Course Title: 8th Grade Science

Department: Science
Grades: 8th Credits: 1

Course Overview/Description

The Middle School Science adopted curriculum is Amplify Science, written by the Lawrence Hall of Science at UC Berkeley (creators of the FOSS Science kits) and integrated into a digital platform developed by Amplify. Amplify Science is aligned with the Next Generation Science Standards (NGSS) three dimensions (Disciplinary Core Ideas, Scientific and Engineering Practices, and Crosscutting Concepts) which are integrated into individual performance expectations which guide both instruction and assessment. The Amplify Science program engages learners in phenomenon-anchored science and engineering unit storylines as its instructional model. At the 8th grade level, students get an integrated course where they explore Life Science, Earth and Space Science, and Engineering Design topics.

Scope and Sequence

Timeframe	Unit	Instructional Topics
4 weeks (September 7 - October 1)	**Unit 1 - Nature of Science**	**• Identify the goal of science • Scientists answer questions by using data and information from text. • Scientific Argument (CER)**
4 weeks (October 4 - October 29)	**Unit 2 - Microbiome**	**• Life science is the study of living things • All living things are made of cells • Microorganisms on and in the human body**
4 weeks (November 1 - November 30)	**Unit 3 - Metabolism**	**• Molecules needed by the cells • Body Systems • Cellular Respiration**
4 weeks (December 1 - December 22)	**Unit 4 - Traits and Reproduction**	**• Exploring variation in spider silk • Examining spider genes • Investigating spider inheritance**
4 weeks January 3rd - January 28)	**Unit 5 - Populations and Resources**	**• Stability and change in populations • Energy and changes to populations • Indirect effects in ecosystems**
4 weeks January 31 - February 25)	**Unit 6 - Earth, Moon, and Sun**	**• Light and dark on the Moon • Moon Phases • Lunar and Solar Eclipses**
4 weeks February 28 - March 24)	**Unit 7 - Ocean, Atmosphere, and Climate**	**• Air Temperature • Ocean Currents • Ocean Currents and Prevailing Winds**
4 weeks April 4 - April 29)	**Unit 8 - Weather Patterns**	**• Understanding Clouds • Investigating Temperature • Exploring Wind and Pressure**
4 weeks May 2 - June 3)	**Unit 9 - Earth's Changing Climate (May 11-13 Mini Unit YMCA Camp U-Nah-Li-Ya)**	**• Climate and the Atmosphere • Energy entering and leaving Earth's system • Human Activity and Climate**

UNIT 2: Microbiome 15-20 days

Description: Findings about the human microbiome are all over the news and are attracting the attention of scientists from many different fields—for good reason! There is evidence to suggest that the approximately 100 trillion bacteria living on and in the human body may correlate to many different health conditions. Further, altering one's microbiome can result in altering one's health, for better or worse. Most notably, a treatment known as a fecal transplant—a transplant that involves using microorganisms from one person's healthy gut microbiome to cure another person who is suffering from a potentially deadly infection—has been under review. These developments have sent many from the scientific community to further investigate the human microbiome. In this unit, students take on the role of student researchers as they work out and explain the anchor phenomenon for the unit—a fecal transplant cured a patient suffering from a potentially deadly C. difficile infection.

INSTRUCTIONAL TOPIC: How small are the microorganisms that live on and in the human body? -- 3-5 Days

Description: Students are introduced to their role as student researchers at the Microbiome Research Institute. They view the engaging (and disgusting) Gross Microscopy slideshow and are introduced to the Chapter 1 Question: How small are the microorganisms that live on and in the human body?

Learning Targets

- **Students investigate the scale of microorganisms that live on and in the human body (1.1)**
- **Students research the scale of single-celled organisms and construct scale models of single-celled microorganisms. (1.2)**
- **Students identify that all organisms are made of cells and almost all cells are microscopic. (1.2)**
- **Students consider how the scale of molecules compares to the scale of cells (1.3)**

INSTRUCTIONAL TOPIC: What types of microorganisms are helpful and harmful? -- 8-12 Days

Description: Students return to the images of a bacteria culture that they observed in Lesson 1.3 in order to see what happened after several more days of growth. These new observations provide evidence about the microorganisms living on our bodies. Then, students read more about how the human body acts as a home for trillions of these microorganisms in the "The Human Microbiome" article. As they read, they are introduced to and practice a method of careful, attentive reading and discussion called Active Reading. This type of reading helps them understand key ideas from the article. The purpose of this lesson is to provide an important introduction to the Active Reading approach, which students will use throughout the Amplify Science Middle School curriculum. It also sets the stage for the investigations that students will be conducting throughout the remainder of the unit

Learning Targets

- **Students obtain and evaluate information about how the human body acts as a home for trillions of microorganisms (2.2)**
- **Students analyze and interpret data about the microorganisms that make up the gut microbiome in a fecal transplant (2.2)**
- **Students evaluate evidence about the effects of antibiotics on the microorganisms that make up the human microbiome (2.3)**
- **Students obtain information from an article to learn about how bacteria interact with the environment of the body (2.4)**
- **Students construct their final arguments about fecal transplants by analyzing and interpreting data about the effect of a fecal transplant (2.5 and 2.7)**

UNIT 3: Metabolism 18-20 days

Description: Through inhabiting the role of medical students in a hospital, students—as they first diagnose a patient and then analyze the metabolism of world-class athletes—are able to draw the connections between the large-scale, macro-level experiences of the body and the micro-level processes that make the body function. By investigating the anchor phenomenon—a patient whose body systems are not working properly, students learn how body systems work together to provide the trillions of cells in the human body with the molecules they need. By exploring how athletic training improves the body's function, students learn how energy is released in the cells through cellular respiration and how that energy supports movement and cellular growth and repair.

INSTRUCTIONAL TOPIC: How do the trillions of cells in the human body get what they need to function, and what do the cells do with the things they absorb? -- 3-5 Days

Description: Students complete a Pre-Unit Assessment consisting of 12 multiple-choice questions and 2 written response questions in which students analyze and interpret data and construct explanations. After this assessment, students begin the unit by viewing a dramatic video that immerses them in their new role as medical students. Students build on the video by brainstorming initial thoughts about why their patient, Elisa, could be feeling so tired. Students continue their efforts to diagnose Elisa. Next, students receive a new set of evidence about Elisa's diet and sleep habits. Students critique this evidence, considering whether enough data was collected. Finally, students reconsider the possible claims about why Elisa is so tired

Learning Targets

- **Students use a model of the human body to make observations at the molecular scale (scale, proportion, and quantity) (1.2)**
- **Students obtain information to determine the molecules that cells need to function in a healthy body (1.3)**

INSTRUCTIONAL TOPIC: What is happening in Elisa's body that could be preventing molecules from getting to her cells? -- 8-12 Days

Description: Students participate in a classroom-sized model of the human body in which students play the roles of body systems delivering molecules (represented by pipe cleaners) to cells. Students prepare to diagnose Elisa by engaging in a jigsaw reading experience. Each student becomes an expert on one of four medical conditions—anemia, asthma, diabetes, or pancreas injury—that might explain Elisa's symptoms. Students read Patient Stories: Problems with Body Systems article. Using what they learn from the article, students create models to represent what happens in a body that has the condition they read about. Students complete a Critical Juncture Assessment (CJ) consisting of twelve multiple-choice questions and two written response questions. The CJ is designed to reveal students' current levels of understanding about the core content from the unit. Students share their analysis with their groups in order to make a diagnosis, and finally, each student produces a written argument about the diagnosis.

Learning Targets

- **Students create a model of the human body in which they play the roles of body systems delivering molecules to cells. (2.1)**
- **Students evaluate information about metabolic conditions that affect the body's subsystems and the whole body (2.2)**
- **Students create models to represent the changes to a body and its' subsystems caused by a metabolic condition (2.3)**
- **Students use a digital model to test how a medical condition can affect the functioning of the body and its subsystems (2.4)**
- **Students analyze and interpret data about how Elisa's body is taking in and absorbing different molecules (2.7)**
- **Students construct written arguments based on this evidence, explaining the diagnosis of a patient (2.7)**

INSTRUCTIONAL TOPIC: How do molecules in the cells of the body release energy? -- 5-7 Days

Description: Students dive deeper into metabolism, focusing on how molecules from food and air are involved in releasing the energy that the cells and body need to function. Students collect evidence from two sources; first, they examine what happens to their own heart rates and breath rates when they exercise, and then they observe what is happening inside the body at the molecular level, using the Simulation. These activities allow students to discover that glucose molecules and oxygen molecules are needed in cells for energy release, which is preparation for learning about the process of cellular respiration

Learning Targets

- **Students collect and analyze evidence about which molecules are needed in the cell for energy release (3.1)**
- **Students engage in a hands-on investigation of a chemical reaction that releases energy (3.2)**
- **Students investigate how energy from cellular respiration is needed for cells to build protein molecules from amino acids (3.3)**
- **Students analyze and interpret data about the differences in cellular respiration between an average healthy body and the body of a highly trained athlete (3.4)**

UNIT 4: Traits and Reproduction 18-20 days

Description: In the Traits and Reproduction unit, students take on the role of student genetic researchers, working with the fictional bioengineering firm, Bay Medical Company. Bay Medical Company is attempting to breed spiders with the type of silk that can be used for medical applications (e.g., to create artificial tendons). The student genetic researchers are faced with the challenge of explaining how the silk flexibility traits of closely related spiders can vary, which serves as the anchor phenomenon for the unit. To explain this mystery, students create physical models, read articles, and observe genetics in action, using the Traits and Reproduction Simulation. Through their research, students learn about the role proteins, genes, and sexual reproduction play in trait variation. They are able to apply what they have learned about spiders to a human context.

INSTRUCTIONAL TOPIC: What determines an organism's traits at the molecular scale? -- 5-6 Days

Description: Students complete a Pre-Unit Assessment consisting of 12 multiple-choice questions and 2 written response questions in which students analyze and interpret data and construct explanations. Students learn that Darwin's bark spiders, a newly discovered spider species, have the strongest spider silk on Earth. When bred for optimal silk flexibility, their silk may have important medical applications. students investigate how protein molecules in an organism's cells affect its traits. Students then draw and label a visual model to illustrate their ideas about how different protein molecules result in variation among spider silk traits. Students observe that a change to protein molecules causes a change to traits.

Learning Targets

- **Students investigate how the structure of proteins determines their function (1.3)**
- **Students communicate how differences in the structure of protein molecules cause differences in traits (1.4)**
- **Students analyze and interpret evidence about how a specific protein affects a person's running ability (1.5)**

INSTRUCTIONAL TOPIC: How can organisms make different protein molecules for a particular feature? Why do some organisms make one type of protein for a feature and other organisms make two? -- 4-6 Days

Description: Students, playing the role of ribosomes, follow the instructions in order to construct models of protein molecules. Students explore in the Sim, comparing spiders with only one type of protein for a feature in their cells to spiders that have two different types of proteins for a feature in their cells. Students reflect on and apply their growing understanding of the role genes play in producing proteins that determine traits.

Learning Targets

- **Students evaluate information as they actively read "Hemophilia, Proteins, and Genes," an article about how genes provide instructions (2.1)**
- **Students engage in a physical model representing genes and construct protein molecules (2.2)**
- **Students identify that organisms have two copies of a gene and that these copies may be identical or different. (2.3)**
- **Students construct visual models to communicate how different gene variation causes variation at the macroscale (2.4)**

INSTRUCTIONAL TOPIC: How do organisms get their genes? How does sexual reproduction result in variation among offspring? -- 6-8 Days

Description: Students read, annotate, and discuss the article "Why Are Identical Twins Rare?" This article introduces ideas about inheritance in humans. Students develop a robust understanding of how genes are inherited through sexual reproduction. Students will also counter the common misconception that organisms can get more of their genes from one parent. Students identify how sexual reproduction leads to variation in offspring' gene versions and traits. Students apply what they have learned about traits, proteins, genes, and inheritance to explain variation in the spider family and help Bay Medical Company with their research.

Learning Targets

- **Students evaluate information as they read "Why Are Identical Twins Rare?," an article about inheritance in humans (3.1)**
- **Students identify how genes inherited during sexual reproduction cause offspring to have different gene combinations (3.2)**
- **Students use a digital model to make and test predictions about the gene versions that offspring could inherit from a specific set of parents (3.3)**
- **Students gather evidence from a model about how genetic diseases are randomly passed on from parents to offspring (3.4)**
- **Students write scientific arguments explaining that the spider offspring have different traits at the macroscale because of the protein molecules they produce at the molecular scale (3.6)**

UNIT 5: Population and Resources 18-20 days

Description: Ecosystems are complex systems; determining what might have caused a change in the size of a particular population is not a straightforward question but is an important one as population sizes are changing more than ever due to human activities. A population's size can be determined by the availability of its resources, whether it be food, water, habitat, or something else. In this unit, we focus mainly on eating relationships and reproduction as factors that affect a population's size. Understanding how different populations are connected to one another as part of a food web is one key to understanding how changes in one population may affect change in another. In the role of student ecologists at a research center near the fictional Glacier Sea, students investigate what may have caused a puzzling increase in the size of the moon jelly population there, which serves as the anchor phenomenon for the unit.

INSTRUCTIONAL TOPIC: What caused the size of the moon jelly population in the Glacier Sea to increase? -- 5-6 Days

Description: Students are introduced to the crosscutting concept of Stability and Change within an ecosystem through the case of the moon jelly population explosion in the Glacier Sea. Students use a physical token model to learn that births and deaths are always happening in a population, but the number of births compared to deaths determines a population's size. They then apply this key concept to explain that the Glacier Sea moon jelly population increased because births were greater than deaths.

Learning Targets

- **Students ask questions and develop initial models to investigate interactions among organisms in an ecosystem (1.2)**
- **Students produce line graphs about how births and deaths can cause a population to change (1.3)**
- **Students analyze data and construct visual models of how births and deaths affected population size (1.4)**

INSTRUCTIONAL TOPIC: What could have caused the births to increase or the deaths to decrease in the moon jelly population? -- 4-6 Days

Description: Students consider what can change the number of births and deaths in a population. They investigate how changes to a population's resource and consumer populations affect the flow of energy storage molecules in an ecosystem, resulting in a change to a population's size. Students apply what they learn to explain what could have caused births to increase or deaths to decrease in the Glacier Sea moon jelly population.

Learning Targets

- **Students conduct a hands-on experiment with yeast and discover that populations get the energy they need to reproduce by consuming food which then undergoes chemical reactions to release stored energy (2.2)**
- **Students use food webs to gather evidence about how the size of a resource population affects the number of births in a consumer population (2.3)**
- **Students construct explanations showing how the size of a consumer population affects the number of deaths in the resource population (2.4)**
- **Students construct visual models showing how a change to the jellies' resource population could have caused births to increase (2.7)**

INSTRUCTIONAL TOPIC: How could a population besides the zooplankton or sea turtles have caused the moon jelly population to increase? -- 6-8 Days

Description: Students return to the Glacier Sea food web to consider what other populations besides zooplankton and sea turtles might have caused the moon jelly population to increase. They use the Sim to investigate competition and other indirect effects in an ecosystem. Students apply what they learn to support a claim about how a population that is not the jellies' direct resource or consumer population could have caused the moon jelly population to increase.

Learning Targets

- **Students gather evidence from the article "Jelly Population Explosion" and from a digital model (3.2)**
- **Students investigate how populations can indirectly affect one another in an ecosystem (3.3)**
- **Students construct arguments about why the moon jelly population increased (3.3)**

UNIT 6: Earth, Moon, Sun 18-20 days

Description: Most students and many adults have no idea why the Moon looks different from night to night. For many, the predictable pattern of moon phases is just a mysterious and beautiful part of our night sky. In fact, understanding why we see the Moon as we do requires some fairly challenging spatial reasoning. This unit helps students gain a deeper understanding of everyday observations of the Moon, transforming the experience of Moongazing into an act of profound and expansive perception. By the end of the unit, students will be able to explain the mechanisms behind patterns of light and dark on the Moon, moon phases, and lunar eclipses.

INSTRUCTIONAL TOPIC: Why is there a border between light and dark on the Moon? -- 5-6 Days

The purpose of this chapter is to establish a fundamental grasp of how and why the Moon appears to be both light and dark, laying a necessary foundation for subsequent investigations into how and why the appearance of the Moon changes over time. Students also use these models to explore the concept of scale, learning what it means for a model to be "to scale" and why models of the solar system are frequently "not to scale."

Learning Targets

- **Students investigate where the Moon gets its light by analyzing and interpreting photos of light on the Moon (1.2)**
- **Students consider how scale is used in models (scale, proportion, and quantity) (1.3)**
- **Students construct explanations about why there is a border between light and dark on the Moon (1.4)**

INSTRUCTIONAL TOPIC: Why does the border between light and dark on the Moon change location? -- 4-6 Days

Description: In this chapter, students begin by learning about the different phases of the Moon, working to explain why the appearance of the Moon that we observe from Earth changes so frequently in spite of the fact that the sun consistently illuminates half the Moon. Students discover that the Moon's changing appearance is the product of movement, finding that the Moon looks different to an observer on Earth when it is in different positions around Earth. As the chapter continues, students use these same sources of evidence to find that the Moon moves through these positions on a monthly cycle as it orbits Earth, which causes the phases of the Moon to follow a consistent pattern. By the end of this chapter, students are ready to construct a visual model that depicts this pattern and to leverage the model's predictive power to advise Eric Wu about when he can and cannot take his photographs for About Space magazine. The purpose of this chapter is for students to learn about how the orbital motion of the Moon creates the monthly pattern of moon phases that we observe from Earth.

Learning Targets

- **Students gather evidence from the Earth-Moon-sun system (systems and system models to evaluate two competing claims about why the appearance of the Moon from Earth changes from night to night. (2.2)**
- **Students create visual models of the Moon phases, use a digital model to test their ideas, and revise their models to communicate their new understanding. (2.3)**
- **Students construct explanations about the relationship between the monthly pattern of the Moon's orbital motion and the monthly pattern of the Moon phases (2.4)**
- **Students use a digital model to gather evidence to help them explain different scenarios involving the positions of the Moon and Earth (2.7)**

INSTRUCTIONAL TOPIC: What are the conditions that cause a lunar eclipse? -- 6-8 Days

Description: In this chapter, students investigate lunar eclipses. At the beginning of this chapter, students are presented with an image of the Moon in Top View during a lunar eclipse. Prompted by this image, students begin to investigate why the Moon is completely dark during a lunar eclipse, using the Moon Sphere Model and the Sim to find that, unlike the moon phases they have been studying, lunar eclipses are caused by Earth casting a shadow on the Moon. Having discovered this, students begin a second investigation into why lunar eclipses do not happen every time Earth is in between the sun and the Moon. Using the Sim as evidence, students find that this is due to the fact that the Moon's orbit around Earth is not in the same plane as Earth's orbit around the sun, which makes it unusual for Earth to be aligned directly between the Moon and the sun. Once students have all of this evidence, they are ready to model the conditions that cause a lunar eclipse and to advise Eric Wu on when to photograph an eclipse for About Space magazine. The purpose of this chapter is for students to learn that the Moon is completely dark during a lunar eclipse because Earth is directly between the Moon and the sun, blocking the sun's light and casting its shadow on the Moon.

Learning Targets

- **Students use models to investigate how the relative positions of the Earth, Moon, and sun in the Earth-Moon-sun system can create lunar eclipses (3.1)**
- **Students read an article to evaluate information about patterns in the appearance of the Moon (3.2)**
- **Students construct explanations of why lunar eclipses do not happen every time Earth is positioned between the sun and the Moon (3.3)**
- **Students engage in scientific argumentation to support a claim about when it is possible to see a lunar eclipse. (3.4)**

UNIT 7: Ocean, Atmosphere, and Climate 18-20 days

Description: In the Ocean, Atmosphere, and Climate unit, students investigate how ocean currents behave and what effect they have on the climate of different locations around the world, specifically the air temperature of various locations. Energy flow from the sun is what drives this story. The sun transfers energy unevenly across Earth, with the most energy transferred at the equator and the least transferred at the poles. This energy from the sun is the main factor in what determines the air temperature of a place. Winds push the ocean surface, which contributes to the behavior of ocean currents. As surface ocean currents move around Earth—warm water is carried away from the equator and cold water is carried away from the poles—they gradually exchange energy with the atmosphere of the regions they pass. This results in the warming or cooling of the air affecting the overall temperature and climate of a region. When changes in the atmosphere or oceans occur that affect the patterns of these ocean currents, the effects can be felt around the world.

INSTRUCTIONAL TOPIC: What determines the air temperature? -- 5-6 Days

Description: Students begin by learning that Earth is heated unevenly because different amounts of incoming energy from the sun are absorbed by the surface, depending on latitude. Students observe a heating experiment and use the Sim to gather evidence about how energy is transferred to the air. They learn that energy from the sun is not transferred directly to the air but, instead, is transferred first to the surface and then to the surrounding air. After looking at maps that show incoming energy from the sun and air temperatures around the world, students come to the realization that the air temperature of different locations is determined by the amount of energy transferred from the surface to the air, which is ultimately determined by latitude and by the amount of incoming energy absorbed from the sun.

Learning Targets

- **Students use a simulation to investigate the relationship between air temperature and energy (1.2)**
- **Students investigate how energy is transferred to air (1.3)**
- **Students analyze and interpret world maps of incoming solar energy and temperature to construct visual models (1.4)**
- **Students use data to explain that different locations have different air temperatures because more energy is transferred to locations closer to the equator (1.5)**

INSTRUCTIONAL TOPIC: Other than latitude, what else affects the air temperature? -- 4-6 Days

Description: Students investigate how ocean currents can transport water from one part of the world to another, bringing warm or cool water to a particular location and affecting the amount of energy in the air and, therefore, the air temperature. Ocean currents that form near the equator are warm because they gain a lot of energy from the sun. When these warm currents move away from the equator, they carry the energy from the sun with them and then exchange energy with the air of the places they pass. Locations that are situated near warm ocean currents thus have more energy in the air and will be warmer than places that are far from warm ocean currents. When cold ocean currents pass a location, they have the effect of cooling the air. If the air of the location is warmer than the passing cold ocean current, the air will transfer energy to the current, which cools the air.

Learning Targets

- **Students obtain evidence from the article about how currents can affect temperature (2.2)**
- **Students analyze evidence from a hands-on experiment and observe the transfer of energy in the Simulation. (2.3)**
- **Students construct visual models and write scientific explanations about how ocean currents affect the air temperature (2.4)**
- **Students model and communicate to their peers about how geography, latitude, and ocean currents determine climate (2.7)**

INSTRUCTIONAL TOPIC: What determines how the ocean currents move? -- 6-8 Days

Description: Students are introduced to prevailing winds, winds that move in one direction and are large enough in scale to push ocean currents. Along with the positions of the continents, winds determine the movement of ocean currents. Students learn that changes in winds cause changes in ocean currents and thus, changes in the amount of energy that currents can bring to places far from the equator. This allows students to conclude that a change in air temperature during El Niño years is caused by a change in prevailing winds.

Learning Targets

- **Students obtain information about how Earth's prevailing winds cause ocean currents (3.1)**
- **Students gather evidence about how wind and continents affect ocean currents (3.2)**
- **Students investigate how changes to prevailing winds at a global scale can affect ocean currents, which can then affect energy transfer and air temperature at a local scale (3.3)**
- **Students use evidence to write scientific arguments about why air temperature is cooler during El Niño years. (3.4)**

UNIT 8: Weather Patterns 18-20 days

Description: Weather is a complex system that affects our daily lives. Understanding how weather events, such as severe rainstorms, take place is important for students to conceptualize weather events in their own community. In the role of student forensic meteorologists, your students will investigate severe rainstorms in a fictional town called Galetown, which serves as the anchor phenomenon for the unit. They investigate how water vapor, temperature, energy transfer, and wind influence local weather patterns and how these factors can lead to severe rainstorms. Using physical models, a digital simulation, and hands-on activities as well as information gathered from data and science texts, students will investigate the mechanisms by which a warm weather rainstorm can be generated, through the lens of energy transfer. Building on their understanding of the sun as a source of energy, coupled with their knowledge of evaporation and condensation as mechanisms by which water transfers energy to the atmosphere, students will investigate multiple variables that contribute to rainstorm severity. From their investigations, students will learn about how differences in the amount of water vapor, temperature, and air pressure can affect the amount of rain

INSTRUCTIONAL TOPIC: How does an increased amount of surface water cause increase in rainfall? -- 5-6 Days

Description: Students watch an intriguing video that presents the mystery of the rainstorms in Galetown, describes the damage that the storms are causing, and introduces students to some of the claims the residents have about what is causing the severe storms. Then, after doing a hands-on activity about condensation, reading an interesting article about clouds, completing activities in the Weather Patterns Simulation, and building models, students discover that the creation of a lake near Galetown has contributed to the severity of the storms. Students learn that the lake is causing an increase in water vapor in air parcels near the lake, which, as energy transfers out of these air parcels, can lead to more condensation that can later fall as rain.

Learning Targets

- **Students conduct an investigation of how the amount of surface water affects the amount of water vapor in the air (1.2)**
- **Students use digital models to show energy transfer from an air parcel results in condensation, which can lead to rain (1.3)**
- **Students understand that changes that occur in the atmosphere cause condensation and cloud formation (1.4)**
- **Students construct visual models to explain the effect of increased surface water on the amount of rainfall (1.6)**

INSTRUCTIONAL TOPIC: How can higher temperatures affect the amount of rain? -- 4-6 Days

Description: Students explore why the amount of rain in Galetown is different from storm to storm. They begin by discovering the temperature gradient in the troposphere and see a demonstration that shows how an air parcel will rise when it is warmer than the air that surrounds it. Students continue their investigations by reading about a disaster in California caused by severe rainstorms and investigate their ideas further in the Weather Patterns Simulation by trying to model creating severe storms to explain the relationship between warmer air temperatures and the amount of rain. Finally, students create a model to explain how the warmer air temperatures in Galetown also contributed to the severe storms.

Learning Targets

- **Students investigate what happens to an air parcel as it rises in the troposphere and changes temperature (2.1)**
- **Students identify relationships between energy, the height of a parcel in the troposphere, and the amount of rain (2.3)**
- **Students construct models explaining how greater changes to an air parcel's temperature can lead to more severe rainstorms (2.4)**
- **Students use the digital model to play a game in which they create different amounts of rainfall (2.6)**

INSTRUCTIONAL TOPIC: How can pressure differences and resulting wind affect rainfall? -- 6-8 Days

Description: Students investigate why the most recent storm in Galetown had the most severe rainfall. Students begin to consider the role of wind in the formation of rainstorms by watching a video that explains how wind can move air parcels higher into the troposphere. They then use the Sim to explore this concept further. By looking at data from real storms from all over the world, students are able to identify the factors that lead to severe storms, including wind. A model is used to give students the opportunity to apply their understanding that wind contributes to more severe rainfall by moving an air parcel higher into the troposphere where it will lose more energy, leading to more condensation and an increase in the amount of rain.

Learning Targets

- **Students investigate how air pressure differences result in wind and how wind affects rainfall (3.1)**
- **Students analyze and interpret the evidence to determine that wind can affect the severity of a storm (3.2)**
- **Students write arguments about why Galetown's recent storms have been so severe (3.3)**

UNIT 9: Earth's Changing Climate 18-20 days

Description: Earth's climate is changing, with average temperatures increasing by about 0.8°C since 1880. While the increase may sound small, the result is not. One of the many observable changes is that ice on Earth is vanishing, which is the anchor phenomenon for this unit. Students learn how energy from the sun interacts with Earth's atmosphere and surface. They learn that the amount of energy absorbed at the surface controls global average temperature and that the increase in Earth's temperature correlates with an increase in the amount of carbon dioxide and methane in the atmosphere. Through investigations, they learn that human activities, including increased combustion of fossil fuels and greater numbers of livestock kept for the benefit of humans, are responsible for increasing amounts of carbon dioxide and methane in the atmosphere. Along the way, students learn some of the effects of climate change, some possible solutions, and compare our current climate change to other climate changes in Earth's history.

INSTRUCTIONAL TOPIC: Why is the ice on Earth's surface melting? -- 5-6 Days

Description: Students are introduced to their role as student climatologists and begin their investigation of what can cause global temperature to increase or decrease. They explore the Earth's Changing Climate Simulation, test effects of changes to the atmosphere, and examine data about the atmosphere. They conclude that increases in carbon dioxide and methane correlate with increases in energy absorbed by the surface and increases in temperature.

Learning Targets

- **Students distinguish between fluctuations and trends in data to identify changes in Earth's global average temperature and ice cover (1.2)**
- **Students use a digital model to gather evidence about what causes ice on Earth's surface to melt (1.3)**
- **Students interpret in order to see how changes in the amounts of different gases in the atmosphere correspond with changes in global temperature and the amount of energy absorbed by Earth's surface (1.4)**
- **Students analyze and interpret graphs of the concentrations of different gases in the atmosphere over time (1.5)**

INSTRUCTIONAL TOPIC: Why do temperatures on Earth increase when the amount of carbon dioxide or methane in the Earth system increases? -- 4-6 Days

Description: Students focus on the flows of energy, both entering and exiting the Earth system. They read about climate change in Earth's history, run tests in the Simulation, and use a simple physical model. They discover that if the amount of carbon dioxide or methane increases in the atmosphere, more energy enters the Earth system than exits, and this is why increased amounts of these gases cause warming. They discover that these gases redirect outgoing energy back toward Earth's surface, thereby decreasing the amount of energy that leaves the system.

Learning Targets

- **Students use a hands-on model, a digital model, and a video to discover how energy can both enter and exit the Earth system (2.1)**
- **Students evaluate information as they read an article about periods of climate change in Earth's history, in order to better understand how energy entering and exiting the Earth system affects climate (2.2)**
- **Students construct a visual model showing how carbon dioxide affects the amount of energy entering and exiting the Earth system (2.3)**
- **Students construct visual models explaining why the energy flow into and out of the Earth system changed (2.5)**
- **Students gather evidence about interactions between sunlight and carbon dioxide and methane in the atmosphere (2.6)**
- **Students construct visual models that show interactions between sunlight and carbon dioxide and methane in the atmosphere (2.7)**

INSTRUCTIONAL TOPIC: What can be done to stop the carbon dioxide and methane in Earth's atmosphere from increasing? -- 6-8 Days

Description: Students figure out that human activities such as combustion, keeping of livestock, and deforestation cause these gases to increase in the atmosphere. They also see evidence that increasing population increases human activities, and that has a direct effect on our planet. Students read an article about different strategies for reducing the amount of carbon dioxide and methane in the atmosphere.

Learning Targets

- **Students conduct investigations by using the digital model and analyze and interpret data about human activities and population and their effect on carbon dioxide and methane in the atmosphere (3.1)**
- **Students obtain information as they readan article about how some human actions cause climate changes, and others reduce climate change (3.2)**
- **Students construct visual models and make explanations to communicate how one action to reduce climate change would affect gases in the atmosphere (3.3)**