Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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The Sun

Curriculum Unit 98.06.03
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This unit will be implemented in a second grade classroom. It is also intended to be written with grades slightly above and below in mind. Because of the age level of the students, the unit will not include any abstract data or experiments and students will not be required to memorize historical facts and figures. They will, however, be involved with learning data and performing experiments on the Sun dealing with things in their every day lives. These activities will be explained as this unit unfolds.

GENERAL OBJECTIVES

v Students will discuss how the Sun affects our everyday lives.
v Students will learn how the Sun affects our seasons.
v Students will use the Scientific Process as a means for experimentation to explore different aspects of the Sun and its effects on the Earth.
v Students will acquire knowledge of the Sun through an interdisciplinary approach.
v Students will discuss the structure of the Sun and how it interacts with the Earth and other planets.

RATIONALE

The purpose of this unit is for students to see how important the Sun is to our existence. Students at this age have a limited knowledge of the Sun's purpose and take its existence for granted. At this point, they realize that the Sun is hot and when it is out, it is a nice day. When it is behind clouds, it is usually raining. It is also very bright and, if you try to look at it directly, it hurts your eyes. These limited observations can be expanded greatly through inquiry and experimentation.

As a result of this unit, students will expand their knowledge of the Sun through inquiry and experimentation. They will learn how the Sun affects seasons by finding answers to questions about the Earth's position during the seasons. Students will also explore how the Sun is responsible for the growth of food on our farms and how plants in turn give off oxygen for us to breathe.

Students will also explore the structure of the Sun. They will discuss its temperature, size and distance from the Earth. Every reference made about the Sun, such as size, will be compared to that of the Earth with the thought in mind that students, as well as adults, are more familiar with the structure of the Earth and will, therefore, be able to absorb and understand the information given about the Sun.

Students will also learn a brief history of some of the first astronomers and their discoveries on the Sun. Hypothesis that were true as well as false throughout history will be discussed. Events in history, such as how astronomers were treated for their beliefs about the Solar System, will be discussed briefly. This historical data will serve as background information and it will in no way be expected to be memorized. It will facilitate discussions about fairness and stubbornness. I wish to implements all of this information, or as much as possible, through experimentation using the Scientific Process and other "hands-on" activities. This method will allow students to become involved and in turn will make learning more meaningful. I will begin the unit with a KWL chart to establish how much the students already know and what they would be interested in learning.

It is my intention to include subject areas such as Language Arts, Math, Art, Science, History, and Music into this unit. The unit will be divided up into these subject areas and narrative and activities will be included in each. This section will follow a section devoted to general information about the Sun. Again, whenever possible, this background information will be given with a reference to the Earth in order to make the data less abstract.

THE SUN: BACKGROUND INFORMATION

The Sun is one of the billions of stars in our galaxy. Since it is so close to the Earth, we are able to use it as a learning link to the other stars in the galaxy. It is the only star whose surface and atmosphere can be observed directly from earth. We are able to study its basic properties such as size, temperature, mass, age, and chemical composition. By observing our Sun and Solar System, scientists have developed theories of their formation. To back up these theories, scientists are able to study the formation of new stars in our galaxy, which they believe is a process that is identical to the way our Sun and planets formed.

The Sun is about 93,000,000 miles away from Earth. Its light reaches us in a little more than eight minutes. It is thought by some that we experience seasons due to the changing distance from the Sun. In other words, the Earth is closer to the Sun during the summer and farther from the Sun during the winter. This is not true. As a matter of fact, the Earth is actually slightly closer to the sun in the middle of winter. If this is the case, then how do we experience seasons and temperature extremes? The Earth's equator is tilted 23 and a half degrees from the plane of its orbit around the Sun. This tilt affects the amount of sunlight different places on the Earth receive throughout the year. When the Northern Hemisphere is tipped towards the Sun, we receive sunlight for more than 12 hours a day, which is the reason for our long summer days. Moreover, since the Northern Hemisphere is tipped towards the Sun, we receive more direct sunlight than during the winter months. That is to say, the sun seems to be directly over us during the summer and the sunlight hits us more directly causing hotter days. During the winter months, the Sun's light hits us at an angle. Because of this angle, the light is more spread out and diluted causing cooler temperatures. To view this in another way, point a flashlight directly onto a wall a couple of feet in front of you. Notice how the light is dense and concentrated. This is the effect the Sun has on the Northern Hemisphere during the summer. Now take the flashlight and point it about 6 feet above your head onto the wall. Notice how the light is less concentrated in one area. Its luminosity is not as strong. The Sun has a similar effect during the winter when the Northern Hemisphere is tipped away from it.

The Sun's diameter is 865,280 miles, which is equivalent to 109 Earth diameters. Also, its mass is 332,946 times that of the Earth. Its gravitational pull is stronger than the Earth's. To escape the gravitational pull of the Sun, an object would have to travel 617.5 km per second. An object would have to travel 11.2 km per second to escape Earth's gravitational pull.

The surface temperature of the Sun is about 5,800 degrees Kelvin. The core is about 15,000,000 degrees Kelvin. The composition of the Sun is 92.1% hydrogen, 7.8% helium, and 0.1% other elements. All of these elements are in a gaseous state.

For most of its lifetime, a star gets its energy from a process called nuclear fusion. Stars, like our Sun, during this period are called main sequence stars. Our Sun has been in this phase for about 4.5 billion years. It has about another 5 billion to go before it depletes its hydrogen supply and will have to burn other elements. Each second, the Sun converts 5 million tons of hydrogen atoms into energy. All of this energy production is at the Sun's core.

THE SUN'S ATMOSPHERE

The atmosphere of the Sun begins with the photosphere. It is from this layer that almost all of the Sun's light is emitted. This layer has the lowest temperature of about 5,800 degrees Kelvin. It is also in this layer that sunspots are seen, which will be discussed later.

Just above the photosphere is the chromosphere. It is about 6,000 miles thick. In this layer, spikes of gases occur called spicules. Spicules have the appearance of a thick line of trees coming off of the Sun's surface. They rise to heights of 3,000 to 6,000 miles above the Sun's photosphere and last for about 10 minutes.

Finally, the corona extends above the chromosphere. This outer atmosphere is much hotter than the Sun's photosphere. It has an average temperature of about 2,000,000 degrees Kelvin. From this layer, gaseous streams extend millions of miles into space.

SUNSPOTS

High magnetic fields on the photosphere layer cause dark patches on the Sun called sunspots. They appear black or darker than their surrounding area because they are about 1,500 degrees Kelvin cooler. The sunspot's dark central region is called the umbra and the lighter outside region is called the penumbra. The penumbra acts like little metal shavings near a magnet, which gives scientists the idea that sunspots act as magnetic fields. Sunspots tend to be features that change shape and location and can last for days or months.

SOLAR FLARES

A solar flare is a quick and powerful eruption which occur near large sunspot groups and extend from the Sun. Flares release a huge amount of energy in a very short time. Erupted materials can reach speeds of up to 600 miles per second. A flare can have a lifetime of from 10 minutes to several hours.

PROMINENCES

A prominence can look like a solar flare. However, they can last from hours to days. Moreover, they can reach thousands of miles in altitude. Although a prominence appears to be erupted material from the Sun, as do solar flares, they are cool regions of the Sun's outer atmosphere that are moving along a magnetic field.

SOLAR ECLIPSE

A solar eclipse occurs when the Moon covers the Sun. When the Sun is completely covered by the Moon, it is called a total eclipse. When it is not fully covered it is called an annular eclipse. Some of the phases of a solar eclipse are known as a Bailey's bead. This occurs when parts of the Sun's photosphere are visible through lunar valleys. Another phase of a solar eclipse is called a diamond ring. This happens when an oval patch of light shines from behind the Moon giving it the effect of a diamond ring set on a circular disk. A schedule of solar eclipses will be included in this unit.

RAINBOWS

Rainbows are a beautiful sight and we usually see a correlation between a rain shower and the presence of a rainbow. When we see a rainbow we are seeing the Sun's light passing through water droplets. The light refracts or bends on waterdrops that behave like prisms and spread sunlight into their separate colors. When this refracted light reflects off the inside of the water droplet, a rainbow occurs. Its colors include violet, blue, green, yellow, orange, and red. The most effective rainbows occur when the Sun is near the horizon. Rainbows do not occur when the Sun is high in the sky.

SUN HALO

One may witness a phenomenon that looks like a circular rainbow surrounding the Sun. This is called a Sun Halo. It occurs when the Sun's light refracts in the ice crystals that form in the very high cirrus clouds. The colors of a Halo are not as vivid as a rainbow's because the ice crystals have a variety of shapes and sizes.

EARLY ASTRONOMERS AND THEIR DISCOVERIES

The so-called "Golden Age" of astronomy was from about 600 B.C. -150 A.D. and celebrated in Greece, although some scientists argue that the Golden Age is right now. Although the Greeks used philosophical thought to render decisions of astronomical anomalies, they also relied on empirical data. As they developed geometry and trigonometry, they were able to assess sizes and distances of the Sun and Moon.

The Greeks, however, believed that the Earth was a motionless body at the center of the Universe. Some early Greeks believed in a rotating Earth, but most thought that the Earth was too large to move and in fact they had no feeling of motion.

The early Greeks also noticed that all of the stars, except for seven, remained in the relatively same position to one another. The seven bodies, called planets by the Greeks, included the Sun, Moon, Mercury, Venus, Mars, Jupiter, and Saturn. Each was thought to have a circular orbit around the Earth.

One of the first important astronomers to emerge after the Middle Ages was Nicolaus Copernicus. He purported that the Earth was a planet and that a rotating Earth could explain the motions of the heavenly bodies. Upon this conclusion, Copernicus reconstructed the Solar System with the Sun at the center and the Planets rotating around it.

Another scientist, Galileo Galilei, became interested in constructing telescopes after hearing about a Dutch lens maker that devised a system for magnifying objects. With his telescope, he made some important observations. One relative to this unit is the discovery of sunspots. Be tracking these blemishes, he concluded that the Sun has a rotational period of about a month.

In the 1600's, the Roman Church refused the Copernican theory because of beliefs that it was contrary to scripture. They also told Galileo to abandon his beliefs of the Copernican theory. He, however, refused and began working on a written work called Dialogue of the Great World Systems. Although this book was published, readers became aware that it held the views that were contrary to the Roman Church. Galileo was placed under house arrest and remained there for the last ten years of his life. Despite his restrictions, including total blindness, he continued working.

SCHEDULE OF SOLAR ECLIPSES

This schedule lists all of the solar eclipses through the year 2010. The estimated time of the eclipse is given along with a note on whether the eclipse will be (T) total or (A) annular.

DATE

Aug 21, 1998

Feb 16, 1999

Aug 11, 1999

Jun 21, 2001

Dec 14, 2001

Jun 10, 2002

Dec 4, 2002

May 30, 2003

Nov 23, 2003

Apr 8, 2005

Oct 3, 2005

Mar 29, 2006

Sep 22, 2006

Feb 6, 2008

Aug 1, 2008

Jan 29, 2009

Jul 11, 2010

APPROXIMATE TIME

21:00

02:00

06:00

07:00

16:00

19:00

03:00

23:00

18:00

16:00

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ACTIVITIES FOR SUBJECT AREAS

The following section will discuss different subject areas that teachers are likely to use in their classrooms. Along with these subject areas, activities dealing with the Sun will be included. An example of three lesson plans will follow.

KWL CHART

I always feel that the best way to start any new subject is with a KWL chart. This gives teachers an idea of how fast or slow to progress with students. It also gives teacher an idea of how knowledgeable students are with the given subject area. Lastly, it gives students an opportunity to express what they want to learn about the given subject and this makes it more exciting for them.

SCIENCE

The best way I feel to introduce the Sun to students is through the subject of science. This first introduction can include simple observations. After students have completed the KWL chart, I would suggest allowing them to make Sun journals. It would be best for them to bring in a new notebook, however, if this can not happen, you can easily make them with construction paper and writing paper.

Take students outside with their Sun journals. Allow them to make some observations about the Sun. Let them notice the Sun's heat, brightness, size, etc. Allow them time to write these observations down in their Sun journals. This would be a good activity to do three or four times a week. If the Sun is not seen due to a very cloudy day, do it anyway. Let students observe the differences in temperature. Ask them if they can see the Sun behind the clouds. Allow them to record all of the differences they see on a cloudy day.

Discuss evaporation with students. Let them know that the Sun helps moisture to evaporate more quickly. To demonstrate this, wet two different towels. Hang one of them in the classroom and one outside where the Sun's light will hit it directly. Let students record this experiment in their Sun journals and have them predict which towel they think will be dry first. They will most likely record that they feel that the water on the towel hanging outside will evaporate first. After students record their predictions, let them explain why they have made that prediction. I feel that it is always important to ask students "why?" when they are doing something. This ensures that they are not just passively writing any answer. Moreover, it allows them to think critically. After about two hours, let students check the two towels. You will obviously find that the towel in the Sun has dried out more quickly than the towel in the classroom. Let students record the results in their Sun journals.

Here is a quick way to make a rainbow. You will need a hose with a spray attachment on the end. On a sunny day, take the garden hose and just start to squeeze the nozzle so the water comes out in a fine mist. If the mist is fine enough, you should see a small rainbow in the spray. Experiment by spraying the hose high and low to see what happens. Remember that this will only happen on a bright, sunny day.

You may want to discuss the concept of seasons to the students right away. It may take them a while to grasp. You will need a flashlight and a globe. You will benefit from a larger globe. Pose the question to students "When do you think the Sun is closer to us, during the winter or the summer?" Chances are, the students will believe that the Sun is closer to us during the summer months when it is hot and further away from us during the winter months when it is cold. Let students know that the opposite is true and ask them how could it be that the Sun is further from us in the summer, but it is hotter? Also, how is it that the Sun is closer to us in the winter, but it feels colder. Allow students to make predictions, then explain the following. The Earth does slightly change its distance from the Sun, but what makes the biggest difference to us, as far as the temperature is concerned, is how the Sun's light rays hit us differently during the summer and the winter. This would be a good time to demonstrate the Sun's light rays with the flashlight. Tell students that you are going to demonstrate how the Sun hits the United States during the summer. It is important to start using the words United States instead of the Earth because while we are enjoying summer, the Southern Hemisphere is dealing with winter. Turn off the lights in the classroom and stand about six feet from the blackboard. Shine the flashlight directly in front of you onto the blackboard. Notice how dense the light ray is in color. Explain to students that when the Sun's light rays hit us in the summer, they are very direct like this. Since the light ray is so direct, there is no dilution of its energy and we feel more intense heat. Next, demonstrate how the Sun hits the United States in the winter. Stand a little closer to the blackboard and this time shine the light on an upward angle. A larger less colorful patch of light should be shining on your black board. Allow students to make comparisons between the two demonstrations. They should notice that this time the light ray looks not as dark in color. Prompt them to use the words less powerful. Tell them that during the winter months, the Sun is hitting the United States on an angle like this and since the light ray is not as concentrated and more spread out, it does not feel as powerful to us and therefore, it feels colder to us.

When students are comfortable with this concept, move the demonstration to a large globe. It may be helpful to have a smaller pen type flashlight so the light can shine directly on the smaller model of the United States on the globe. Imitate the Earth's axis by tilting it forward so the United States is pointing towards the flashlight. Make sure it is dark in the room and shine the flashlight on the globe. Make sure it is directly hitting the United States. See if students remember what season this is imitating. Since the light ray is directly hitting the United States, the students should recall that this is like the summer. Now tilt the globe so the United States is pointing away from the flashlight's light ray. Explain to students that this is what the United States looks like in relation to the Sun during the winter months. Shine the flashlight on the globe hitting the United States at an angle. The light ray should not be as concentrated, but should be more spread out and diluted. Prompt students to come to the conclusion that the Sun's light is hitting the United States at an angle and the light energy is not as powerful.

Depending on your grade level, this can be somewhat abstract for students. It would make sense to repeat this lesson a couple of times or perhaps make it a center so students can see the demonstration in a smaller group.

When doing science with students, always allow them to make their own predictions and ask them why they are making that prediction. Allow them to record their predictions in their Sun journals and check journals weekly.

ART

There are endless art projects that can be done with the Sun as the topic. The first one I would suggest is to make a large mural of the Sun on a bulletin board. A good way to do this is to find a good picture of the Sun and, through your copy machine, make a copy of that picture onto a blank overhead projector transparency. Simply place the transparency where you would put in the copy paper and the copy will come out fine. Next, cover your bulletin board with black paper. Then project and enlarge the image on the bulletin board with your overhead projector. Allow students to copy and color the image with finger-paints. Use a variety of bright yellows and oranges. Keep this mural up for the duration of the unit.

Another good project is a Sun mask. You can start by coloring a paper plate yellow. Next, cut out holes for the eyes and mouth. Using yellow construction paper let students cut out little solar flames to be attached all around the paper plate. Finally, let students tape on an ice-cream stick so they can hold the masks up to their faces.

A good final art project would be to make a rainbow. You can do this by cutting rainbow shapes out of oak tag or other thicker cardboard. Let students draw six different color sections with pencil first. When each section is made, use glitter to represent each of the colors of the rainbow. It would be ideal if you could find violet, blue, green, yellow, orange, and red glitter. Spread glue on each section of the rainbow one section at a time. Pour a different color glitter on each section and save the excess. Complete all six sections and allow drying overnight.

HISTORY

You may or may not want to get into history depending on your grade level. I suggest that you somehow try to fit in a little history of astronomy and some early thoughts on the Sun. I suggest that you refer back to the "Early Astronomers and Their Discoveries" section of this unit. Discuss with students how the early astronomers had the wrong idea of our solar system, i.e. the solar system was thought to be Earth centered and not Sun centered. Discuss how the church became involved in science and treated astronomers unfairly because of their beliefs.

Discuss with students how early explorers studied the heavens with telescopes that were much more primitive than we use today. If you have computers in your classroom or library, find some encyclopaedia software and let students observe telescopes in a center. Make sure they are able to see the history of the telescope and the changes that were made up until now.

MATH

Math may be a tough subject to fit into a science-based unit so you may have to use a little imagination. Here are a few suggestions.

Any opportunity you have to use word problems, use words and characters dealing with the Sun. Follow along these lines:

> 1. Galileo saw 10 stars through his telescope one night and 8 stars through his telescope the next. How many stars did he see all together?
> 2. Copernicus saw 12 meteorites on one night and 8 on the next. How many more meteorites did he see on the first night?

Continue with questions like this throughout the unit to keep math relevant to the Sun.

Of course if your have an older class and you are able to deal with larger numbers, feel free to subtract the distances of different planets from each other. If your students are ready for it, here are some figures. MEAN

DISTANCE FROM THE SUN

PLANET MILLIONS OF MILES

Mercury 36

Venus 67

Earth 93

Mars 142

Jupiter 483

Saturn 886

Uranus 1780

Neptune 2790

Pluto 3670

LANGUAGE ARTS

I would approach language arts by beginning with the vocabulary words that will be used throughout the unit. A variety of activities can be done with these vocabulary words. I would suggest breaking the words up into groups of ten to do the various exercises. I would start by discussing the words with the students and when they are ready, have them make their own sentences with each word. For example, if the word is "star" they could write, "I saw a shiny star at night." Let them do this for ten words at a time.

Another activity I like to do with vocabulary words is to have students put them in alphabetical order. Some students may find this easier than others. Depending on your grade level, you may have to explain how to do this with words that start with the same letter.

A third exercise that is fun to do with vocabulary words is finding rhyming words. Students are given a word like "Sun" and they are asked to find as many rhyming words as they can. I like to have students go through each letter in the alphabet and use the letters that make sense, i.e. bun, fun, gun, nun, run, etc.

Lastly, I like to challenge students by asking them to take all ten vocabulary words and write a story using all ten words. They should underline each word as they use it. This exercise can be very challenging and you may want to reserve it for your higher students.

Use this following list of vocabulary words throughout your unit:

Sun
Heat
Season
Star
Space

Night
Moon
Earth
Summer
Winter
Rainbow
Eclipse
Solar
Gas
Light

Energy

Mile
Sunlight
Science

Atmosphere

Gravity
Sunspot
Prominence
Astronomer
Colors
Galileo
Daytime
Horizon
Sunrise
Sunset
Rotate
Orbit
Solstice
Axis
Telescope
Scientist
Experiment
Evaporation
Shade
Cloud

LESSON PLAN 1

Language Arts (Creative Writing)

OBJECTIVES:

Students will write a creative story on the theme of travelling to the Sun with a stress on proper punctuation and capitalization.

DURATION:

45 mins.

MATERIALS:

Writing paper, construction paper for a cover.

PROCEDURE:

As students get to know the Sun throughout this unit, they will realize that it is too hot to travel to. Discuss with them what would happen if a special space ship was created that could bring people to the Sun. Give students the writing prompt asking them to use their imaginations and write about what they would find on the Sun if they went there. Give students about half an hour to complete this. Stress the importance of how every sentence begins with a capital letter and ends with some form of punctuation be it a period, question mark, or exclamation mark.

Let students fold construction paper like a book cover and decorate it. When their story is complete and edited, they can place the story in the cover and staple it in place.

FOLLOW-UP:

Let students have an author's day where they are allowed to read their stories to the class. Invite parents in to listen. Hang stories around the room when complete.

LESSON PLAN 2

Science (Reading a thermometer)

OBJECTIVES:

Students will be able to read a thermometer and record daily temperatures.

DURATION:

Half-hour lesson on learning to read temperature. 5 minutes to record daily temperature.

MATERIALS:

1. A classroom thermometer
2. Science journals

PROCEDURE:

Begin by showing students the larger numbers on the thermometer. Notice that they go in increments of ten. Practice counting by tens with students. Next, show students the smaller lines that fall between the larger numbers. Have a student count from one large number to the next, i.e. from 20 to 30. They will find a difference of 10 degrees between each larger number and each small line equals one degree. Next, ask students what they think the red liquid is and what it is used for. Prompt students to the correct answer and ask them how they think they would read the temperature according to where this red liquid is. Let students learn to read different temperatures by putting thermometer over a candle, then in a glass of cold water.

Once students are used to reading the temperature, they can record it daily in their science journals.

FOLLOW-UP

Let students make their own thermometer out of construction paper showing what their favorite temperature is.

LESSON PLAN 3

ART (The Sun in its Solar System)

OBJECTIVES:

Students will create a Sun in a space environment out of various materials.

MATERIALS:

1. shoe box
2. black, white, and yellow paint
3. small Styrofoam ball
4. string
5. tacks
6. tape

DURATION:

Half-hour increments

PROCEDURE: Paint the inside of the shoebox black. Allow drying then paint in little white specs for stars. At the same time, paint the small Styrofoam ball yellow and allow drying. When all the paint is dry, attach a small piece of string to the ball with a tack. Tape the other end of the string to the top of the inside of the shoebox. The string should be long enough to hang down to the middle of the shoebox.

FOLLOW-UP

Allow students to display Suns in a showcase in the hallway or on windowsills in the classroom.

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