locate examples of each on Earth. • Observe plate boundaries on Earth and determine different types of geoscience processes are likely to occur along those boundaries. • Determine major plate movement based on continental shapes, seafloor structure, rock strata, and index fossils. Students can write a letter from the perspective of Alfred Wegener or another scientist of their choice explaining the evidence that proves continental drift. They should consider layers of the earth, plate tectonics, plate boundaries, fossil distribution, mountain ranges, continental shapes, and carbon dating/radiometric isotopes in their response. • STEM: Design or redesign and test a tool used for tracking plate movement.

Modifications: *Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)*

- *Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)*
- *Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.*
- *Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).*
- *Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).*
- *Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).*
- *Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.*
- *Use project-based science learning to connect science with observable phenomena.*
- *Structure the learning around explaining or solving a social or community-based issue.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities.*

Leveraging English Language Arts/Literacy and Mathematics

English Language Arts/Literacy-

- Assess the extent to which the reasoning and evidence have helped scientists prove theories over time (e.g., Alfred Wegener, Sir Isaac Newton, and Albert Einstein).
- Comparing models, concepts, and ideas in several texts by different authors and determine their accuracy (i.e., comparing the scale of the planets in a text book and their actual size).
- Pose relevant, specific questions based in fact and elaborate answers by synthesizing text and data and citing textual evidence.

Mathematics-

- Use proportions and ratios to help understand the scale of the Solar System. Reveal how using smaller units help make massive numbers more tangible (and vice versa).
- Use timelines to aid in understanding of the history of the Universe, of Earth, of the life cycle of a star, and of other cyclic patterns.

Samples of Open Education Resources for this unit:
Solar System Visualizer is an interactive animation of planetary orbits. This also has a comparison between our Solar System and several other solar systems in our Universe. Solar System Scope is another interactive animation of our Solar System. This interactive allows for students to experiment with time and space within the system and to observe the changes that happen over time. Interactives: Dynamic Earth is a content-rich interactive for students to explore independently. Each topic includes an interactive assessment where students take conceptual knowledge and apply it to real-life examples. NASA Astronomy Picture of the Day is a daily picture from space, ideal for science journal writing or bell-ringer writing. PhET Simulator is a resource of simulations of hundreds of concepts. NSTA Classroom Resources is a website of sample lessons aligned directly with each 6th grade space and Earth science unit. Moon the Size of a Pixel is an interactive, accurate scale of the solar system based on the moon being the size of a pixel. This scale truly expresses the size of the planets themselves as well as the distances between each planet. Brainpop is a website of short mini-lesson videos. CK-12 is a resource where you can create supplemental content in online “flexbooks” for students aligned with NGSS.

Differentiation

504	• preferential seating • extended time on tests and assignments • reduced homework or classwork • verbal, visual, or technology aids	• modified textbooks or audio-video materials • behavior management support • adjusted class schedules or grading • verbal testing
Enrichment	• Utilize collaborative media tools • Provide differentiated feedback • Opportunities for reflection •	• Encourage student voice and input • Model close reading • Distinguish long term and short term goals
IEP	• Utilize "skeleton notes" where some required information is already filled in for the student • Provide access to a variety of tools for responses • Provide opportunities to build familiarity and to practice with multiple media tools • Graphic organizers	• Leveled text and activities that adapt as students build skills • Provide multiple means of action and expression • Consider learning styles and interests • Provide differentiated mentors
ELLs	• Pre-teach new vocabulary and meaning of symbols • Embed glossaries or definitions • Provide translations • Connect new vocabulary to background knowledge	• Provide flash cards • Incorporate as many learning senses as possible • Portray structure, relationships, and associations through concept webs • Graphic organizers
At-risk	• Purposeful seating • Counselor involvement • Parent involvement	• Contracts • Alternate assessments • Hands-on learning

21st Century Skills	
• Creativity • Innovation • Critical Thinking	• Problem Solving • Communication • Collaboration
Integrating Technology	
• Chromebooks • Internet research • Online programs	• Virtual collaboration and projects • Presentations using presentation hardware and software

Earth and Space Science	Grade 6	Unit 2 - Earth's Systems	Trimester 1-2

Earth and Space Science Unit - Earth's Systems: (30 Instructional Days) In this unit, students examine geoscience data in order to understand processes and events in Earth's history. Important crosscutting concepts in this unit are *scale, proportion, and quantity*, *stability and change,* and *patterns* in relation to the different ways geologic processes operate over geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth's systems. Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data.

Students are expected to demonstrate proficiency in *analyzing and interpreting* data and *constructing explanations*. They are also expected to use these practices to demonstrate understanding of the core ideas.	
Overarching Essential Questions	**Overarching Enduring Understandings**
• How do the materials in and on Earth's crust change over time? • What factors interact and influence weather and climate? • How can natural resources be both necessary and hazardous on Earth?	• Geosystems on Earth have changed the Earth's crust drastically over time and still continue today. • Several factors, including water, air pressure and heat, interact and influence weather and climate. • Geoscience processes provide resources needed by society but also cause natural hazards that present risks to society.
Student Learning Objectives	
Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]	MS-ESS2-1
Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. *[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]*	MS-ESS2-4
Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. *[Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic*	MS-ESS3-1*

traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]	
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. *[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]*	MS-ESS2-5
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]*	MS-ESS2-6
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	MS-ETS1-1
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	MS-ETS1-2
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success	MS-ETS1-3

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	MS-ETS1-4

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Asking Questions and Defining Problems Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ● Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models Modeling** Developing and using models in 6–8 builds on K–5 experiences and progresses to dev eloping, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MSESS2-1) (MSESS2-6) ● Develop a model to describe unobservable mechanisms. (MS-ESS2-4) ● Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data**	**ESS2.A: Earth's Materials and Systems** ● All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes** ● Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) ● Global movements of water and its changes in form are propelled by sunlight and gravity.(MS-ESS2-4) ● The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants	**Cause and Effect** ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS2-5) **Energy and Matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4) **Systems and System Models** ● Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6) **Stability and Change** ● Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MSESS2-1) **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● All human activity draws on natural resources and has both short and longterm consequences, positive as well as negativ e, for the health of people and the natural env ironment. (MS-ESS3-1)

Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS-1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● Construct a scientific explanation based on valid and reliable ev idence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1) **Planning and Carrying Out** Investigations Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ● Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)	of local weather patterns. (MS-ESS2-5) ● Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2- 6) **ESS3.A: Natural Resources** ● Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS2.D: Weather and Climate** ● Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) ● Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) ● The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and	**Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1

Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2) •	globally redistributing it through ocean currents. (MS-ESS2-6) **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) • Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution**	

	• Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4	

Embedded English Language Arts/Literacy and Mathematics
ELA/Literacy- *RST.6-8.1 - Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5), (MS-ESS3-1)* *RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-5),(MS-ETS1-2),(MS-ETS1-3)* *RST.6-8.7 - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-1), (MS-ETS1-2)* *WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS2-5), (MS-ETS1-1)* *WHST .6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)*

WHST .6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1), (MS-ETS1-2)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1), (MS-ESS2-6)

Mathematics-

MP.2 Reason abstractly and quantitatively. (MS-ESS2-5)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1)

6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)

Technology--

8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.

8.1.8.A.3 Use and/or develop a simulation that provides an environment to solve a real world problem or theory.

8.2.12.A.2 Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability and waste

8.2.8.D.1 Design and create a product that addresses a real world problem using a design process under specific constraints.

8.2.8.D.3 Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.

Social Studies--

SOC.6.1.8.B.1.b -Analyze the world in spatial terms (e.g., longitude, latitude) using historical maps to determine what led to the exploration of new water and land routes.

SOC.6.2.8.B.2.a - Determine the extent to which geography influenced settlement, the development of trade networks, technological innovations, and the sustainability of early river valley civilizations.

SOC.6.2.8.B.2.b - Compare and contrast physical and political maps of early river valley civilizations and their modern counterparts (i.e., Mesopotamia and Iraq; Ancient Egypt and Modern Egypt; Indus River Valley and Modern Pakistan/India; Ancient China and Modern China), and determine the geopolitical impact of these civilizations, then and now.

Three-Dimensional Teaching and Learning

Using Models and Analyzing Patterns

Students will continue to build their understanding of different cycles and patterns on a slightly smaller scale than in the Universe as a whole. While observing cycles here on Earth, students will further understand that the energy of the sun and the force of gravity do not end with planetary movement; instead, it drives integral parts of our Earth: the water cycle, the rock cycle, the carbon cycle, etc. By using models and observing patterns within these cycles, students will create a more comprehensive, interconnected concept of the cycling of materials and energy on Earth, rather than compartmentalized, unrelated sets of information.

Connections to Mathematics and Social Studies

Analyzing data about weather and distribution of resources on Earth is a natural link to data analysis and statistics in the math curriculum. This unit provides a rich basis for students to understand how the overall distribution of water and natural resources on Earth affected the first inhabitants of the world, where hunter-gatherers settled, and the affect that geography had on Earth's inhabitants.

Prior Learning

Earth and Space Science-

- Observable patterns can help predict future changes to a system.
- The water cycle is one of many cycles that occur on Earth.
- Natural geoscience processes happen sporadically, and often can be difficult to track or predict with perfect accuracy.
- Understanding that gravity affects all materials on Earth, including water in the hydrosphere.

- Understanding that all matter is made of atoms.

Mathematics-

- Basic concept of large-scale time.
- Abstract reasoning and basic number sense.
- Understanding of basic probability.
- Understanding of units of measurement.
- Recording and analyzing data in the form of tables, graphs, infographics, etc. Students should be able to understand the difference between a long-term trend vs. an individual data point (e.g., when analyzing weather on a day-by-day basis vs. climate over a large period of time).

- **Part A:** How do the materials in and on Earth's crust change over time?

Concepts	Formative Assessment
● Materials in and on Earth cycle through several processes to create different physical and chemical changes on Earth's crust. ● The rock cycle is an integral piece for scientists to understand the history of our Earth. Different types of rocks form in various conditions. ● The rock cycle creates uneven distribution of minerals on Earth.	*Students who understand the concepts are able to:* ● Explain and show in detail one or more geoscience processes (i.e., tectonic plate movement) that result in a change to Earth's surface. Students should be able to justify the *cause and effect* of each process. ● Create a model of the rock cycle and clarify the conditions that create each type of rock/each step of the process. Students should be able to indentify different parts of the rock cycle based on the rocks and minerals produced at each step. ● Analyze large- and small-scale maps of the world to formulate arguments about the uneven distribution of minerals on Earth. Students should be able to argue where locations of petroleum, metal ores, and soil will be based on their understanding of how each are produced (locations of the burial of organic marine sediments and subsequent geologic traps, locations of past volcanic and hydrothermal activity associated with subduction zones, locations of active weathering and/or deposition of rock, respectively).

Part B: How can natural resources be both necessary and hazardous on Earth?

Concepts	Formative Assessment
• Geoscience processes such as volcanoes, earthquakes, tsunamis, and meteor impacts have both created and destroyed natural resources over time. These resources are necessary for human life. • Natural resources are limited and typically non-renewable, and their distributions are significantly changing as a result of removal by humans. • Acquisition of natural resources can often be hazardous, and often do not present long-term solutions for our energy needs.	*Students who understand the concepts are able to:* • Identify several natural resources and their basic development and/or location on Earth. • Research and present several methods of acquiring natural resources, such as hydraulic fracturing, mining, solar panels, etc. • Create an argument of the future of natural resources on Earth and justify their argument with reliable data and research. • STEM: Design or redesign a method for extracting a type of natural resource from Earth within the constraints of its location.

Part C: What factors interact and influence weather and climate?	
Concepts	**Formative Assessment**
• The hydrologic cycle is driven by the energy of the sun and the force of gravity. The net amount of water in our hydrosphere does not change; it simply changes state. Water influences weather, circulates in the oceans, and shapes Earth's surface. • Weather largely depends on heat, precipitation, and air pressure. Uneven heating and rotation of the Earth causes atmospheric and oceanic circulation which directly influences weather and climate. • Different tools can be used to monitor changes in weather, as well as predict future changes in climate over time.	*Students who understand the concepts are able to:* • Use models and data to display how solar energy and gravity drive the hydrologic cycle. Students should be able to hypothesize how this cycle could theoretically change if different parts of its makeup were altered (e.g. what if the sun was further from Earth? What if Earth were not as massive as it is? What if Earth's overall temperature drastically increased or decreased?) • STEM: Create a terrarium and record daily data in order to watch trends in the movement of water in the system. (Unit 2: Experiment with altering the system by overwatering, underwatering, and adding pollution.) • Predict weather patterns based on variations in heat, precipitation, and air pressure. Students should be able to explain how wind is produced and solar energy and gravity causes large-scale wind and water currents. • Create or model a method or tool for collecting data and tracking weather changes, such as a wind vane, water gauge, or weather balloon.

Modifications: ***Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)***
• *Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)*

- *Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.*
- *Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques- auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).*
- *Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).*
- *Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).*
- *Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.*
- *Use project-based science learning to connect science with observable phenomena.*
- *Structure the learning around explaining or solving a social or community-based issue.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities*

Leveraging English Language Arts/Literacy and Mathematics

English Language Arts/Literacy-

- Compare models, concepts, and ideas in several texts by different authors and synthesizing textual and artistic depictions of information.
- Create models of information in conjunction with textual or verbal explanations of the information.
- Pose relevant, specific questions based in fact and elaborate answers by synthesizing text and data and citing textual evidence.

Mathematics-

- Use data tables and graphs to analyze weather patterns and climate change over time.
- Create inequalities to explain how uneven distribution of air molecules creates wind, how uneven distribution of solar energy creates wind and water patterns, etc.
- Use percentages to understand humidity and likelihood of weather events.

Samples of Open Education Resources for this unit:
Interactives: Dynamic Earth is a content-rich interactive for students to explore independently. Each topic includes an interactive assessment where students take conceptual knowledge and apply it to real-life examples. PhET Simulator is a resource of simulations of hundreds of concepts. NSTA Classroom Resources is a website of sample lessons aligned directly with each 6th grade space and Earth science unit. Brainpop is a website of short mini-lesson videos. CK-12 is a resource where you can create supplemental content in online "flexbooks" for students aligned with NGSS. PBS Learning Media offers interactives and support articles of many Earth and Space topics. Autodesk is a resource for mostly-free programs for digital design; ideal for STEM-based projects. Gulf of Mexico Oil Spill Interactive is a page on Smithsonian's site about oceans. This gives some background to students about oil spills and the effect humans have on Earth.

Differentiation		
504	● preferential seating ● extended time on tests and assignments ● reduced homework or classwork ● verbal, visual, or technology aids	● modified textbooks or audio-video materials ● behavior management support ● adjusted class schedules or grading ● verbal testing
Enrichment	● Utilize collaborative media tools ● Provide differentiated feedback ● Opportunities for reflection ●	● Encourage student voice and input ● Model close reading ● Distinguish long term and short term goals

IEP	- Utilize “skeleton notes” where some required information is already filled in for the student - Provide access to a variety of tools for responses - Provide opportunities to build familiarity and to practice with multiple media tools - Graphic organizers	- Leveled text and activities that adapt as students build skills - Provide multiple means of action and expression - Consider learning styles and interests - Provide differentiated mentors
ELLs	- Pre-teach new vocabulary and meaning of symbols - Embed glossaries or definitions - Provide translations - Connect new vocabulary to background knowledge	- Provide flash cards - Incorporate as many learning senses as possible - Portray structure, relationships, and associations through concept webs - Graphic organizers
At-risk	- Purposeful seating - Counselor involvement - Parent involvement	- Contracts - Alternate assessments - Hands-on learning

21st Century Skills

- Creativity - Innovation - Critical Thinking	- Problem Solving - Communication - Collaboration

Integrating Technology

• Chromebooks • Internet research • Online programs	• Virtual collaboration and projects • Presentations using presentation hardware and software

Earth and Space Science	Grade 6	Unit 3 - Earth and Human Activity	Trimester 2

Earth and Space Science Unit 3- Earth and Human Activity: (20 Instructional Days) In this unit of study, students analyze and interpret data and design solutions to build on their understanding of the ways that human activities affect Earth's systems. The emphasis of this unit is the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of these uses. The crosscutting concepts of *cause and effect* and *the influence of science, engineering, and technology on society and the natural world* are called out as organizing concepts for these disciplinary core ideas.	
Overarching Essential Questions	**Overarching Enduring Understandings**
• How can natural hazards be predicted? • How do human activities affect Earth systems? • How do we know our global climate is changing?	Some natural hazards can be accurately predicted due to particular signs and phenomena, while others still are largely unpredictable. Humans have a vast impact on Earth systems, and human impact rate increases with population. Long-term trends in temperature and weather patterns provide evidence of human impact on rising global temperatures.
Student Learning Objectives	
Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. *[Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]*	**MS-ESS3-1***

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. *[Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]*.	**MS-ESS3-2**
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]*	**MS-ESS3-3**
Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. *[Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]*	**MS-ESS3-4**
Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. *[Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]*	**MS-ESS3-5**

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions	**MS-ETS1-1**
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ● Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) ● Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	**ESS3.A: Natural Resources** ● Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS3.B: Natural Hazards** ● Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and	**Patterns** ● Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Cause and Effect** ● Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1),(MS-ESS3-4) **Stability and Change** ● Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5) ***Connections to Engineering, Technology, and Applications of Science***

• Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2, MS-ETS-1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1) • Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)	likelihoods of future events. (MS-ESS3-2) **ESS3.C: Human Impacts on Earth Systems** • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4) **ESS3.D: Global Climate Change** • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of	**Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1),(MS-ESS3-4) • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2),(MS-ESS3-3) ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4) **Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by

• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5) **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) • Models of all kinds are important for testing solutions. (MS-ETS1-4)	differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

	ETS1.C: Optimizing the Design Solution • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

Embedded English Language Arts/Literacy and Mathematics

ELA/Literacy-

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-2),(MS-ESS3-4)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2)

WHST.6-8.1 Write arguments focused on discipline content. (MS-ESS3-4)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3), (MS-ETS1-2)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3), (MS-ETS1-1)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-4), (MS-ETS1-2), (MS-ETS1-3)

Mathematics-

MP.2 Reason abstractly and quantitatively. (MS-ESS3-2)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3),(MS-ESS3-4)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4),(MS-ESS3-5)

Technology--

8.1.8.B.1 Synthesize and publish information about a local or global issue or event(ex. telecollaborative project, blog, school web).

8.1.8.C.1 Collaborate to develop and publish work that provides perspectives on a global problem for discussions with learners from other countries.

8.2.8.A.4 Redesign an existing product that impacts the environment to lessen its impact(s) on the environment.

8.2.12.A.2 Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability and waste

8.2.8.D.1 Design and create a product that addresses a real world problem using a design process under specific constraints.

8.2.8.D.3 Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.

8.2.8.B.1 Evaluate the history and impact of sustainability on the development of a designed product or system over time and present results to peers.

Social Studies--

SOC.6.1.8.B.1.b -Analyze the world in spatial terms (e.g., longitude, latitude) using historical maps to determine what led to the exploration of new water and land routes.

SOC.6.2.8.B.2.a - Determine the extent to which geography influenced settlement, the development of trade networks, technological innovations, and the sustainability of early river valley civilizations.

SOC.6.2.8.B.2.b - Compare and contrast physical and political maps of early river valley civilizations and their modern counterparts (i.e., Mesopotamia and Iraq; Ancient Egypt and Modern Egypt; Indus River Valley and Modern Pakistan/India; Ancient China and Modern China), and determine the geopolitical impact of these civilizations, then and now.

Three-Dimensional Teaching and Learning

Analyzing Cause and Effect

Students will again analyze cause and effect as they did with Unit 1, but this time on the human scale. Students will use critical thinking practices to determine the impact that humans have on the Earth. Students will analyze the difference between correlation and causation, and create arguments regarding climate and changes on the Earth with respect to human impact. Students should take note that "The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes" (MS-ESS-3-4).

Connections to Engineering

This unit in particular asks students to think creatively to design, redesign, and assess models for monitoring and minimizing human impact on the environment (MS-ESS-3-3, MS-ETS-1-1). The end of the unit includes a project where students design a sustainable city. Students should be able to draw from Units 1-3 to justify and reason through their decisions in the design process. Students should engage in a communication- and research-based process to evaluate the criteria and constraints of the project.

Prior Learning

<u>Earth and Space Science-</u>

- Observable patterns can help predict future changes to a system.
- Humans depend on the Earth for natural resources created by geoscience processes over time.
- Humans have a great impact on the Earth, and can alter in the Earth in both a positive and a detrimental way.

Mathematics-

- Abstract reasoning and basic number sense.
- Understanding of population and percentages.
- Recording and analyzing data in the form of tables, graphs, infographics, etc. Students should be able to understand the difference between a long-term trend vs. an individual data point (e.g., when analyzing weather on a day-by-day basis vs. climate over a large period of time).

Part A:How Can Natural Hazards be Predicted?

Concepts	Formative Assessment
• Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. • Some natural hazards form within the Earth whereas others occur in the form of severe weather in the atmosphere. • Humans can protect themselves from natural hazards from technologies that can track/predict hazards as well as technologies that can protect humans, such a storm cellars or dunes.	*Students who understand the concepts are able to:* • Research to become an “expert” on a particular weather pattern and report the findings in an engaging way. Students should be able to explain the predictable signs of a particular weather pattern. • STEM: Create a tool for monitoring a particular weather pattern or natural hazard. • Analyze data about the magnitudes, frequencies, and locations of natural hazards and create an argument about how some natural hazards can be predicted and others cannot.

Part B: How do human activities affect Earth systems?

Concepts	Formative Assessment

• Increases in human population and consumption greatly affects the Earth in regards to several factors such as land use, water use, and pollution.
  • Human error can often create irreversible damage on the environment, such as with an oil spill.
  • New technology and designs are necessary to help monitor and minimize human impact on the Earth.
	Students who understand the concepts are able to:
	• STEM: Collaboratively work to resolve an “oil spill” (water, oil, and feathers in a tin pan) and create a novel way of cleaning oil out of water.
	• STEM: Add pollutants to their terrariums from Unit 2 and predict and analyze the effect that pollution has on the system.
	• STEM: Design a method or technology to monitor or minimize human impact on Earth
	• Analyze data about human population and consumption and construct an argument about their link to changes in the environment.

Part C: How do we know our global climate is changing?	
Concepts	**Formative Assessment**
● Long-term trends in weather and climate shows a rise in global temperatures over time. ● Global climate can change because of several factors, both by natural geoscience processes, as well as by human activity. ● Evidence of global climate change includes tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities.	*Students who understand the concepts are able to:* • STEM: Collaborate and research in order to create a fictional sustainable city. Include designs and justifications for parks, buildings, cars, houses, etc. • Explain several factors that affect global climate, including those that humans influence and those that humans do not. • Analyze data (tables, graphs, maps) and create an argument about the link between human activity and changes in global temperatures and atmospheric levels of gases.

Modifications: ***Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)***

- *Restructure lesson using UDL principals (*http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA*)*
- *Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.*
- *Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).*
- *Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).*
- *Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).*
- *Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.*
- *Use project-based science learning to connect science with observable phenomena.*
- *Structure the learning around explaining or solving a social or community-based issue.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities.*

Leveraging English Language Arts/Literacy and Mathematics

English Language Arts/Literacy-

- Assess the extent to which the reasoning and evidence support that humans have an impact on the environment, especially concerning global temperatures.
- Comparing models, concepts, and ideas in several texts by different authors and determine their accuracy.
- Pose relevant, specific questions based in fact and elaborate answers by synthesizing text and data and citing textual evidence.
- Write an argument or informational piece about the topic of human impact on the environment.

Mathematics-

- Use tables, maps, timelines, and graphs to analyze trends in data.
- Use ratios to help in understanding the amounts of natural resources are on Earth and their change in amount over time.
- Incorporating variables to represent data and possible outcomes as a result of human activity.

Samples of Open Education Resources for this unit:

Interactives: Dynamic Earth is a content-rich interactive for students to explore independently. Each topic includes an interactive assessment where students take conceptual knowledge and apply it to real-life examples.

PhET Simulator is a resource of simulations of hundreds of concepts.

NSTA Classroom Resources is a website of sample lessons aligned directly with each 6th grade space and Earth science unit.

Brainpop is a website of short mini-lesson videos.

CK-12 is a resource where you can create supplemental content in online “flexbooks” for students aligned with NGSS.

PBS Learning Media offers interactives and support articles of many Earth and Space topics.

Autodesk is a resource for mostly-free programs for digital design; ideal for STEM-based projects.

Gulf of Mexico Oil Spill Interactive is a page on Smithsonian’s site about oceans. This gives some background to students about oil spills and the effect humans have on Earth.

Differentiation

504	● preferential seating ● extended time on tests and assignments ● reduced homework or classwork ● verbal, visual, or technology aids	● modified textbooks or audio-video materials ● behavior management support ● adjusted class schedules or grading ● verbal testing
Enrichment	● Utilize collaborative media tools ● Provide differentiated feedback ● Opportunities for reflection ●	● Encourage student voice and input ● Model close reading ● Distinguish long term and short term goals
IEP	● Utilize “skeleton notes” where some required information is already filled in for the student ● Provide access to a variety of tools for responses ● Provide opportunities to build familiarity and to practice with multiple media tools ● Graphic organizers	● Leveled text and activities that adapt as students build skills ● Provide multiple means of action and expression ● Consider learning styles and interests ● Provide differentiated mentors
ELLs	● Pre-teach new vocabulary and meaning of symbols ● Embed glossaries or definitions ● Provide translations ● Connect new vocabulary to background knowledge	● Provide flash cards ● Incorporate as many learning senses as possible ● Portray structure, relationships, and associations through concept webs ● Graphic organizers
At-risk	● Purposeful seating ● Counselor involvement ● Parent involvement	● Contracts ● Alternate assessments ● Hands-on learning

21st Century Skills	
• Creativity • Innovation • Critical Thinking	• Problem Solving • Communication • Collaboration
Integrating Technology	
• Chromebooks • Internet research • Online programs	• Virtual collaboration and projects • Presentations using presentation hardware and software

Appendix

[Unit 1 Curriculum Guide]

[Unit 2 Curriculum Guide]

[Unit 3 Curriculum Guide]