Allamuchy Township School District
Allamuchy, NJ

Course Title
Grade 6 Science

CURRICULUM GUIDE
FINAL DRAFT

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This curriculum may be modified through varying techniques,
strategies and materials, as per an individual student's
Individualized Education Plan (IEP).

Approved by the Allamuchy Board of Education
At the regular meeting held on
And
Aligned with the New Jersey Core Curriculum Content Standards
And Common Core Content Standards

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Philosophy and Rationale

The Allamuchy Township School Grade 6-8 Science Curriculum is based on the Next Generation Science Standards. The standards are broken down into 4 main sections. Middle School Life Science, Middle School Earth and Space Science, Middle School Physical Science, and Middle School Engineering Design.
The purpose of scientific study is to understand the world in which we live. We believe in inquiry based learning, exploring and discovering using tools, technology and text. Students are encouraged to be curious and inquisitive in a multi-sensory, material-rich environment. Students learn science by exploring and discovering; using tools, technology, and media; asking questions/making connections; communicating what they know; taking risks and being creative; networking with the community; and utilizing community resources. The science and engineering practices that the NGSS are based on include developing and using models, analyzing and interpreting data, constructing explanations and designing solutions and engaging in argument from evidence.

Mission Statement

The mission of the Allamuchy Township District, in partnership with the larger community, is to provide a comprehensive, caring program for all of our students which:

   *Nurtures the unique talents and interests of each individual
   *Supports social responsibility and a love of learning
   *Embraces the total development of each student intellectually, morally and physically
   *Develops confidence, creativity and skills necessary to face the challenges of a technologically advanced and ever-changing society
   *Promotes a culture of mutual respect with all other community members
   *Supports the attainment of the New Jersey Core Curriculum Content Standards

The District seeks to exceed objective standards of achievement set by both the State and Federal government and to provide an educational experience beyond the boundaries established by the Core Curriculum Standards.

Unit 1 - Growth, Development, and Reproduction of Organisms

Scope and Sequence
Time: Approximately 30 days

In this unit of study students use data and conceptual models to understand how the environment and genetic factors determine the growth of an individual organism. They connect this idea to the role of animal behaviors in animal reproduction and to the dependence of some plants on animal behaviors for their reproduction. Students provide evidence to support their understanding of the structures and behaviors that increase the likelihood of successful reproduction by organisms.

Corresponds to Module C in textbook

Stage 1: Desired Results

Content Standards
MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Essential Questions
What influences the growth and development of an organism?

Enduring Understandings
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.
  - There are a variety of ways that plants reproduce.
- Specialized structures for plants affect their probability of successful reproduction.
- Some characteristic animal behaviors affect the probability of successful reproduction of plants.
- Animals engage in characteristic behaviors that affect the probability of success reproduction.
- There are a variety of characteristic animal behaviors that affect their probability of successful reproduction.
- There are a variety of animal behaviors that attract a mate.
- Successful reproduction of animals and plants may have more than one cause, and some cause-and-effect relationships in systems can be described using probability.
- Genetic factors as well as local conditions affect the growth of organisms.
  - A variety of local environmental conditions affect the growth of organisms.
- Genetic factors affect the growth of organisms (plant and animals).
- The factors that influence the growth of organisms may have more than one cause.
- Some cause-and-effect relationships in plant and animal systems can only be described using probability.

Knowledge and Skills (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
   ● Collect empirical evidence about animal behaviors that affect the animals' probability of successful reproduction and also affect the probability of plant reproduction.
   ● Collect empirical evidence about plant structures that are specialized for reproductive success.
   ● Use empirical evidence from experiments and other scientific reasoning to support oral and written arguments that explain the relationships among plant structures, animal behavior, and the reproductive success of plants.
   ● Identify and describe possible cause-and-effect relationships affecting the reproductive success of plants and animals using probability.
   ● Support or refute an explanation of how characteristic animal behaviors and specialized plant structures affect the probability of successful plant reproduction using oral and written arguments.
   ● Conduct experiments, collect evidence, and analyze empirical data.
   ● Use evidence from experiments and other scientific reasoning to support oral and written explanations of how environmental and genetic factors influence the growth of organisms.
   ● Identify and describe possible causes and effects of local environmental conditions on the growth of organisms.
   ● Identify and describe possible causes and effects of genetic conditions on the growth of organisms.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
Benchmarks (embedded student proficiencies)
Assessment Methods (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan
Instruction should result in students being able to use arguments based on empirical evidence and scientific reasoning to support an explanation of how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants. Students may observe examples of plant structures that could affect the probability of plant reproduction, including bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract pollen-transferring insects, and hard shells on nuts that squirrels bury. Possible activities could include plant experiments (e.g., students could count the number of butterflies on brightly colored plants vs. the number of butterflies on other types of plants and record data they collect in a table), using microscopes/magnifiers to view plant structures (e.g., dissecting a lily), going on field trips, both virtual and actual.
Students may observe examples of animal behaviors that affect the probability of plant reproduction, which could include observing how animals can transfer pollen or seeds and how animals can create conditions for seed germination and growth (e.g., students may conduct an experiment using rapid cycling Brassica rapa [Fast Plant] and collect data on how many plants produce seeds with and without the aid of a pollinator.
Students could then observe examples of animal behaviors (using videos, internet resources, books, etc.) that could affect the probability of successful animal reproduction. These behaviors could include nest building to protect young from cold, herding of animals to protect young from predators, and colorful plumage and vocalizations to attract mates from breeding. Students may be able to identify and describe possible cause-and-effect relationships in factors that contribute to the reproductive success of plants and animals by using probability data from the rapid-cycling Brassica rapa (Fast Plant) experiments and drawing conclusions about one relationships between animals and plants.
At this point, students can present an oral/written argument supported by evidence and scientific reasoning that characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. Students may use evidence from experiments or other sources to identify the role of pollinators in plant reproduction.

Instruction that results in students being able to construct an evidence-based scientific explanation for how environmental and genetic factors influence the growth of organisms could begin with students conducting experiments and collecting data on the environmental conditions that affect the growth of organisms (e.g., the effect of variables such as food, light, and water on plant growth).

Students could then examine genetic factors (inherited traits) that influence the growth of organisms, including parental traits and selective breeding. This unit could end with students using an oral and/or written argument, supported by evidence and scientific reasoning from their experiments, to explain how environmental conditions and genetic factors affect the growth of an organism.

Suggested Activity: Discuss how animal behavior helps prevent extinction. Example: discuss how zebras keep their babies safe in the middle of the herd from a cheetah. Discuss how the environment and heredity help in the development of organisms. Example: a lecture on droughts affecting plant growth.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Cite specific, empirical, textual evidence to support analysis of how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.
- Trace and evaluate the argument and specific claims in a text about how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. Distinguish claims that are supported by empirical and scientific reasoning from claims that are not.
- Write an argument focused on how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.

Mathematics

- Understand that a set of data collected to answer a statistical question about how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively, has a distribution which can be described by its center (mean), spread (range), and overall shape (shape of the distribution of data).
- Summarize numerical data sets, collected to answer statistical questions about how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively, that have a distribution that can be described by its center (mean), spread (range), and overall shape (shape of the distribution of data) in relation to their context.

Modifications:

- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources

- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

Unit 2 - Matter and Energy in Organisms and Ecosystems

Scope and Sequence
Time: Approximately 30 days

In this unit of study, students analyze and interpret data, develop models, construct arguments, and demonstrate a deeper understanding of the cycling of matter, the flow of energy, and resources in ecosystems. They are able to study patterns of interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on populations. They also understand that the limits of resources influence the growth of organisms and populations, which may result in competition for those limited resources.

Corresponds to Module C in textbook

Stage 1: Desired Results

Content Standards
MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Essential Questions
How and why do organisms interact with their environment and what are the effects of these interactions?

Enduring Understandings
- Organisms and populations of organisms are dependent on their environmental interactions with other living things.
- Organisms and populations of organisms are dependent on their environmental interactions with nonliving factors.
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with others for limited resources.
- Access to food, water, oxygen, or other resources constrain organisms' growth and reproduction.
- Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms.
- Mutually beneficial interactions may become so interdependent that each organism requires the other for survival.
- The patterns of interactions of organisms with their environment, both its living and nonliving components, are shared.
- Interactions within ecosystems have patterns that can be used to identify cause-and-effect relationships.
- Patterns of interactions among organisms across multiple ecosystems can be predicted.

- Patterns of interactions can be used to make predictions about the relationships among and between organisms and abiotic components of ecosystems.
- Food webs are models that demonstrate how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.
- Transfers of matter into and out of the physical environment occur at every level.
- Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments and back to the water in aquatic environments.
- The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.
- The transfer of energy can be tracked as energy flows through an ecosystem.
- Science assumes that objects and events in ecosystems occur in consistent patterns that are understandable through measurement and observation.

Knowledge and Skills (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
- Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- Use cause-and-effect relationships to predict the effect of resource availability on organisms and populations in natural systems.
- Construct an explanation about interactions within ecosystems.
- Include qualitative or quantitative relationships between variables as part of explanations about interactions within ecosystems.
- Make predictions about the impact within and across ecosystems of competitive, predatory, or mutually beneficial relationships as abiotic (e.g., floods, habitat loss) or biotic (e.g., predation) components change.
- Develop a model to describe the cycling of matter among living and nonliving parts of an ecosystem.
- Develop a model to describe the flow of energy among living and nonliving parts of the ecosystem. Track the transfer of energy as energy flows through an ecosystem.
- Observe and measure patterns of objects and events in ecosystems.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
Benchmarks (embedded student proficiencies)
Assessment Methods (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan
Instruction should result in students being able to use arguments based on empirical evidence and scientific reasoning to support an explanation of how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants. Students may observe examples of plant structures that could affect the probability of plant reproduction, including bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract pollen-transferring insects, and hard shells on nuts that squirrels bury. Possible activities could include plant experiments (e.g., students could count the number of butterflies on brightly colored plants vs. the number of butterflies on other types of plants and record data they collect in a table), using microscopes/magnifiers to view plant structures (e.g., dissecting a lily), going on field trips, both virtual and actual.
Students may observe examples of animal behaviors that affect the probability of plant reproduction, which could include observing how animals can transfer pollen or seeds and how animals can create conditions for seed germination and growth (e.g., students may conduct an experiment using rapid cycling Brassica rapa [Fast Plant] and collect data on how many plants produce seeds with and without the aid of a pollinator.

Students could then observe examples of animal behaviors (using videos, internet resources, books, etc.) that could affect the probability of successful animal reproduction. These behaviors could include nest building to protect young from cold, herding of animals to protect young from predators, and colorful plumage and vocalizations to attract mates from breeding. Students may be able to identify and describe possible cause-and-effect relationships in factors that contribute to the reproductive success of plants and animals by using probability data from the rapid-cycling Brassica rapa (Fast Plant) experiments and drawing conclusions about one relationships between animals and plants.

At this point, students can present an oral/written argument supported by evidence and scientific reasoning that characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. Students may use evidence from experiments or other sources to identify the role of pollinators in plant reproduction.

Instruction that results in students being able to construct an evidence-based scientific explanation for how environmental and genetic factors influence the growth of organisms could begin with students conducting experiments and collecting data on the environmental conditions that affect the growth of organisms (e.g., the effect of variables such as food, light, and water on plant growth).

Students could then examine genetic factors (inherited traits) that influence the growth of organisms, including parental traits and selective breeding. This unit could end with students using an oral and/or written argument, supported by evidence and scientific reasoning from their experiments, to explain how environmental conditions and genetic factors affect the growth of an organism.

Suggested **Activity:** Create a poster showing reactants and products of photosynthesis and how they relate to cellular respiration; Make a model showing how food is changed by the body to energy and then is released by an organism. Example: a model showing a plant using energy from the sun to make food.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Cite specific, empirical, textual evidence to support analysis of how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.
- Trace and evaluate the argument and specific claims in a text about how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. Distinguish claims that are supported by empirical and scientific reasoning from claims that are not.
- Write an argument focused on how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.

Mathematics

- Understand that a set of data collected to answer a statistical question about how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively, has a distribution which can be described by its center (mean), spread (range), and overall shape (shape of the distribution of data).
- Summarize numerical data sets, collected to answer statistical questions about how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively, that have a distribution that can be described by its center (mean), spread (range), and overall shape (shape of the distribution of data) in relation to their context.

Modifications:
- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources
- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

Unit 3 - Interdependent Relationships in Ecosystems

Scope and Sequence
Time: Approximately 30 days

In this unit of study students build on their understanding of the transfer of matter and energy as they study patterns of interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on a population. They construct explanations for the interactions in ecosystems and the scientific, economic, political, and social justifications used in making decisions about maintaining biodiversity in ecosystems.

Corresponds to Module C in textbook

Stage 1: Desired Results
Content Standards
MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystems affect on populations.
MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-ETS1-1: 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-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3: 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.

Essential Questions
What happens to ecosystems when the environment changes?

Enduring Understandings
- Ecosystems are dynamic in nature.
- The characteristics of ecosystems can vary over time.
- Disruptions to any physical or biological component of an ecosystem can lead to shifts in all the ecosystem's populations.
- Small changes in one part of an ecosystem might cause large changes in another part.
- Patterns in data about ecosystems can be recognized and used to make warranted inferences about changes in populations.
- Evaluating empirical evidence can be used to support arguments about changes to ecosystems.
- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems.
- The completeness, or integrity, of an ecosystem's biodiversity is often used as a measure of its health.
- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines.
- Changes in biodiversity can influence ecosystem services that humans rely on.
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
- A solution needs to be tested and then modified on the basis of the test results, in order to improve it.
- Models of all kinds are important for testing solutions.
- 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.

- Small changes in one part of a system might cause large changes in another part.
- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Knowledge and Skills (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
- Construct an argument to support or refute an explanation for the changes to populations in an ecosystem caused by disruptions to a physical or biological component of that ecosystem. Empirical evidence and scientific reasoning must support the argument.
- Use scientific rules for obtaining and evaluating empirical evidence.
- Recognize patterns in data and make warranted inferences about changes in populations.
- Evaluate empirical evidence supporting arguments about changes to ecosystems.
- Construct a convincing argument that supports or refutes claims for solutions about the natural and designed world (s).
- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.
- Create design criteria for design solutions for maintaining biodiversity and ecosystem services.
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
Benchmarks (embedded student proficiencies)
Assessment Methods (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan
At the beginning of this units of study, students will begin to collect empirical evidence that will be used to argue that physical or biological components of an ecosystem affect population. Students will evaluate existing solutions for maintaining biodiversity and ecosystem services to determine which solutions are most promising. AS part of their evaluation, students will develop a probability and use it to determine the probability that designed systems, including those representing inputs and outputs, will maintain biodiversity and ecosystem services. They will develop mathematical model (s) to generate data to test the designed systems and compare probabilities from the models to observe frequencies. If the agreement is not good, they will explain possible sources of the discrepancy.

Distinguish among facts, reasoned judgement based on research findings, and speculation. During this process, students will distinguish among facts reasoned judgment based on research findings, and speculation while reading text about maintaining biodiversity and ecosystem services. Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion.

After determining that ecosystems are dynamic in nature, students may construct an argument to support an explanation for how shifts (large and/or small) in populations are caused by change to physical or biological components in ecosystems (e.g. gas explosions, tornado's, mining, oil spills, clear cutting, hurricanes, volcanoes, etc.).

Students will study the variety of species found in terrestrial and oceanic ecosystems and use the data they gather to make decisions about the health of the ecosystem. Students may compare, through observations and data analysis, the biodiversity before and after events affecting areas - for examples: the Pinelands, that were lost due to the creation of the reservoir; the underground coal fires in Centralia, PA, that caused people to abandon the town; the volcanic eruption of Mt. St. Helen's, WA; the nuclear reactor meltdown in Chernobyl, Ukraine.

Students should recognize patterns in data about changes to components in ecosystems and make inferences about these changes contribute to changes in the biodiversity of populations. Students should investigate and design investigations to test their ideas and develop possible solutions to problems caused when changes in the biodiversity of an ecosystem affect resources (food, energy, and medicine) as well as ecosystem services (water

purification, nutrient recycling, soil erosion prevention) available to humans. Students can then construct arguments using evidence to support recognized patterns of change in factors such as global temperatures and their effect on populations and the environment. As part of their argument, students need to note how small changes in one part of an ecosystem might cause large changes in another part. While collecting evidence for their arguments about maintaining biodiversity, students will trace and evaluate specific claims in a text, distinguish claims that are supported by reasons and evidence from claims that are not. Students will evaluate the argument and claims in text, assess whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.

As a culmination of this unit of study, students will take the evidence they have collected and their understanding of how changes in the biodiversity of populations can impact ecosystem services and use that evidence and understanding to evaluate competing design solutions. Students will include multimedia components and visual displays as part of their argument about competing design solutions based on jointly developed and agreed-upon design criteria to clarify evidence used in their arguments. The multimedia component and visual display should clarify claims and findings and emphasize salient points in their argument. Students will use a systematic process for evaluating their design solutions with respect to how well they meet the criteria and constraints. Students may determine the systematic process they will use, or the teacher can determine a process for students to use to evaluate ecosystem services. Any process used should include mathematical models that generates date for the iterative testing of competing design solutions involving a proposed object, tool, or process maintaining biodiversity and ecosystem services and quantitative reasoning and abstract reasoning. Ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. For this unit of study, design solution constraints could include scientific, economic, and social considerations. After determining the process for evaluating the design solutions and establishing the criteria and constraints, students will compare competing design solutions to determine the optimal solution.

Suggested **Activity:** Discuss evidence that shows how changing an ecosystem changes the population of an ecosystem. Example: a lecture showing a fire and how it affects the environment and the organisms living in the environment.; Do a project showing how to maintain an ecosystem. Example: a project showing how to purify water at our school. Create 3D Energy Pyramid; Create a digital interactive food web that traces energy from light through an ecosystem.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Distinguish among facts, reasoned judgement based on research findings, and speculation when reading text about maintaining biodiversity and ecosystem services. Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion.
- Trace and evaluate the argument and specific claims in a text about maintaining biodiversity and ecosystem services, distinguish claims that are supported by reasons and evidence from claims that are not. Trace and evaluate the arguments about specific claims in a text and assess whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
- Include multimedia components and visual displays as part of an argument about competing design solutions on jointly developed and agreed-upon design criteria to clarify information. Include multimedia component and visual displays should clarify claims and finding and emphasize salient points in the presentation.

Mathematics
- Model design solutions for maintaining biodiversity and ecosystem services with mathematics. Use ratio and rate reasoning to evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- Develop a model that generates data for the iterative testing of competing design solutions involving a proposed object, tool, or process that maintains biodiversity and ecosystem services, reasoning quantitatively (with amounts, numbers, sizes) and abstractly (variables).
- Develop a probability and use it to find that designed systems, including those representing inputs and outputs, will maintain biodiversity and ecosystem services. Compare probabilities from the model to observe frequencies. IF the agreement is not good, explain possible sources of the discrepancy.

Modifications:
- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources
- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

Unit 4 - Force and Motion

Scope and Sequence
Time: Approximately 30 days

In this unit of study, students use system and system models and stability and change to understanding ideas related to why some objects will keep moving and why objects fall to the ground. Students apply Newton's third law of motion to related forces to explain the motion of objects. Students also apply an engineering practice and concept to solve a problem caused when objects collide.

Corresponds to Module K in textbook

Stage 1: Desired Results
Content Standards
MS-PS2-1: Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-ETS1-1: 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-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3: 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-ETS1-4: Develop a model to generate data for interactive testing and modification of proposed object, tool, or process such that an optimal design can be achieved.

Essential Question
How can we predict the motion of an object?

Enduring Understandings
- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).
- Models can be used to represent the motion of objects in colliding systems and their interactions, such as inputs, processes, and outputs, as well as energy and matter flows within systems.
- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values, by the finding of scientific research and by differences in such factors as climate, natural resources, and economic conditions.
- 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, which are likely to limit possible solutions.

<u>Knowledge and Skills</u> (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
- Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.
- Define a design problem involving the motion of two colliding objects that can be solved through the development of an object, tool, process, or system and that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
- Evaluate competing design solutions involving the motion of two colliding objects based on jointly developed and agreed-upon design criteria.
- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.
- Analyze and interpret data to determine similarities and differences in findings.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
<u>Benchmarks</u> (embedded student proficiencies)
<u>Assessment Methods</u> (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan
Throughout this unit of study, students will be examining and interacting with objects in motion. They will begin this unit by investigating Newton's third law of motion by observing the action/reaction forces involved during a collision. Students will expand their idea of collisions beyond the narrow view of collisions as being an accident in which two or more objects crash into each other. They will learn that scientists' use of the word collision does not refer to the size of the force; instead it describes any interaction between two objects. We want students to understand that a collision can be as small as an ant walking on a blade of grass - this is, that a collision is any touch between two objects, no matter how small or large the force.

Some possible observations may include the action/reaction forces involved in roller skating, skateboarding, moving boxes of different masses, etc. Students will then apply Newton's third law to possible problems and solutions. Some possible investigations could include designing and launching rockets or protecting eggs in a collision.

Students then investigate Newton's first and second laws of motion through hands-on activities in which they observe the result of balanced and unbalanced forces on an object's motion. Some examples may include using a seesaw or kicking a ball. In addition, students will observe how an object's motion will change depending upon the mass of the object and the amount of force applied. Activities could include pushing of different masses and comparing the forces needed to accelerate the objects.

Students could begin by observing collisions. An example of a collision could be an egg in a cart rolling down an incline and colliding with a barrier. Based on their observations of collisions, students will jointly develop and agree upon the design problem that they will focus on. Students will begin by making a clear statement of the problem they are going to attempt to solve. Once students have a clearly stated problem, the teacher will need to provide them with time and opportunity to participate in a short research project where they will gather background information that will help them come up with possible design solutions. Students will need to document their findings, making sure that they cite the resources they use.

After students have collected evidence, they can then begin to brainstorm possible solutions. To begin this process, students will need to identify the constraints and criteria for a successful design solution. This would involve them identifying the limits of the design. For example, time, materials, and resources could be some constraints. Students will next identify the criteria for a successful design. For example, one criterion could be that the egg in the collision does not break at all, or that it may crack as long as the contents do not spill out.

After the constraints and criteria have been identified, students can then generate possible solutions. Multiple solutions could be generated. Using the evidence collected during their research, as well as information they have learned as a part of their classroom experience, students can eliminate the solutions that seem least likely to be successful and focus on those that are more likely to be successful.

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After student have identified the solutions that are most likely to be successful, they will evaluate their competing design solutions using a rubric, checklist, or decision tree to assist them in selecting the design solution they will take into the next phase of the process.

Students have reached the stage where they will need to create a model that can be tested. The model could be physical, graphical, mathematical, or it could be a scale model. Students will use the model to collect evidence that will help them determine which of the possible design solutions will be taken into the prototype phase. During the prototype phase, students will create their actual model. Once students have constructed their devices, they should gather necessary data from tests performed on their design solutions. They will analyze and interpret these data to determine which design may be more successful. Once students have evaluated competing solutions and analyzed and interpreted data, they may then begin to modify their original designs. It is important that students consider the benefits of each design solution. This is when they are deciding whether different parts of their solutions can be combined to maximize efficiency. The final goal is for students to identify the parts of each design solution that best fit their criteria and combine these parts into a design solution that is better than any of its predecessors. Students will then translate this activity to a real world-example in which they see the influence of science, engineering, and technology on society and the natural world.

Suggested **Activity:** Make a model showing that for every action there is an equal and opposite reaction. Example: a demonstration showing two cars colliding and what results; Make a model showing that an object won't move unless a force acts on it. Example: a demonstration showing a bat hitting a baseball.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Cite specific textual evidence to support analysis of science and technical tests, attending to the precise details of explanations or descriptions of the application of Newton's third law involving the motion of two colliding objects.
- Follow precisely a multistep procedure when carrying out experiments to apply Newton's third law when designing a solution to a problem involving the motion of two colliding objects, take measurements, or performing technical tasks.
- Follow precisely a multistep procedure when performing an investigation that provides evidence that the change in an object's motion depends on the sume of the forces on the object and the mass of the object, taking measurements or performing technical tasks.
- Compare and contrast the information gained from experiments, simulations, videos, or multimedia sources with that gained from reading texts about the application of Newton's third law to the motion of two colliding objects. Conduct a short research project to answer a question about the application of Newton's third law when designing a solution to a problem involving the motion of two colliding objects, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- Conduct a short research project to answer a question about how the sum of the forces on the object and the mass of the object change an object's motion, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- Gather relevant information from multiple print and digital sources that provide information about the application of Newton's third law when designing a solution to a problem involving the motion of two colliding objects; assess the credibility of each source and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- Draw evidence from informational texts to support analysis, reflection, and research about the application of Newton's third law when designing a solution to a problem involving the motion of two colliding objects.

Mathematics
- Reason abstractly and quantitatively when collecting and analyzing data about the application of Newton's third law in the course of designing a solution to a problem involving the motion of two colliding objects.
- Analyze data in the form of numbers and symbols to draw conclusions about how the sum of the forces on an object and the mass of an object change the object's motion.
- Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in a design that applies Newton's third law to a problem involving the motion of two colliding objects.
- When collecting and analyzing data from investigation about how the sum of the forces on tan object and the mass of the object changes the object's motion, write, read, and evaluate expressions in which letters stand for numbers.

Modifications:
- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources
- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

Unit 5 - Types of Interactions

Scope and Sequence
Time: Approximately 30 days

In this unit of study, students use cause and effect; system and system models; and stability and change and change to understand ideas that explain why some materials are attracted to each other while others are not. Students apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other whiles other repel. In particular, students develop understandings that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative. Students also develop ideas that objects can exert forces on each other even though they objects are not in contact, through fields. Students are expected to consider the influence of science, engineering, and technology on society and the natural world. Students are expected to demonstrate proficiency in asking questions, planning and carrying out investigations, designing solutions, and engaging in argument.

Corresponds to Module K in textbook

Stage 1: Desired Results

Content Standards
MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Essential Questions
Is it possible to exert on an object without touching it?

Enduring Understandings
- Fields exist between objects that exert forces on each other even though the objects are not in contact.
- The interactions of magnets, electrically charged strips of tape, and electrically charged pith balls are examples of fields that exist between objects exerting forces on each other, even though the objects are not in contact.
- Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object or a ball, respectively).
- Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.
- Factors affect the strength of electric and magnetic forces.
- Devices that use electric and magnetic forces could include electromagnets, electric motors, and generators.
- Electric and magnetic (electromagnetic) forces can be attractive and repulsive.
- The size of an electric or magnetic (electromagnetic) force depends on the magnitudes of the charges, currents, or magnetic strengths involved and on the distance between the interacting objects.
- Cause-and-effect relationships may be used to predict the factors that affect the strength of electrical and magnetic forces in natural or designed systems.
- Gravitational interactions are always attractive and depend on the masses of interacting objects.

- There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass.
- Evidence supporting the claim that gravitational interactions are attractive and depend on the masses of interacting objects could include data generated from simulations or digital tools and charts displaying mass, strength of interactions, distance from the sun, and orbital periods of objects within the solar system.

Knowledge and Skills (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
- Students will conduct an investigation and evaluate an experimental design to produce data that can serve as the basis for evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- Students will identify the cause-and-effect relationships between fields that exist between objects and the behavior of the objects.
- Students will ask questions about the data to determine the effects of the strength of electric and magnetic forces that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
- Students will perform investigations using devices that use electromagnetic forces.
- Students will collect and analyze data that could include the effect of the number of turns of wire on the strength of an electromagnet or the effect of increasing the number or strength of magnets on the speed of an electric motor.
- Students construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- Students use models to represent the gravitational interactions between two masses.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
Benchmarks (embedded student proficiencies)
Assessment Methods (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan
Students will conduct investigations of fields that exist between objects exerting forces on each other, even though the objects are not in contact. Through first-hand experiences or simulations, students will observe and evaluate the behavior of objects and record evidence of fields that exist and are responsible for the observed behavior of the objects. Students can investigate the interactions between magnets, electrically charged strips of tape, and/or electrically charged pith ball.s Through hands-on investigation or simulation, students will be able to observe how the motion or behavior of objects change when they are exposed to electric or magnetic fields. For example, a pith ball could be suspended from a lightweight string and students can apply a charge to a balloon, comb, or plastic rod and make observations about the motion of the pith ball when these objects are placed in close proximity to the ball. The same type of investigation could be conducted with magnets or strips of electric tape. If instruction starts with students making these observations, students could then generate questions that they could use to ask questions about the cause-and-effect relationships that could explain their observations. A short research project could be conducted to provide data that students would use to help them answer their self-generated questions.
Students will investigate magnetic and electric forces to determine the nature of the force (repulsive, attractive, or both), and factors that affect the strength of the forces. Before beginning the investigations, students will generate questions that will be used to guide their investigations. Depending on the nature of their questions, students may need to cite specific textual evidence to support the generation of a hypothesis. During the

investigations, students will identify cause-and-effect relationships and use their understanding of these relationships to make predictions about what would happen if a variable in the investigation were changed. They will also determine the impact of distance on the strength of a force. Investigations may include the use of electromagnets, electric motors, or generators. During these investigations, students will collect data that they will use to answer their self-generated questions.

Students will investigate magnetic and electric forces to determine the nature of the force (repulsive, attractive, or both) and factors that the strength of the forces. Before beginning the investigations, students will generate questions that will be used to guide their investigations. Depending on the nature of their questions, students may need to cite specific textual evidence to support the generation of a hypothesis. During the investigation students will identify cause-and-effect relationships and use their understanding of these relationships to make predictions about what would happen if a variable in the investigation were changed.

They will also determine the impact of distance on the strength of a force. Investigations may include the use of electromagnets, electric motors, or generators. During these investigations, students will collect data that they will use to answer their self-generated questions. Investigations can take place in the classroom, outdoor environment, or museums and other public facilities with available resources and when appropriate. Students will frame a hypothesis based on observations and scientific principles about the behavior of electromagnetic forces and carry out investigations to collect data about the factors that affect the strength of electric and magnetic forces. Examples of investigations could include the effect of the number of turns of wire on the strength of an electromagnet or the effects of increasing the number or strength of magnets on the speed of an electric motor. Students will analyze both numerical and symbolic data and use these data to determine the factors that affect the strength of electric and magnetic fields. Students will conclude this portion of the unit by citing specific textual evidence to support the analysis of information they access while reading science and technical texts or online sources about electric and magnetic forces, attending to the precise details of explanations or descriptions.

The next portion of this unit will focus on gravitational forces. Students will construct and present oral and written arguments using evidence to support the claim that gravitational interactions are always attractive and depend on the masses of interacting objects. Students will also understand that there is gravitational force between any two masses, but it is very small except when one or both of the objects have large mass. Because of this, gravitational fields will only be observed through the observation of simulations, the use of models, or the analysis of data. These could include simulations of digital tools and charts displaying mass, strength and interactions, distance from the sun, and orbital periods of objects within the solar system. Models used need to represent gravitational interactions between two masses within and between systems.

Suggested **Activity:** Discuss why electricity and magnetic forces can be strengthened or weakened. Example: A lecture on electrical circuits in the house and demagnetizing a magnet with high heat.; Show a model of how gravity is affected by the weight of an object. Example: Show a model of the sun and the planet's gravitational attraction to it.; Do an experiment that will show that forces occur even though the objects are not touching. Example: An experiment showing iron files around two magnets with like or unlike poles.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Cite specific textual evidence to support analysis of information about science and technical texts regarding the factors that affect the strength of electric and magnetic forces, attending to the precise details of explanations or descriptions.
- Write arguments focused on evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Mathematics

- Reason abstractly and quantitatively while using data to determine the factors that affect the strength of electric and magnetic forces.

Modifications:
- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources
- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

Unit 5 - Astronomy

Scope and Sequence
Time: Approximately 25 days

In this unit of study 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 system 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 explore the objects in our solar system and obtain the data that support the theories explaining the formation and evolutions of the universe. Students examine geosciences data in order to understand the processes and events in Earth's history.

Corresponds to Module H in textbook

Stage 1: Desired Results

Content Standards
MS-ESS1-1: 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.
MS-ESS1-2: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system.

Essential Questions
What pattern in the Earth-sun-moon system can be used to explain lunar phases, eclipses of the sun and moon, and seasons? What is the role of gravity in the motions within galaxies and the solar system? What are the scale properties of objects in the solar system?

Enduring Understandings
- Patterns in the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models.
- The Earth and solar system 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.
- Patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky.
- Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observations.
- Gravity plays a role in the motions within galaxies and the solar system.
- Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them.
- Earth and its solar systems are part of the Milky Way galaxy, which is one of many galaxies in the universe.
- 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.
- The solar system appears to have formed a disk of dust and gas, drawn together by gravity.
- Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system.

- Science assumes that objects and events in the solar system occur in consistent patterns that are understandable through measurement and observations.
- Objects in the solar system have scale properties.
- Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects.
- 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.
- The solar system consists of the sun and a collections of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
- Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are tool large.
- Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.

Knowledge and Skills (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
- Analyze and interpret data to determine similarities and differences among objects in the solar system.
- Students develop and use a physical, graphical, or conceptual model to describe patterns in the apparent motion of the sun, moon, and stars in the sky.
- Students develop and use models to explain the relationship between the tilt of Earth's axis and seasons.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
Benchmarks (embedded student proficiencies)
Assessment Methods (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan
At the beginning of the unit, students will develop and use mathematical, physical, graphical or conceptual models to describe the cyclical patterns of lunar phases, eclipses of the sun and moon, and seasons. Students can use mathematics to create scale models of the solar system to investigate relative distances between the planets and their orbits around the sun or to represent the distance from the sun to the Earth during different Earth seasons. Students can also use physical models to examine the phases of the moon using a light sources and a moon model to view the various shapes of the moon as it orbits the earth. Students may also keep a lunar calendar for one month and analyze the results by looking for differences and patterns. Using a model of the sun, Earth, and moon, students can view the positions of these planetary objects during a solar or lunar eclipse. To investigate seasons, students can simulate the position and tilt of the Earth as it revolves around the sun, using computer simulations, hands-on models, and video.
Students will explore, through the development and use of models, the role of the force of gravity in explaining the motions within our solar system and the Milky Way Galaxy. As part of their study of the solar system and its components, including the sun, planets and their moons, and asteroids, they will use models and examine simulations to determine how gravity holds these systems together.
Students will explore, through the development and use of models, the role of the force of gravity in explaining within our solar system and the Milky Way Galaxy. As part of their study of the solar system and its components, including the sun, planets and their moons, and asteroids, they will use models and examine simulations to determine how gravity holds these systems together. To visualize how gravity pulls objects down towards its center, students can experiment with dropping spheres of different masses but of the same diameter as a way to determine that gravity acts on both objects and that they drop at the same rate. If technology is available, students can measure the acceleration of the objects as they fall from various heights. Students will be able to determine that the objects speed up as they fall, therefore proving that a force is acting on them. If motion detectors are not available for use, they could observe these using simulations.

After students have had opportunities to participate in the investigations, they should prepare multimedia visual displays that present their findings. As part of their presentation, students will use mathematical models or simulations that show the relationship between relative sizes of objects in the solar system and the size of the gravitational force that is being exerted on the object. They should be able to compare and contrast the weight of an object if tt were on the surface of different-sized planets that have very different masses. Students will gather evidence that every object in the solar system is attracted to every other object in the solar system with a force that is related to the mass of the objects and the distance between the objects. They should extend this understanding of gravity to explain why objects in the solar system do not simplify flow away from each other. Students should also make connections between their understanding of the force of gravity and the formation of the solar system from a cloud of dust and gas. As part of their mathematical model of the solar system, students will use variables to represent numbers and write expressions when solving a problem involving the role of gravity in the motions within galaxies and within the solar system. The variable can represent an unknown number or any number in a specified set.

Students will also analyze and interpret data from Earth-based instruments to determine the scale properties of objects within our solar system. Examples of models that students could use include physical (such as the analogy of distance along a football field or computer visualization of elliptical orbits), conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state). Students can construct scale models of the solar system that will help them visualize relative sizes of objects in the system as well as distances between objects. Students can use graphs or tables to make comparisons between the size and gravitational pull of the planets and their moons.

Suggested **Activity:** Make a model showing how the earth, moon and sun interact to form eclipses, lunar phases and seasons. Example: A demonstration showing a flashlight (the sun) and spheres to simulate eclipses.; Do a demonstration that shows how much larger the sun is to the other planets in the solar system. Example: Demonstration showing the sun is 99% of the solar system.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Include multimedia components and visual displays in presentations to describe the cyclical patterns of lunar phases, eclipses of the sun and moon, seasons, and the role of gravity in the motions within galaxies and the solar system. The presentation needs to clarify claims and findings and emphasize salient points.
- Cite specific textual evidence to support analysis of science and technical text about scale properties of objects in the solar system.
- Integrate quantitative or technical information expressed in words in a text about scale properties of objects in the solar system with a version of that information expressed visually in a flowchart, diagram, model, graph, or table.

Mathematics

- Reason quantitatively and abstractly about the size of an object's layers, surface features, and orbital radius where appropriate.
- Use mathematics to model the motion of the sun, moon, and stars in the sky and the role of gravity in the motions within galaxies and the solar system.
- Understand the concept of a ration and use ratio language to describe ratio relationship between the measurements of the cyclical motions between at least two bodies in the solar system and the relative sizes of objects and/or distances between objects and the impact of gravity on the motion of these objects.
- Recognize and represent proportional relationships between the measurement of patterns in the cyclical motions of the sun, moon, and stars in the sky and mathematical proportions relative to the sizes of objects and the effect of gravity on the motion of these objects.

- Use variables to represent numbers and write expressions when solving a problem involving the role of gravity in the motions within galaxies and within the solar system. Understand that a variable can represent an unknown number, or depending on the problem, any number in a specified set.

Modifications:
- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources
- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

Unit 7 - Weather and Climate

Scope and Sequence
Time: Approximately 25 days

In this unit of study, students make sense of how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. A system approach is also important here, examining the feedbacks between systems as energy from the Sun is transferred between systems and circulates through the ocean and atmosphere.

Corresponds to Module E in textbook

Stage 1: Desired Results

Content Standards
MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
MS-ESS2-5: Collect data to proved evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
MS-ESS2-6: 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.

Essential Questions
What factors interact and influence weather and climate?

Enduring Understandings
- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- The cycling of water through Earth's systems is driven by energy from the sun and the force of gravity.
- Within Earth's systems, the transfer of energy drives the motion and/or cycling of water.
- The motions and complex interactions of air masses result in changes in weather conditions.
- The complex patterns of the changes in and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.
- Examples of data that can be used to provide evidence for how the motions and complex interactions or air masses result in changes in weather conditions include weather maps, diagrams, and visualizations; other examples can be obtained through laboratory experiments.
- Air masses flow from regions of high pressure to regions of low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time.
- Because patterns of the changes and the movement of water in the atmosphere are so complex, weather can only be predicted probabilistically.
- Sudden changes in weather can result when different air masses collide.
- Weather can be predicted within probabilistic ranges.
- Cause-and-effect relationships may be used to predict changes in weather.
- Unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- Patterns of atmospheric and oceanic circulation that determine regional climates vary by latitude, altitude, and geographic land distribution.

- Atmospheric circulation that, in part, determines regional climates is the result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds.
- Ocean circulation that, in part, determines regional climates is the result of the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents.
- Models that can be used to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates can be diagrams, maps and globes, or digital representations.

Knowledge and Skills (SWBAT embedded course proficiencies)
Students who understand the concepts are able to:
- Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- Model the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle.
- Collect data to serve as the basis for evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
- 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.

Stage 2: Evidence of Understanding, Learning Objectives and Expectations
Benchmarks (embedded student proficiencies)
Assessment Methods (formative, summative, other evidence and/or student self- assessment)

Stage 3: Learning Plan

During this unit, students will answer the question "What factors interact and influence weather and climate?" beginning with the cycling of water in Earth's systems. Models will be created and emphasis will be on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Students will model the continuous movement of water from land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation. Students will focus on the global movement of water and its changes in form that are driven by sunlight as it heats the Earth's surface water.

The motions and complex interactions of air masses result in changes in weather conditions. The patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. Students will collect data from weather maps, diagrams, visualizations, and laboratory experiments to explain how the movements of air masses from regions of high pressure to regions of low pressure cause weather at a fixed location. For example, students can observe the movement of colored water that simulates the movement of hot and cold air masses. Students can observe the cooler water flowing in the direction of the warmer area and equate this with wind being created from the uneven heating of the Earth. Students will compare data collected from sources such as simulations, video, or experiments to identify the patterns of change in the movement of water in the atmosphere that are used to make weather predictions, understanding that any predictions are reported within probability ranges. Students will also make predictions about the conditions that result in sudden changes in weather.

Students will use models, diagrams, maps, and globes to understand atmospheric and ocean circulation patterns. Since the ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents, the ocean will be studied as a system with interactions such as inputs, outputs, processes, energy, and matter. Students will model how the unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. They will describe how the unequal heating of the global ocean produces convection currents. By examining maps, globes and digital representations of the movement of ocean currents, students will model the patterns by

latitude, altitude, and geographic distribution. They will show that these patterns vary as a result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing wines.

Digital models like NOAA videos can be used to help students visualize how variations in density due to temperature and salinity drive a global pattern of interconnected ocean currents. This can be demonstrated in the classroom using models in which colored water with different temperatures or water with different densities is added to clear tubs of water. Students can observe that the warmer water is pushed upwards by the colder water. This same demonstration can be used with water that has different salinities. Using a turntable and drawing a straight line from the middle to the edge can model the Coriolis effect. If a turntable is not available, a Lazy Susan is a great substitute. The turntable or Lazy Susan can be painted with chalk paint, and the students can draw the line using chalk. Using chalk paint and chalk will enable the teacher to use them over and over. After the turntable is stopped, students will see that the motion of the turntable resulted in a curved line, and they will then be able to correlate how the rotation of Earth results in the movement of air.

Suggested **Activity:** Make a model of the water cycle and how it gets its energy from the sun. Examples: Make a poster of the water cycle that shows precipitation, condensation and evaporation.; Lecture on how air masses result in weather conditions. Example: Act as a weatherman and report weather conditions.; Make a model showing how the seasons work. Example: Make a model showing how the seasons differ from location to location.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

- Support the analysis of science and technical texts by citing specific textual evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
- Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with information that is gained from reading text about how the complex patterns of the changes and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents are major determinants of local weather patterns.
- Gather relevant information from multiple print and digital sources about how the complex patterns of the changes and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- Include multimedia components and visual displays in presentations to clarify information about how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

Mathematics
- Reason abstractly and quantitatively by using data such as weather maps, diagrams, and visualizations or obtained through laboratory experiments to predict weather within probabilities ranges.
- Understand that positive and negative numbers are used together to describe quantities having opposite directions or values. Use positive and negative numbers to represent changes in atmospheric and oceanic temperatures, explaining the meaning of 0 in each situation.

Modifications:
- Provide students with multiple choices of how they can represent their understandings
- 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.

Resources
- District approved science textbook
- Websites
- Videos
- Nonfiction/fiction sources

New Jersey Core Curriculum and Common Core Content Standards

http://www.state.nj.us/education/cccs/

Integration of 21ˢᵗ Century Theme(s)
The following websites are sources for the following 21ˢᵗ Century Themes and Skills:
http://www.nj.gov/education/code/current/title6a/chap8.pdf
http://www.p21.org/about-us/p21-framework .
http://www.state.nj.us/education/cccs/standards/9/index.html

21st Century Interdisciplinary Themes (into core subjects)
• **Global Awareness**
• **Financial, Economic, Business and Entrepreneurial Literacy**
• **Civic Literacy**
• **Health Literacy**
• **Environmental Literacy**

Learning and Innovation Skills
• **Creativity and Innovation**
• **Critical Thinking and Problem Solving**
• **Communication and Collaboration**

Information, Media and Technology Skills
• **Information Literacy**
• **Media Literacy**
• **ICT (Information, Communications and Technology) Literacy**

Life and Career Skills
• **Flexibility and Adaptability**
• **Initiative and Self-Direction**
• **Social and Cross-Cultural Skills**
• **Productivity and Accountability**
• **Leadership and Responsibility**

Integration of Digital Tools
- **Classroom computers/laptops/Chromebooks**
- **Technology Lab**
- **Voice amplification device**
- **Other software programs**