Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2005 Volume IV: The Sun and Its Effects on Earth

The Sun: Earth's Friend and Foe

Curriculum Unit 05.04.05
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Introduction

Establishing an understanding of scientific inquiry is essential for students to be able to comprehend the world around them. Scientific inquiry is a natural ability that children discover at an early age. However, as more complex concepts surround young learners they can enhance their skills to develop scientific ideas and to relate to how scientists think. The development of scientific inquiry will be the aim of my curriculum unit entitled "The Sun: Earth's Friend and Foe". In this unit, students will discover the sun's properties, as well as positive and negative effects it has on the earth.

This unit meets many of the New Haven science curriculum standards, but expands the usual themes covered by most science textbooks. While studying earth science is part of the curriculum, the primary focus is usually on the nine planets and the night sky. This unit will extend the students knowledge of earth and will include an additional component of the sun.

This unit is intended for fifth grade students, but could easily be modified to educate other grade levels. The students who will be participating in this unit directly are fifth grade students at Betsy Ross Arts Magnet School. While the students in my classes range in ability, the first class is grouped as high mathematics students. Their mathematics curriculum is based on the sixth grade curriculum, but also includes fifth grade concepts. The other science class that I teach consists of students who are on an average mathematics level, but have an average to above average ability in language. Both classes have the same science curriculum but it is modified based on their strengths and weaknesses. All classes contain students with special needs who need modifications and additional help. They have full academic instruction in addition to a special art component. This curriculum coincides with the mission of Betsy Ross, because the fusion of arts and academics allows students to use a creative approach to problem solving.

Objectives

The objectives of this unit are for students to use scientific inquiry to understand scientific concepts, to use the scientific method to hypothesize results, to make connections to mathematics, to understand the basic principles of the sun, and to develop an understanding of the sun-earth relationship.

Content Standards

The New Haven Public School District requires that their educators address specific curriculum standards throughout the year. This is to ensure that students are receiving a complete education. This unit includes both science and math standards. The science standards addressed by this unit are that students will learn, use, and practice the ability to do scientific inquiry. Students will also understand properties of the earth, sky, and solar system. The mathematical applications will achieve the goals that are based on the Connecticut Mastery Strands. This includes strands such as number sense, place value, customary and metric measure, graphs, and mathematical applications. (Appendix A)

Unit Goal

The goal of this unit is for students to determine the positive and negative effects of the sun. Not only will students be able to identify these factors but they will be able to determine why. (Appendix B)

Unit Overview

This unit is organized in two sections, each with suggested technology links and interdisciplinary ideas. The first section of this unit will describe the sun's formation, properties, and structure. The second section will focus on the relationship between the Earth and the sun. Topics, such as the Earth's rotation, seasons, tides, life cycle, heat, weather, and the solar effects on human health will be discussed.

Both sections have suggested scientific experiments, hands on activities, or demonstrations that can be found in Appendix C. My reason for this style of teaching is that understanding the workings of the universe is a very abstract concept for students. They have difficulty grasping concepts that they can not see or witness. In order to understand the abstract ideas of the sun and the surrounding universe, it is important to displays these in a format that the students can understand. This can be done by providing students with hands on activities so they can conceptualize what is occurring. By establishing prior knowledge before explanations begin, students can create visualizations when the theories are introduced.

Connections to mathematics will also be made throughout the unit to integrate the content areas and to provide extensions. As teachers know, there is limited time each day to include all the subjects that need to be taught. With science often taking a back seat to mathematics and literacy, integrated lessons allows teachers to fit it all in. My focus is on the integration of mathematics and science because these are the subjects that I am required to teach. Each student is an individual and has different interests and learning styles, by including mathematics and a variety of teaching methods within the unit, teachers can involve students in different ways depending on their preferences.

Internet resources are also provided throughout the unit and at the end. As technology becomes an increasingly integral part of the classroom and our culture, it is important for students to know how to access accurate information and guide their way through the internet. The web resources provided throughout the unit are for teachers to introduce to their students while teaching the correlating topic. The websites can be show to a whole class or students can individually view them in a computer lab setting. They can be used as part of the lesson or as independent research. The resources at the end of the unit are for additional research and information. Information, pictures, videos, and games found on the internet are a valuable tool to use in the classroom and build knowledge.

When discussing temperature or distance I decided to convert the information to customary measurements. I am aware that it is more common in scientific journals and texts to report temperature in Celsius or using the Kelvin scale, but students at this level are more familiar with Fahrenheit. Labeling degrees in Fahrenheit and distance in miles is easier for students to understand and conceptualize, and in turn better understand the information. As part of the integrated unit, an activity is provided on how to convert between the unit of Celsius, Fahrenheit, and Kelvin.

The Unit

Our Sun the Star

The sun is the center of our solar system and is a 4.5 billion years old star. The sun is a main sequence star and is approximately 870,000 miles in diameter. While the sun is just another star, it is by far the largest object in our solar system. "The sun has almost a thousand times more mass than all the planets, moons, asteroids, comets, and meteoroids put together".1 However, compared to other stars, the sun is the size and weight of an average star and about halfway through its life cycle. A stars color depends on its surface temperature, ranging from the hottest stars that are white or blue, to green, yellow, orange, and red is the coolest. The sun is a yellow dwarf star.

Eight billion years after the Big Bang the sun was born. After stars are born they begin a process of nuclear fusion. The stars start fusing atoms together in the order from lightest to heaviest. When the star runs out of one type of atom it will move to the next heaviest one. Stars, including the sun, first fuse hydrogen to helium, helium to carbon and oxygen, and then carbon and oxygen to a variety of elements. When the heaviest element runs out the star will die. However, the sun halts in the carbon – oxygen phase and scientist predict that it will be another 5 billion years before the sun dies out. When it does expand to become what is called a red giant and engulf most of our solar system2.

Scientific Activity 1: Don't be a Galileo

Internet Connection: The Sun

www.brainpop.com

As part of the introduction to the sun, students can watch a short cartoon about the sun and take a mini quiz for reinforcement.

Mathematical Connection: How much is a million? How much is a billion?

Students are dealing with large numbers such as millions and billions. To improve number sense, *How Much is a Million?* by David M. Schwartz and illustrated by Steven Kellogg is a good way to introduce large number concepts to students.

Internal Structure

In order to understand how the sun works, it is important to know that the internal structure of the sun is made up of three layers. Starting at the center and moving outward, the sun's inner most layer is called the thermonuclear energy core. The radius of the core is 30 % of the solar radius, i.e., it is about 130,000 miles thick. The center of the core has a temperature of27 million degrees Fahrenheit. The core, however, contains most of the mass of the Sun, about 94% of the mass. The energy generating core is a part of the next layer, the radiative zone of the sun. Together they cover 70% percent of the solar radius, i.e. about487,000 miles. Energy is transported by radiation in this layer (hence the name). The outward most layer is called the convective zone because energy transport in this region occurs by convection, which this through upward rising streams of hot material. It covers the outer 30% of the Sun, i.e., the remaining 130,000 miles. The temperature inside the Sun decreases steadily outwards through these layers, from 27 million degrees Fahrenheit at the center to a mere 9,900 degrees Fahrenheit at the surface 3, 4.

Scientific Activity 2: Layers of the Sun

Internet Connection: Internal and External Structure

http://www.spaceweathercenter.org/living_with_a_star/03/03.html

This site displays an interactive diagram of the sun's internal and external structure and can be used to provide a visual demonstration of the sun.

Mathematical Connection: Fahrenheit, Celsius, and Kelvin

While for this unit, temperature is converted into Fahrenheit, as students read independently about this topic they will find that temperature is documented as Celsius and Kelvin. In order for students to understand they need to know how to make these conversions. Students can use the following conversions to determine the temperature in Fahrenheit.

Celsius to Fahrenheit – Multiply Celsius by 1.8 then add 32

Fahrenheit to Celsius – Subtract 32 from Fahrenheit then divide by 1.8

Celsius to Kelvin – Celsius plus 273

Fahrenheit to Kelvin – Convert to Celsius then add 273

Kelvin to Celsius – Kelvin minus 273

Kelvin to Fahrenheit – Convert Fahrenheit to Celsius and then minus 273

How the Sun Works

The sun is essential to life on our planet because of the light and heat that it provides. For centuries scientists hypothesized about how the sun actually created heat. Heat is a form of energy that travels from low to high temperatures. It was not until Albert Einstein's famous theory, $E = mc2$ that astronomers were able to discover how the sun really works. Scientists determined that in the core of all stars, where there are extremely high temperatures, thermonuclear fusion can take place. The sun is comprised of mostly hydrogen and helium. Within the core energy is released through thermonuclear fusion where hydrogen is converted into helium. The energy travels from the internal part of the sun through two energy transport mechanisms known as radiative diffusion and convection. In the inner 70% of the sun (core and radiative zone), photons are carrying energy from one region to another. In the outer 30% of the sun (the convections zone), heat is transported through convection by which causes the circulation of fluids. Here, hot gases rise to the surface and cool gases retreat back to the interior. While it takes about 170,000 years for energy from the sun's center to reach the surface, it takes only eight minutes for that energy to travel from the sun to the Earth.

External Structure

The sun's exterior has three layers. While there is no solid surface to the sun, the visible part of the sun is called the photosphere radiates at 9,900 degrees Fahrenheit. This inner most layer is where energy escapes from the sun. The photosphere is hot, but cool spots known as sunspots are found on this layer. Sunspots are magnetically active parts of the sun where the temperature is cooler causing it to look darker than the rest of the photosphere. While these spots look small, each sunspot is generally the size of the Earth. Sunspots can occur alone, but they generally appear in groups. The number of sunspots on the sun is somewhat predictable, they follow approximately an eleven year cycle ranging from many to few spots. Sunspots also continuously appear at the same latitudes on the sun and gradually move closer to the equator.

Internet Connection: Sunspots

http://www.spaceweathercenter.org/living_with_a_star/05/05.html

At this site students can read about sunspots, as well as view pictures and a short film clip. This site also provides information about the history of sunspot, the solar cycle, and the connection to the Earth's climate.

Mathematical Connection: Measuring a Timeline Relative to Sunspots

1610: Sunspots were discovered by Italian astronomer Galileo Galilei by using his invention, the telescope.

1833: E.H. Burrit discovered that different amount of sunspots were appearing at different times.

1843: Heinrich Schwabe discovers the frequency of appearance of sunspots and that they appear in cycles.

1852: Rudolph Wolf discovers that the sunspot cycle is 11 years long.

1908: George Ellery Hale determined that sunspots are associated with the sun's magnetic field.

The chromosphere radiates at 18,000 degrees Fahrenheit and is the middle section of the external sun. This small layer around the sun can be seen most clearly during a solar eclipse. The temperature in the chromosphere increases as one goes farther away from the sun, which is opposite of what happens in the photosphere. The chromosphere emits spikes of rising gas known as solar flares and prominences, and is the source of ultraviolet light. One manifestation of this activity is a prominence. Prominences are arching columns of gas released from the sun's surface that can last anywhere from a few hours to a few months. Complex sunspot groups can also be the cause of solar flares. Solar flares spread across the atmosphere in a rippling pattern that can affect life on Earth. These solar flares were discovered in 1859 by two scientists, Richard C. Carrington and Richard Hodgson5.

Internet Connection: Solar Flare

http://sunearth.gsfc.nasa.gov/sunearthday/media_viewer/flash.html

http://www.spaceweathercenter.org/living_with_a_star/04/04_02.html

Both sites provide videos and pictures where students can view solar flares.

The corona which is much hotter than the surface of the sun, radiating at 3.6 million degrees Fahrenheit, is the white outer most section of the atmosphere. While the corona is hotter than the photosphere and chromosphere, it is lower in density causing it glow less brightly and actually "feel" cooler. The corona is the source of X- rays, solar wind, and coronal mass ejections. An outflow of gas through coronal holes in the corona cause solar winds. These winds are actually parts of the sun's mass being ejected into space. While this depletes the mass on the sun, the percentage actually being ejected is minuscule. The sun will lose only 0.01% of its mass through solar winds and coronal mass ejections in its lifetime. Coronal mass ejections can occur almost anytime, but are most intense during high sunspot activity. These ejections are a billion tons of high temperature gases being emitted towards the Earth. Because we cannot look directly at the sun, it was difficult to observe and study the corona. Generally, the corona can only be seen clearly during an eclipse, at other times the light from the photosphere hide it. However, in 1930 a French astronomer by the name of Bernard Lyot created an invention called the coronagraph that allowed astronomers to study the corona. Scientist no longer have to wait until a solar eclipse to get a look at the hottest part of the sun3, 6.

Internet Connection: Coronal Mass Ejections

http://sunearth.gsfc.nasa.gov/sunearthday/media_viewer/flash.html

http://www.spaceweathercenter.org/living_with_a_star/04/04_02.html

Both sites provide videos and pictures where students can view coronal mass ejections.

Solar flares, solar winds, and coronal mass ejections can all affect our life on Earth. Before the invention of the telegraph, approximately one hundred and fifty years ago these solar particle events were not of great significance because we did not have the technology we rely on today. These events can affect the function of the artificial satellites that are in orbit around the Earth. There are five types of satellites: communication

satellites which we use for television and telephone transmission, navigation satellites used mainly for military purposes but also for GPS locators, weather satellites which study the atmosphere, military satellites used to observe the earth, and scientific satellites to study the solar system. While our society has become reliant on these satellites, particles from the sun can possibly destroy them. For example, in October of 2003, solar flares destroyed a satellite from Japan that was being used for communication purposes7.

Solar events can also adversely affect astronauts. Radiation emitted by the sun can be hazardous to human health. Magnetic energy can disrupt radio waves and cause difficulties for traveling spacecrafts. Power grid outages are also known to occur because of the sun's forces. A strong magnetic storm caused approximately 17 % of Quebec to be out of power for nine hours in March of 19898, 9.

Internet Connection: Solar Energy Disrupts Life

http://image.gsfc.nasa.gov/poetry/blackout/blackout.html

http://www.windows.ucar.edu/spaceweather/effects3.html

Students can read about how solar events have effected or life on Earth.

The Sun meets the Earth

The Earth's Rotation

Simultaneously the Earth moves in two different ways. The Earth revolves around the sun at a slightly elliptical orbit and takes approximately 365.26 days to complete one revolution. The rotation axis of the Earth is tilted by 23.5 degrees from the direction perpendicular to the Earth's orbit around the sun.

Scientific Activity 3: Round and Round

Internet Connection: The Earth's Rotation and Revolution Around the Sun

http://www.classzone.com/books/earth_science/terc/content/visualizations/es0408/es0408page01.cfm?chapter_no=04

At this site students can see a presentation of the Earth rotating and revolving around the sun.

Changing Seasons

The change in seasons is caused by the tilt of the Earth's axis. The Earth's tilt allows for northern and southern hemisphere to receive different amounts of sunlight from different angles. For example, during the summer in the northern hemisphere the sun is positioned high above the continent allowing for direct sunlight, while in the southern hemisphere the sun is striking the continent at a lower angle. Also, the northern hemisphere will receive 12 hours of sunlight, causing longer days and shorter nights. It is often a misconception that the seasons are caused by change in the distance from the Earth to the sun. The distance from the Earth to the sun only changes about 3% during a rotation. This is not enough to affect the Earth's seasons. In fact, the

Earth is the closest to the sun during the winter in the northern hemisphere.

Causing Tides

Many people believe that it is the moon that controls the tides on our Earth, while this is correct, the sun also plays a role. The gravitational forces exerted by the moon forces the Earth into the shape of a football. Because of the solid land on Earth the moon's pull cannot effect the land much, however the pull does effect the oceans and produce tides. As a result of the gravitational pull the water on earth is pulled in specific directions causing high and low tide. As the gravitational force bulges the water toward the moon a bulge is then equal on the opposite side of the Earth. However when the sun, Earth, and moon all align the tidal forces are particularly strong causing extremely high and low tides known as spring tides. When the sun and the moon are at a ninety degree angle the forces are less strong causing smaller high and low tides called neap tides.

Internet Connection: Tides

http://www.oceanicresearch.org/time_lapse.htm

Students can view the tidal cycle in elapsed time.

www.brainpop.com

Students can watch a short cartoon about how the moon effects tides.

http://www.sfgate.com/getoutside/1996/jun/tides.html

Students can view an animated diagram of the sun's effect on the tides.

Mathematical Connection: Graphing the Tides

Students can use their local newspaper to record and create a line graph of high and low tides.

Life on Earth

Water, food, and oxygen are essential to human survival, each of which is obtainable because of the sun.

Plant life

For a plant to grow it needs water, air, nutrients, and the sun. Through a process called photosynthesis, a plant can convert the sun's energy to chemical energy. While water enters the plant through the roots, sunlight reaches the leaves, forming glucose and oxygen. The glucose is stored by converting it to carbohydrates which are used to feed the plant. Aiding in the energy storage process is chlorophyll. Chlorophyll is found in leaves and is what gives them their green color.

Without the sun, plants could not produce the food they need to grow. Without plants, animal and human life could not survive. Plants are a necessary part of the food chain. Humans consume both plants and animals. The animals that we eat consume plants. Thus, without the sun there would not be food for animals to survive10.

Scientific Activity 4: Geometric Plants

Internet Connection: Photosynthesis

www.brainpop.com

Students can view a fun cartoon on how photosynthesis works.

http://www.harcourtschool.com/menus/science/grade5_nl.html

Students can watch an interactive presentation of how photosynthesis works.

Oxygen

Oxygen is a waste product of plants through the process of photosynthesis. As plants produce their food using carbon dioxide, water, and sunlight, they release oxygen into the air. Without oxygen humans could not breathe, an obvious essential to life on Earth.

Water

The water we use and drink is part of a natural process known as the hydrologic or water cycle. The hydrologic cycle takes place in five steps that run simultaneously and continuously. Together, evaporation, condensation, precipitation, infiltration, and runoff constitute the hydrologic cycle. The sun's role in the water cycle takes place in evaporation. Water from the Earth's surface, is heated by the sun causing the water molecules to rise up from the Earths surface. As water vapor rises it condenses turning back to liquid in the form of clouds. When the clouds become saturated the water falls back to the Earth in precipitation. As the precipitation reaches the Earths surface it infiltrates the land or returns to a water source through runoff. This constant cycle is necessary to provide humans, plants, and animals with the water they need to survive. Without the sun, water would not be able to evaporate and we would run out of useable water. 11

Internet Connection: The Hydrologic Cycle

http://observe.arc.nasa.gov/nasa/earth/hydrocycle/hydro1.html

A power point presentation of the hydrologic cycle that students can do on their own or as a class.

Keeping us Warm

The Earth needs the sun for heat. Without the sun's warmth, the temperature would become nearly freezing -460 degrees Fahrenheit, known as absolute zero. In three days, we would use up all the Earth's recourses just to stay warm. Fortunately for us, the temperature stays "…between the freezing point of water (32 degrees F) and the normal body temperature of humans (98.6 degrees F). If the average temperature ever varied very far above or below these two extremes for very long, we could not survive".12, 13, 14

Weather

While the direct influence of the sun on the climate has puzzled scientists, it is clear that the sun definitely

effects the weather here on Earth. Climate describes the weather over an extended period of time in one place. Weather can change on a daily basis and it is what is occurring in a place at a given time. For example, the climate in Florida is generally warm and sunny, but Florida's weather can be sunny, cold, dry, or rainy. In Connecticut the climate is generally hot in the summer and cold in the winter. According to the CIA World Fact Book, The average annual temperature ranges from 39.5 degrees Fahrenheit to 60 degrees Fahrenheit. The shoreline is generally cooler than inland. However, variations can be seen in Connecticut climate. For example, it can reach as high as 95 degrees Fahrenheit or reach lower than freezing. The sun drives the weather on the Earth. "The weather is caused by the circulation of the atmosphere which is caused by the unequal heating of the earth's surface by the sun".15 Various amounts of sunlight are reaching the Earth in different locations because of the Earth's rotation and revolution. These differences cause parts of the Earth's atmosphere to heat up at different rates. These changes in atmosphere determine our weather.16

Mathematical Connection: Graphing Temperature Change

Students can use the internet to record and create a bar graph of the changing temperature in their local area. Student could also compare it to another part of the world.

The sun's energy not only reaches the atmosphere, but also the ground. As states earlier, the sun plays a major role in our water cycle. As the sun heats the ground, the Earth's surface is heated causing evaporation. The water is evaporated into water vapor and rises to the Earth's atmosphere. As the water vapor rises it collects dust allowing the formation of clouds. As clouds form they combine with other clouds. When the clouds are large enough and heavy with water vapor precipitation occurs. The temperature determines the type of precipitation, rain, snow, hail, and sleet.17, 18

Scientific Activity 5: Cloudy Classroom

Water vapor, which is evaporated into the Earth's atmosphere by the sun, is the cause for much of the powerful weather we witness in Connecticut. Throughout the day, the sun heats the surface causing the Earth's atmosphere to become unstable. If there is enough water vapor in the air, a thunderstorm will occur. A thunderstorm will cause both thunder and lighting. Lighting occurs during a thunderstorm "…when liquid and ice particles above the freezing level collide, and build up large electrical fields in the clouds".19 This electrical filed causes a "spark". While many of us have often heard the phrase "heat lightning" and would assume that hot weather from the sun would cause such an event, it is untrue. Heat lightning is only the view of a thunderstorm in the distance.20

If a thunderstorm develops over the ocean and the temperature of the water is warmer than 81 degrees Fahrenheit and there is high relative humidity a hurricane can form. "A hurricane is a severe tropical storm, that forms in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico or in the eastern Pacific Ocean"21 To be classified a hurricane the winds of the tropical cyclone must exceed 74 miles per hour. While the last hurricane in Connecticut was Hurricane Gloria in 1985, there are still threats especially between the months of June and November.22

Scientific Activity 6: The Eye of the Storm

Internet Connection: Hurricanes

www.brainpop.com/science/

Students can watch a video on thunderstorms and hurricanes

http://www.nationalgeographic.com/ngkids/0308/hurricane/index.html

Students can read and view pictures about hurricanes. This site is intended for students and also provides safety tips.

Staying Healthy

The sun releases multiple types of energy, including ultraviolet light. Ultraviolet light or UV radiation can cause serious health problems. Fortunately the stratospheric ozone protects us from most of the UV light. There are three types of UV radiation, UVA, UVB, and UVC. UVC is completely absorbed by the ozone, UVB is only partially absorbed, and UVA cannot be absorbed at all. Scientists have also discovered that by using harmful chemicals here on Earth we are effecting the strength of the ozone causing more of the bad UV light to get through.

UV radiation is known to cause numerous health problems including skin cancer, cataracts, premature aging of the skin, and immune suppression. At certain times of the day, such as between 11:00 am and 2:00 pm, the sun is the strongest and can cause the most damage. Even on cloudy or cold days the sun is still strong enough to cause damage to the skin As a result of these health risks we need to protect ourselves from the harmful rays of the sun. This can be done by protecting both your skin and your eyes by wearing a hat, sunglasses, and sunscreen with UV protection.23

Scientific Activity 7: UV Beads

Internet Connections: Sun Protection

http://www.epa.gov/sunwise/kids/index.htm

Students can read about the importance of the ozone layer, UV index, and steps to protect themselves from the sun. Fun games are provided to enhance learning at three different levels. This is a great interactive way for students to better understand the sun and its effects.

The sun can be very dangerous to humans, but it is also very important to human health. When UV radiation reaches the skin it triggers the production of Vitamin D. Vitamin D is essential to a healthy human body and the best way to obtain it is through the sun. Vitamin D can also be obtained through other sources, such as salmon, cod liver oil, and mackerel, items most people don't normally eat in their diet. This essential vitamin is also found in milk, but in such limited quantities that you would have to drink 10 glasses of milk a day to get the required amount of Vitamin D needed. Vitamin D is necessary for the human body to absorb calcium and facilitate proper bone growth. Adequate sunlight exposure is also known to prevent heart related illnesses and cancers. Recently, doctors and scientists have discovered that Vitamin D also triggers hormones in our body that affect mood. Sufficient exposure to the sun can be a mood lifter, which is why when a person spends time in the sun they tend to feel good.24

Notes

1 Universe, p. 390, Freedman and Company, Freedman and Kaufmann, 2002

2 Paraphrased from http://www.bbc.co.uk/science/space/solar system/

3 Paraphrased from Eyewitness Visual Dictionaries: The Visual Dictionary of the Universe, Sue Becklake, DK Publishing, 1993

4 Paraphrased from Universe, Freedman and Kaufmann, Freedman and Company, 2002

5 Paraphrased from http://hesperia.gsfc.nasa.gov/sftheory/flare.htm

6 Paraphrased from www.spacweathercennter.org

7 Paraphrased from http://www.knowledge-finder.com/technology/satellite-tv/artificial- satellites-types.html

8 Paraphrased from http://www.knowledge-finder.com/technology/satellite-tv/artificial- satellites-types.html

9 Paraphrased from http://www.ips.gov.au/Educational/1/3/12

10 Paraphrased from http://www.ftexploring.com/photosyn/photosynth.html

11 Paraphrased from http://observe.arc.nasa.gov/nasa/earth/hydrocycle/hydro2.html

12 http://library.thinkquest.org/15215/Friend/temperature.html

13 Paraphrased from http://library.thinkquest.org/15215/Friend/temperature.html

14 Paraphrased from http://members.aol.com/physgeo4/sr2_28.htm

15 http://www.bom.gov.au/lam/weathed.shtml#whatca

16 Paraphrased from http://www.epa.gov/globalwarming/kids/climateweather.html

17 Paraphrased from http://www.weatherquestions.com/How_do_clouds_form.htm

18 Paraphrased from http://mbgnet.mobot.org/salt/cycle/clouds.htm

19 http://www.weatherquestions.com/What_causes_lightning.htm

20 Paraphrased from www.weatherquestions.com/What_causes_thunderstorms.htm

21 http://hurricanes.noaa.gov/

22 Paraphrased from http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/hurr/home.rxml

23 Paraphrased from http://www.pueblo.gsa.gov/cic_text/health/sun_uv/sun-uv-you.htm

24 Paraphrased from http://www.drrisley.com/html/Vitamin%20D.html

Appendix A

Content Standards

As part of the New Haven Public Schools science curriculum many of the required performance standards will be achieved. The following standards will be addressed:

Content Standard 1.0 - Scientific Inquiry

Students will develop abilities necessary to do scientific inquiry by being able to pose a question, state a hypothesis, develop an investigation, observe and document the process and record and determine the results.

Performance Standard 1.1 – Students will inquire and practice the ability to do scientific inquiry.

Performance Standard 1.2 **-** Students will acquire and practice the ability to understand scientific inquiry.

Content Standard 4.0 - Earth Science

Students will develop an understanding of the structures, properties and dynamic processes of the earth, the solar system, the universe and the galaxy; they will be familiar with the origins, evolution, movements and interactions of these systems.

Performance Standard 4.1 - Students will understand the fundamental concepts of the properties and structures of the earth.

Performance Standard 4.2 - Students will understand the fundamental concepts and principles of objects in the sky.

Content Standard 6.0 - Ecology

Students will develop an understanding of personal and community health; of the characteristics of changing populations; of the ecology of and uses of natural resources; of changes in environments; and of the use of science and technology in addressing present-day local and global challenges.

Performance Standard 6.1 - Students will develop an understanding of the value and behaviors of good personal health.

Performance Standard 6.2 - Students will develop an understanding of the use of science and technology and its effect on the characteristics of changing populations, ecology resources and changes in the environment.

Appendix B

Unit Goals

The goal of this unit is for students to understand how the sun effects the Earth both positively and negatively. This can be achieved by students reflecting on what they have learned. To begin the unit, ask the students, "How does the sun effect you?" and record their responses. As a class, discuss what they know about the sun and how it can effect us positively and negatively. On one piece of chart paper write "Earth's Friend" and on a second piece of chart paper write "Earth's Foe". Discuss what these terms mean. Throughout the unit as each of the different topics are discussed, conclude the section by adding information to the appropriate category. For example, after discussing the effects of UV rays on humans, have the students discuss if the effects are positive, negative, or both. Record the information on the chart paper. Upon closure of the unit students can discuss or write their findings based on their continuous reflection.

Appendix C

Scientific Activity 1: Don't be a Galileo

Be sure the students know never look directly at the sun, with or without sunglasses! Legend has it that Galileo Galilei lost his vision from viewing the sun without protecting his eyes. Students can view the sun indirectly with a white piece of paper and a telescope or binoculars. Remember, do not look through the telescope or binoculars at anytime. If binoculars are used, keep the cap on one of the lenses to prevent overlapping images. Set up the telescope or binoculars on a tripod and aim it at the sun. If a white piece of paper is placed across from the lens and image of the sun will appear. Adjust the focusing knob to create a clear picture of the sun and move the paper in and out to adjust the size. Have students record their observations for later use as topics are discussed. By repeating this activity daily student can also observe the progression of sunspot activity. Students will also observe the sunspots rotating. These activities can also be found in *Astronomy for All Ages* .

Scientific Activity 2: Layers of the Sun

Students can create a model and diagram of the sun using half of a styrofoam ball, markers, toothpicks, and a piece of paper. Using half of the styrofoam ball, color the three internal layers of the sun. Trace the flat part of the ball onto a thick white piece of paper. Cut out and discard the circle. Using the toothpicks and paper students can label the internal structure of the sun and the photosphere. The white piece of paper can be used to diagram the outer two layers of the external atmosphere, cut, and then taped to the ball.

Scientific Activity 3: Round and Round

Students can use their bodies to show the rotation and revolution of the sun. Have one student stand in the center of the room to emulate the sun. Students can then form a circle around that person. Students can begin by revolving around the sun. As the student walk in a circle they can also spin themselves. The two movements are examples of how the Earth rotates and revolves.

Scientific Activity 4: Geometric Plants

Planets need sunlight to produce food. Sunlight is absorbed through the leaves and this can be seen through these activities. Pick a tree or house plant for this activity. Cut a shape out of aluminum foil about half the size of the leaf. Paperclip the shape onto the leaf and after a few sunny days, remove the shape. Students can record their observations and discuss the implications.

Scientific Activity 5: Cloudy Classroom

For this activity you will need a jar, ice, metal dish, and warm water. Place the ice in the metal dish and let stand until the dish gets cold. Fill the jar with one inch of warm water. Place the cold dish on top of the jar. As the warm water evaporates, a clod will form near the top of the jar. This activity is from *How the Weather Works* .

Scientific Activity 6: Eye of the Storm

Fill a large clear bowl with lukewarm water. Stir the water in a circle until the water moves by itself around the bowl. Add a few drops of food coloring into the center of the bowl. The food coloring will move outward forming bands just as hurricanes do. This activity is from *How the Weather Works* .

Scientific Activity 7: UV Beads

UV beads are a great tool for students to visualize the effects of ultraviolet light. Search the internet for sites that sell these beads, you can purchase hundreds of beads for only a few dollars. For this activity students should each get 8 beads. Have them bring in their sunglasses and any suntan lotion they may have at their house. On a sunny day have students expose their UV beads in the direct sunlight and record their observations. Discuss what occurred and have the students speculate why. The student can then split their beads into four equal plies. The first pile will be the control, the second covered by sunglasses, the third rubbed with suntan lotion with an SPF less than 15, and the fourth with an SPF 15 or greater. Create a hypothesis with the students on what the effects will be. Record observations and draw conclusions. Hypothesis what would happen on a cloudy day. Test this hypothesis and compare to previous results.

Reading List for Teachers

Ahrens, Donald C. *Meteorology Today: An Introduction to Weather, Climate and the Environment.* Belmont: Brooks and Cole, 2002.

· This college textbook provides an in depth look at the causes of weather conditions.

Freedman, Ronald and Kaufmann III, William. *Universe* . New York: W.H. Freedman and Company.

· This college textbook takes a scientific look at Astronomy and the Solar System.

Gallant, Ray. *When the Sun Dies* . Tarrytown: Cavendish, 1998.

· An interesting resource that can be used by teachers to inform students about the sun – earth connection and the eventual demise of the shining sun.

Student Reading List

Allaby, Michael. *How the Weather Works* . London: Reader's Digest, 1995.

· A great book with numerous scientific experiments to depict how weather works.

Becklake, Sue. *Eyewitness Visual Dictionaries: The Visual Dictionary of the Universe* . New York: DK Publishing, 1993.

· With brief informative descriptions about many aspects of the solar system and an array of pictures and well labeled diagrams, this book can be used by both the teachers and the students.

Gallant, Ray. *Earth's Place in Space* . Tarrytown: Benchmark Books, 2000.

· This children's book describes the history of science from an Astronomy perspective and discusses legends about how previous scientists believed the Solar System worked.

George, Michael. *The Sun* . Mankato: Creative Education, Inc, 1991.

· Incredible images of the sun are displayed in this book with explanations about their origin and cause.

Harrington, Philip and Pascuzzi, Edward. *Astronomy for All Ages: Discovering the Universe through Activities for Children and Adults* . Old Saybrook: The Globe Pequot Press, 1994.

· This book provides fifty – one different experiments on the Solar System for learners of all ages.

The Old Royal Observatory, Greenwich. (1994). *Astronomy* . New York: DK Publishing.

· This book teaches scientific concepts and provides pictures and description of historical information. A great tool for incorporating other content areas.

Internet Sites

http://www.bbc.co.uk/science/space/solarsystem/

This website provides a complete look at all aspects of space, with accurate information, definitions, pictures, and visual demonstrations of our solar system.

http://brainpop.com

A great websites for students to view mini - educational cartoons about science, including the Earth, Solar System, and the Sun.

http://image.gsfc.nasa.gov/poetry/ask/asun.html

This website answers the "frequently asked questions" that students may have about the sun.

http://www.ncdc.noaa.gov/oa/climate/globalwarming.html

A Government sponsored website with information on Global Warming.

http://www.sedl.org/scimath/pasopartners/pdfs/sun.pdf

An excellent website that provides a complete unit entitled "Sun and Star" integrating mathematics and earth science providing teacher background information, activities, and hands on experiments.

http://solar-center.stanford.edu

Offers an array of information about the sun, including lesson plans for teachers.

http://spacescience.spaceref.com/ssl/pad/solar/whysolar.htm

An informative website for teachers about the sun and its features, as well as real photographs from the sun.

http://www.spaceweather.com

A daily account of current sunspot activity and space weather is tracked on this website.

www.spaceweathercenter.org

This professional website is a great resource for teachers and could be used as a classroom tool for pictures, short animations, and games.

http://www.spaceweathercenter.org/living_with_a_star/05/05.html

This is an excellent website for viewing sun spot activity, the Sun's magnetic field, and the 11 year cycle.

http://sunearth.gsfc.nasa.gov

A NASA site for educators provides links to space related websites.

http://sunearthday.nasa.gov/

Sun Earth Day is a Day for students to celebrate the sun - earth connection during the Spring Equinox. This website provides activities and information for teachers and students about this day.

http://www.classzone.com/books/earth_science/terc/content/visualizations/es0408/es0408page01.cfm?chapter_no=04

Shows a clear and accurate moving image of the sun's rotation and revolution.

http://www.pueblo.gsa.gov/cic_text/health/sun_uv/sun-uv-you.htm

Entitled "The Sun, UV, and You", this website from the US Environmental Protection Agency describes UV radiation, how the sun effects human health, ozone depletion, and how it can be prevented.