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Our Intriguing Star... The Sun!

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When we look up at the night sky, we see billions of scintillating points of light, stars that comprise our Milky Way galaxy. There is, however, one star that we do not see at night. We experience it with each new glistening dawn. From Earth's vantage point this star seems enormous. If, however, we were to travel far beyond our solar system's boundaries, into the broader universe and look back, we would observe that *our* star is seemingly minuscule when compared to the countless others that adorn the vastness of space. That star, of course, is our Sun. But what is this celestial sphere that brightens our dawn? My curriculum unit, OUR INTRIGUING STAR... THE SUN, explores these concepts and more.

Developed for Grade 2 space explorers (and modifiable for grades 3 through 5), OUR INTRIGUING STAR... THE SUN is presented in an easy-to-use question and answer format zeroing in on fascinating characteristics of the Sun and its overall impact on planet Earth. Through interactive activities, related films and select readings, and writing activities aligned with Connecticut Mastery Test (CMT) response to writing strands, students grasp that the Sun is more than a source of light and heatthat it impacts planet Earth in ways often taken for granted. The unit, to be implemented within an eight to ten week period, is interdisciplinary. It is aligned with New Haven Public School Curriculum Standards (Science - Scientific Inquiry 1.0; Earth Science CS 4.0 [Study the Sun]; Language Arts - Reading CS 1.0, Writing CS 2.0, and Speaking CS 3.0; and Social Studies - Diversity CS 1.0 [listening/reading multiple sources of info that reflect diverse cultures]).

It is my hope that OUR INTRIGUING STAR... THE SUN (1) encourages elementary school instructors to expand their scope in teaching about the Sun from a less generalized to a more sophisticated perspective; (2) to arouse curiosity and a love of astronomy among our young learners; and (3) to remind us that our Sun and our solar system are but a small part of an awesome universe!

Introduction

Engaging young learners in unexpected ways entices them to buy into new courses of study. Before introducing this unit, on a beautiful sunlit afternoon, accompany your students outside for an out-of-the-norm-after-lunch recess, during which you conduct a "what-do-you-know" session. Begin your discussion with "*Isn't*

it a beautiful day! The Sun feels gooood, doesn't it? Let's close our eyes, and think about our Sun. (Give your students a few seconds.) "*Open them! What can you share?*" Hands will surely fly. " *The Sun gives us light! It gives us heat! It stands still in the morning sky. The Sun goes away at night and disappears when it is cloudy...*" Their comments will be endless, but right then, you can wow your young learners with a few intriguing facts! "*Our Sun is actually a stara hot ball of gas that is constantly emitting heat, lightand magnetic forces, AND it never disappears. The Sun is quite an intriguing celestial bodywant to learn more!*" The response will be unanimous, and the adventure begins!

Section 1: Setting The Tone

Familiarizing our students with astronomy terms enhances the learning experience. Before you initiate this unit, be certain to create a word wall to highlight many of the terms that will be used throughout this study. (Many of the words contained herein are included in non-fictional children's book selections highlighted in the bibliography.) To enhance my word wall, making it user-friendly and experiential for young learners, I include several 4" x 6" laminated color copied photos and/or diagrams (see "*" below) to highlight specific terms as visual vocabulary cues. Images, many of which are provided by NASA, can be downloaded and copied from the web. These items are public domain and can be used as long as they are utilized for classroom purposes.

Word Wall Selections

(table available in print form)

Young Explorers Want To Know!

In addition to providing researched information and related projects for my students, I always take into consideration areas of study that **they** want to pursue. I want my students to have an in-depth understanding of our topic of study. Providing them with an opportunity to give input in the curriculum fosters ownership, involvement, and understanding. The questions that follow are inquiries made by second graders with whom I have interacted. In those instances where abstract concepts sparked additional inquiry, I have included a "Related Activity/Resource" to bring understanding of the concept to life.

Precautionary Note: Before getting into the unit, inform your students to never look directly at the Sun. Highlight that the Sun is very powerful. Its rays can damage our cornea, the part of the eye through which light passes that along with other components, help us see. Emphasize that directly looking at the Sun can permanently damage our eyesight, causing blurred vision or blindness.

The Adventure Begins

The implementation of this unit spans eight to ten weeks, during which time 32 questions will be explored (see Pacing Calendar, Appendix A). This time frame can be shortened or extended as required.

(1) What is the Sun, and what is its age?

The Sun is a gaseous, luminescent sphere that emits light and heat energy, and magnetic force. Comprised predominantly of hydrogen and heliumthe same lightweight gases that cause zephyrs and party balloons to

float in the air, small amounts of oxygen, nitrogen, carbon, and metallic substances comprise this sphere. Our Sun is an estimated 4.5 billion years old!

(2) How large is the Sun?

The Sun is approximately 865,000 miles in diameter. It is so enormous that approximately 1.3 millions Earths can fit within it!

(3) How far away are we from our Sun?

The Sun is an estimated 93 million miles away from our planet. Imagine riding in a car at a constant speed of 60 miles per hour. If we could drive that car directly to the Sun, with no traffic lights or pauses at fast food rest stops interfering, it would take us 177 years to reach the Sun from planet Earth.

(4) Our Sun looks so enormous in the morning and afternoon sky! How can it be smaller than the other stars we see at night?

Again, our star is an estimated 93 million miles from Earth. In distance, stars that we see in the night sky span much farther than that! Our next closest star, Proxima Centauri, is approximately 24.8 trillion miles away. Thus, the distance between Earth and the Sun and Earth and other stars is vast. The distances between us cause an optical illusion, making it appear as if our star is larger.

Related Activity/Resource

To accentuate this concept, conduct an experiment in your school, preferably in a long corridor. You will need four brightly colored paper plates (two 12 inch, two 9 inch, preferably yellow), and a camera. Select four students to stand at strategic distances along the corridor, approximately 12 equidistant feet behind one another. (Onlookers stand at the opposite end of the hall to observe and record their findings.) One child holding the 9-inch plate should stand at the starting point, closest to the onlookers. The second child holding the 12 inch plate stands at the 12-feet away; the next child holding the 9-inch plate, stands an additional 12 feet away, and the last with 12-inch plate in hand, stands at the last station. Have each child hold up his/her plates. Ask the onlookers to describe what they notice. Most will reply that the 9-inch plates appear larger than the 12-inch plate. Highlight that although the Sun is by no means equivalent to a paper plate, the overall concept depicted here helps one understand why our Sun appears to be so enormous in the morning sky. Take snapshots of the experiment in progress, so students will have a visual depiction of their observations for future reference.

(5) Is there gravity on the Sun, and if so, how does the Sun's gravity impact Earth and the remaining planets in our Solar System?

Yes, there is gravity on our Sun. Gravity is an invisible force that pulls us towards any object. That very same invisible force experienced on our planet exists on our Sun. The Sun's gravitational pull is so strong that it keeps the nine planets and other celestial bodies in our solar system in orbit.

(6) Is the Sun stationary?

Many people would wager that the Sun stands perfectly still. Remarkably, like the planets that orbit this celestial body, the Sun rotates on its axis in a counterclockwise-type motion, from west to east. Unlike the four terrestrial planets in our solar system, it rotates at different speeds from its north and south poles to its equatorial center.

(7) Is there a special term for the Sun's rotation?

The Sun's rotation is known as **differential rotation** . The rotation of the Sun varies at different points on its surface. It takes approximately 25 days for the sun to completely rotate near its equator. Near its north and south poles, the Sun rotates a bit slower. Scientists have noted it takes more than 30 days for rotation to occur near the Sun's poles. The fact that the Sun is gaseous allows deferential rotation. In fact, scientists are still attempting to understand why differential rotation occurs.

Related Activity/Resource

To help children get a better understanding of how the Sun rotates at different speeds, conduct this simple activity (which can be effectively coordinated with a physical educational session.) You will need hula-hoops and energized students raring to go. First have your students pretend they are the Sun. The hoops symbolize the gases rotating on the Sun's surface. Have the children begin swirling the hoops around their waste. Have them move at medium speed. They will observe that the hoop spins a bit faster than the movement initiated by their gyrating waists. Emphasize that although the human body and hula-hoops are by no means commensurate with the Sun, the activity gives an example of how different points can rotate at differing speeds.

(8) Does the Sun's rotation cause the Sun to disappear at nighttime?

The Sun does not literally disappear, and its rotation does not impact this occurrence. The illusion that it disappears is actually caused by the Earth's rotation in relation to the Sun. Although the Sun perpetually rotates, it remains in the very center of our solar system. Each of the nine planets revolves around the Sun. Our planet, Earth, rotates around its axis and revolves around the Sun. The rotation of our planet gives the illusion that our Sun has disappeared. When our side of the Earth is turned away from the Sun, we experience nighttime. When our side of the planet faces towards the Sun, it is daytime.

Related Activity/Resource

You will need a flashlight, two nametags marked "Connecticut" and "Beijing" respectively (any state or country on opposite sides of the world can be used), and a pair of students. Have one child pretend he/she is the Sun, the other planet Earth. The child representing Earth will have a nametag affixed to the front and back of his/her shirt indicating the two locales. Have the child holding the flashlight turn it on. The other child rotates slowly while remaining students observe. Ask your students to determine the time of day in each specified locale based on Earth's rotation.

(9) Like the nine planets, does the Sun also revolve?

Yes, our Sun revolves. Although it is in the center of our solar system, it revolves around the center of our galaxy, The Milky Way.

(10) Did scientists always believe the Sun was the center of our solar system around which the planets revolved? Who were the first scientists to believe the Earth revolves around the Sun?

Scholars state that in 150 A.D., a well-known Egyptian astronomer Ptolemy studied the movement of celestial bodies in his homeland, Alexandria. Based on his observations, Ptolemy conjectured that the Earth was a motionless mass at the center of the universe around which other heavenly bodies revolved.

Almost 1,400 years later, two scientists from other cultures countered Ptolemy's theory, setting in motion a new train of thought. In 1543, Polish astronomer, Nicolaus Copernicus, developed the theory that the Earth is a moving planet, and that it and other celestial bodies orbit the Sun. Copernicus did not scientifically prove his theory.

Approximately 50 years later, an Italian mathematician and explorer, Galileo Gallilei, agreed with Copernicus' view. Creating and using one of the first telescopes,

Galileo utilized scientific study to support his conviction.

During Galileo's time, most scientists and Christians agreed with Ptolemy's theory. Galileo, however, stood fast and continued his studies. Galileo suffered imprisonment because of his views and astronomical undertakings. Nevertheless, Galileo's research helped lay the foundation for our understanding of planets orbiting the Sun.

Related Activity/Resource

Shared reading and related writing assignment (see Section 2, Extending and Connecting – Lesson Plans).

(11) Where does the Sun disappear to on cloudy, rainy days?

The Sun does not disappear. It is still above us, hidden by thick clouds that cover the sky. If you were to travel on a jet, above those billowy stratus clouds, you would find our Sun shining brightly!

(12) How hot is our Sun?

That depends upon which part of the Sun we refer to. Our star generally is so hot that if you could land a PT Cruiser on its surface, that vehicle would sublimechange immediately from a solid into a gas! The Sun's core is an approximate 27 million degrees Fahrenheit. The Sun's photosphere is a few hundred miles thick. Circulated gas cools within this region, fluctuating from approximately 10,800 to 7,200 degrees Fahrenheit. That does not include temperatures found in the corona!

(13) Is the Sun solid, like a huge baseball?

Our Sun looks like a brightly lit, solid celestial sphere. In actuality, it is not solid at all. It is made up entirely of gas. If we were to try to stand on its surface, we would fall through it!

The Sun generally is divided into two major regions: the interior and the atmosphere. The interior consists of a very hot and dense core, where energy is generated. The remaining portion of the interior plays no role in energy generation, but energy generated in the core passes through these regions on the way to the atmosphere.

The solar atmosphere is usually divided into three parts: the photosphere, chromosphere, and corona.

(14) What are the attributes of these two regions?

The core is the interior portion of our Sun. Within the interior, nuclear fusion occurs and energy is generated. The core constitutes 30% of the Sun's interior. Gas is dense in this region, somewhat like flakes of snow packed tightly into a snowball. Unlike a snowball, the Sun's core remains gaseous at a whopping 27 million degrees Fahrenheit! The core is part of the radiative zone. The radiative zone comprises 70% of the Sun's interior. There is no bulk movement in this region. Nevertheless, energy in the form of photons travels very slowly through the radiative zone. Above the radiative zone lies the convection zone, where visual columns of gas transfer energy.

The Sun's atmosphere is comprised of three parts: the photosphere, often referred to as the Sun's surface, marks the beginning of the Sun's atmosphere. Within this area, gases circulate like boiling water in a saucepan. The bulk of this region is radiative. It is through the photosphere that our star's intense light and heat are emitted.

The chromosphere is the second layer of the sun's atmosphere. We cannot see it because bright light from the photosphere hides its light similarly to the way our Sun interferes with our ability to see other stars during daylight hours.

The outer portion of the Sun's atmosphere is the corona; the only time we can observe it is during a solar eclipse or through a special instrument called a coronagraph. The corona extends for millions of miles into space. The further the corona extends into space, the higher its temperature. Space scientists believe solar winds are generated in the corona, traveling throughout our solar system and beyond.

Related Activity/Resource: 3D Diagram and Sun Quiz

http://nmp.jpl.nasa.gov/st5/SCIENCE/sun.html This website provides a diagram of the Sun's layers, along with detailed information regarding each section. Provided by NASA, it can be downloaded and used free of charge. This engaging diagram can be enlarged and used during classroom discussion and as a resource tool near your word wall.

Students will create a 3D diagram, depicting the components of our Sun. Colored markers, assorted colored pliable clay, and a diagram master (reproduced on 8 ½ x 11 cardstock) are required. Download diagram from the student friendly website: Sun Printout/Coloring Page: EnchantedLearning.com Have your students fill in the designated spaces with clay. Put on additional accents using marker.

www.enchantedlearning.com/subjects/astronomy/activities/radiobuttonquiz/Sunpz.shtml

This fill-in questionnaire, accompanied by a scrambled image of the Sun, highlights 10 key facts about this celestial sphere. A perfect X-ray image of the Sun emerges if you answer all 10 correctly! Additional information concerning the Sun can be accessed here.

(15) What is nuclear fusion?

Nuclear fusion is a process where hydrogen gases combine to form helium in such a way that they release a tremendous amount of energy. Heat is continuously dispersed into surrounding areas in the form of hot

plasma (a substance that consists of ions and electrons, that individually are not visible to the naked eye). All of this activity and movement causes temperatures to vary from the innermost to the outer regions of the Sun.

(16) Can you give a visual example of what goes on inside the convection zone?

To get a better feel for the process, think of an electric lava lamp. Clumps of wax are in the cylindrical glass portion of the lamp. When the lamp is turned on, heat melts the wax therein. The wax begins to float inside this container in an upward movement. When the melted wax reaches the top, it cools, and then falls back down to the base of the lamp.

The circulatory process continues. This is a visual example.

Related Activity/Resource

Bring in a lava lamp. Plug it in. Have students visually experience the process.

(17) The surface of our Sun looks smoothis it?

The surface of the Sun is very opaqueyou cannot see through it. If we were to take an up-close look at the Sun's surface, we would discover that it consists of individual blazing yellow blobs, each about the size of planet Earth. These objects called granules are actually convection cells in the Sun's outer layer. Because we are so far away from our star, we do not see these cells, but magnified with the use of scientific equipment, astronomers and astrophysicists know they are there!

(18) How does the photosphere produce heat energy?

The photosphere does not produce heat energy. It merely emits energy that has been transferred from the core.

(19) What is the hottest part of the Sun?

The hottest part of the Sun is its core or center. Envision the core as a gigantic nuclear furnace. The temperature there is approximately 27 million degrees Fahrenheit. Now that's hot!

(20) How hot is the corona?

The corona, the least dense region of the Sun's atmosphere, radiates thousands of miles from the Sun's photosphere. You can only see it during a total eclipse of the Sun or when you use specialized scientific equipment called a coronagraph. The corona extends millions of miles into outer space. The farther away from the Sun the corona extends, the hotter the temperature. Temperatures have been known to reach as high as 3.6 million degrees!

(21) Why does the Sun's temperature differ from its inner core to its outer surface?

Again, nuclear fusion occurs in the core, resulting in that phenomenal temperatureapproximately 27 million

degrees Fahrenheit! Energy in the form of heat and light is produced by nuclear fusion. Energy produced in the Sun's core enters the radiative zone. Energy is radiated from this area to surrounding plasma. Photons spread out. These photons come to the inner edge of the convection zone. Here, hot air rises and cool air descends. The convection process continues. From the inner edge to the outer edge of the convection zone, energy cools. By the time it reaches the photosphere, the temperature is approximately 10,800 Fahrenheit.

(22) Is there temperature variation in the Sun's photosphere as well, and if so, why?

Yes, there is temperature variation in the Sun's photosphere. In the photosphere, gas cools from about 10,800 degrees to 7,200 degrees Fahrenheit. This variation occurs because the photosphere is a few hundred miles thick. Through the photosphere, the Sun's intense heat and light is given off. It passes through the atmosphere's outer layers and then into space.

(23) What are photons, where do they begin, and how do they travel?

Photons are particles of light. Within the Sun's core, they move very slowly. This is because the Sun's core is very dense. Photons move so slowly within the Sun's core that it takes approximately 170,000 years for them to travel and finally escape to the solar surface as sunlight. When photons escape the core and enter the photosphere, they begin to travel at a much faster rate. Amazingly, solar energy that reaches us takes only 8 minutes to travel from the photosphere.

Related Activity/Resource

To visualize the movement of photons within the Sun's core, find a place where floating dust particulars are very visible. Explain that because of the Sun's density, photons move very slowly. They bump into gas molecules just like particles of dust we see in the air. Notice that they never go straight, but seem to bump into each other. Photons move in a similar fashion. Within the core, they never travel in a straight direction.

(24) How long does it take the sun's rays to reach Earth?

The Sun's energy reaches Earth in the form of electromagnetic radiation. The Sun's rays (electromagnetic radiation) travel in straight lines. Note that the Sun's light and heat cannot reach us by conduction or convection because space is almost completely empty, i.e., it is in a vacuum, and there is nothing to transfer the energy from the Sun to the earth.

It takes approximately eight minutes and 20 seconds for the Sun's light waves to travel all the way to our planet from the surface of the Sun.

(25) What are solar winds, and do they blow hot air?

The term "solar winds" does make one envision blustery hot air gusting across the earth. Solar winds, however, have nothing to do with gusting air. They are actually tiny particles of small ions that carry electricity (plasma) emanating from the Sun's corona that moves all around. Plasma is affected by the electric and magnetic fields resulting from the extremely hot temperatures from the Sun. These "winds" or fields travel in all directions from 185 to 435 miles an hour. When they travel far away from the Sun, far into outer space, they pick up speed. Solar winds travel so far, they reach our planet and beyond.

(26) Do solar winds affect our planet in any way?

Yes they dodramatically! (They also affect other parts of our solar system.) Solar winds carry magnetic fields. These magnetic fields interact with the Earth's magnetic field. On planet Earth, solar winds contribute to the creation of aurorea (northern and southern lights). These are visible effects of solar winds.

Aurorae are beautiful, colorful displays of light caused by the interaction of solar wind and our planet's magnetic field. Aurorae occur because plasma (electrically charged atoms and electrons energized by extremely high temperatures) is drawn toward the Earth's northern and southern magnetic poles. As plasma nears and reaches the Earth, ions drawn toward Earth's northern and southern magnetic poles result in surrounding areas in Earth's atmosphere to glow. We see that glow in the form of beautiful displays of colorful light. Aurorea are experienced in Alaska, near the North and South poles, and even as near as New Hampshire.

Additionally, near Earth, solar winds move at an extremely rapid speed, as much as 1 million miles per second! The Earth also has a magnetic field. At times, the solar winds are exceptionally strong. When they reach the Earth's atmosphere, they sometimes cause damage to space satellites and other scientific equipment orbiting our planet. They interfere with radioeven cell phone transmissions!

(27) What are solar flares and plages and where are they found?

Solar flares are temporary outbursts of energy (gamma rays [high energy]; light, x-rays, ultraviolet, visible, infra-red [which we feel as heat], microwave, radio, and energetic particles) that extend from the outer edge of the chromosphere into the corona and beyond. Plages are bright patches that are hotter than their surroundings on the Sun's surface. Solar flares and plages are visible only with specialized scientific equipment called a spectrohelioscope.

Related Activity/Resource

http://www.wellesley.edu/Astronomy/facilities.htm#spec

This website provides a birds-eye view of the spectrohelioscope along with other space equipment used to study our Sun and other celestial bodies.

(28) What are sunspots and where are they located?

Sunspots are found on the Sun's photosphere. They look like dark blemishes on this glowing mass. They are caused by magnetic fields within the Sun. Here, the Sun's magnetic field is extremely intense. Sunspots are dark in color because their temperature is low as compared to the surrounding photosphere. The dark brownish center is called the umbra. A light brownish region called the penumbra surrounds it. Their temperatures range between 8,250 and 9,500 degrees Fahrenheit.

Related Activity/Resource

http://solar-center.stanford.edu/solar-images/solar-images.html#need

This is an interactive website to chart and experience the recording of sunspots moving along the Earth's surface. Students will record and graph information for a two-week duration using this simulated image.

(29) What are prominences, and where are they located?

Prominences can be described as balls of flaming, hot gases that bubble and spin on the Sun's surface (photosphere). They often shoot out from the Sun's surface like long wiry arms. Technically speaking, they are high-density clouds of gas projecting outward into space. They can be over 100,000 miles long. They can retain their shape for several months at a time before dissipating.

(30) Some stars are blue or white. Some like our Sun are yellow. Some are red. Why do they differ in color?

The surface temperature of stars causes their color: if the temperature of a star is above 54,000 degrees Fahrenheit, that star takes on a blue violet appearance. When its temperature falls between 13,000 to 20,000 degrees Fahrenheit, the star is white. Between 9,000 and 11,000 degrees, the star is yellow. Between 2,300 and 9,000 degrees Fahrenheit, it is yellowish orange or orange in appearance, and less than 2,300 Fahrenheit, the star is red.

(31) Some days, the Sun appears to be reddish orange in color. Why does this occur?

The reddish orange appearance of our Sun is caused by pollution, specifically dust in Earth's atmosphere. Dust scatters light. Blue and violet light are easily scattered; red is not. Thus, when the sky is very cloudy, we are apt to see an orangey red colored Sun. The Sun itself has not changed colors; it is still yellow.

(*32) How do scientists know so much about our Sun?*

Since 1955, many space probes and scientific equipment have been launched to study our Sun. Specialized instruments are used to measure solar winds, solar flares, cosmic rays, and the Sun's magnetic field. High-powered telescopes and cameras are used to take photos of the Sun. The Solar and Heliospheric Observatory (SOHO), launched in 1955, collects information about solar winds that surround the Sun and extend throughout the solar system. In 1965, 13 space probes were sent constituting the U.S. Pioneer Series. This scientific equipment records and transmits data to National Aeronautics and Space Administration (NASA) scientists. In 1973, The U.S. Skylab space station was used to observe our star. The Ulysses space probe was launched in 1990. It studies activity that occurs at the Sun's north and south poles and the space above and below these areas. YOH KOH, a space probe sent to study the Sun, was sent into space in 1991. A joint mission conducted by the United States, Britain, and Japan, it studies high-energy radiation from solar flares. Today, the study of our Sun using sophisticated technology continues on a worldwide basis.

Section 2: Extending and Connecting – Lesson Plans

Literacy is a major component of the Grade 2 curriculum on a district and statewide level, with major emphasis on reading, reading comprehension, and conveying thought in both written and oral form across disciplines. In line with these requirements, OUR INTRIGUING STAR… THE SUN includes a literacy component.

Non-fictional and folkloric tales will be used for read aloud, shared, guided, and independent reading. These

resources will serve as a springboard to narrative writing and as a foundation for responses to open-ended questions. Note that storywriting and open-ended writing response activities noted herein can be strategically incorporated during weeks three through six or as a follow-up to the completed unit (see Pacing Calendar Appendix A). Additionally, each open-ended question coincides with Connecticut Mastery Test (CMT) response-to-text writing strands.

By implementing this writing component, students will be able to: identify and categorize stories by genre; demonstrate their understanding of covered material through a wide range of writing styles; and recognize that non-fictional works often serve as a framework for fictional writing. Students will also create, edit, and finalize written works. (When editing, students are encouraged to remember the acronym, **COPS C** apitalize, **O** rganize thoughts, use correct **P** unctuation, and be **S** ure the **S** entences make **S** ense. Use of this acronym reminds students to carefully proof their work before asserting, "I'm done!") The ultimate goal: students will develop and/or strengthen narrative and expository writing skills.

Springboards For Writing

Two non-fictional works and three folkloric tales from Australia, Nigeria, and the United States (Oklahoma) respectively will serve as primary springboards for responses to open ended questions and narrative writing. These selections can be read aloud during shared or guided reading with the assistance of an instructor or read by students on an independent basis. (To dispel misconceptions and stereotypes, complement story selections with a unit study on the countries/cultures from which the stories originate. With teacher/school library media specialist assistance, students can conduct special research projects on life in Australia, Italy, Nigeria, and Oklahoma past and present, comparing and contrasting similarities and differences found within each culture. Additionally, avoid the use of stereotypical vocabulary when referring to non-Western cultures [e.g., "tribe, primitive, mystical, hut, jungle..."]. Such efforts help to foster a respect and celebration of diversity.)

The following books will serve as springboards for writing:

Title: The Starry Messenger - Biography

Background Info

This Caldecott-honor book by author/illustrator Peter Sis presents the life of mathematician/astronomer Galileo Gallilei. Galileo's love of Math and Science since childhood, conviction that the Earth and other celestial bodies traveled around the Sun, and conflicts he encountered during adult years resulting from his scientific beliefs are the primary focus. Sidebar commentaries, presented artistically in script, give additional insight into Galileo's life. This information should be read aloud by the instructor.

Title: The Sun – Informational

Background Info

This non-fictional work examines the Sun as a star. Key points include the Sun's distance from earth, its size and temperature; its being the center of our solar system; its components; its thermo-nuclear power, sunspots, eclipses, prominences, flares, and aurorae. Because **The Sun** was written in 1989 and information concerning our solar system and overall universe is ever changing, complement this work with up-to-date

facts found within this unit (e.g., Sun rotation, characteristics and functions of each section of the Sun, Sun color denoting temperature, convection) or at www.nineplanets.org.

Title: Sun Mother Wakes The World – Myth

Background Info

The aboriginal people of the western coast of southern Australia are said to have handed down this creation tale, retold by Diane Wolkstein. This work conveys a twofold message: It first tells of the origins of the ancestors of the Aboriginal people in this region. It subsequently explains how the Sun came to rise, set, and serve as a source of life for mankindawakening the Earth.

Title: Why the Sun and the Moon Live in the Sky - Folktale

Background Info

This Nigerian folktale is retold by Elphinstone Dayrell, a government official stationed in Nigeria who during the early 1900s collected the traditional tales of the Hausa people. This story explains why the Sun and Moon are seen in the sky. It too conveys the importance of effectively communicating and collaborating with others, emphasizing that failing to do so can lead to unanticipated circumstances.

Title: How Grandmother Spider Stole The Sun - Folktale

Background Info

This traditional tale is part of a collection of Native American folklore and myths retold by Joseph Bruchac. Handed down by the Muskogee (Creek) people of Oklahoma, the story explains how the Sun came to be in the sky and why the Fox, Possum, Spider, and Buzzard have the physical attributes they possess today. The work also conveys that those who steal will reap a revealing consequence.

Writing Assignments

Writing prompts contained herein are aligned with CMT open-ended questions/written response strands. Teachers should create a worksheet for each writing prompt noted below. Each worksheet should include space for the student's name, the date, title of the book, author's and illustrator's name, and genre. (The open-ended question or wording for the narrative writing prompt should be imprinted thereon.) By using this format, students will begin to make a connection between the creators of specific works and the genre under which the works can be classified. They will also begin to conceptualize different ways of responding to text.

Open Ended Writing Prompt #1 - Summarize This

Briefly discuss the main events of the above-referenced story. Use details from the text to support your answer in the order in which they occur. Come on! You can do it!

Objective(s)

To demonstrate understanding of the general text.

To select, use, and summarize the primary theme of text.

Requirements

This form is to be used with our three folkloric tales and/or **The Starry Messenger** . Students will classify each literary work by genre and will include the title of the work and name of the author in their response. Students should highlight main characters, the setting, two major problems/events and corresponding solutions/outcomes in the story in sequential order. (CMT Writing Prompt A3.)

Scores/Rubric

Scores of 2, 1, or 0 will be applied based on the following criteria:

2 = student has definitively included primary characters, setting, two major

problems/events supported by two major solutions/outcomes;

sentences are well constructed; comprehension is conveyed

1 = student has generally included main characters, setting, one major

problem/event supported by one major solution/outcome;

sentences are well constructed; basic understanding is conveyed

0 = none of the above criteria have been met

Evaluation

Promote student self-evaluation. Confer with students, reviewing writing results based on achieved rubric score. Make recommendations where required. Have student edit work where necessary. Retain writing samples in student folder for future student self-evaluation, and to generally monitor student progress.

Open Ended Writing Prompt #2 - Rename It

You have just read (title of story selection). If you could rename it, what would YOU entitle the story? Use two to three details from the story to support your title change. Come on! You can do it!

Objective

To determine the main idea/theme within a non-fictional or fictional work.

Requirements

This writing prompt serves as a comprehension exercise. It can be used for any of the five story selections. Students will classify literary work by genre and will include the title of the work and name of the author in their responses. Students should rename the story based on key events or facts cited in the story. Students should begin with the opening statement or similar wording "*if I were to change the title of this story, I would change it to...*" Student should subsequently highlight two to three major events from within the text in support of the title change. (CMT Writing Prompt A1.)

Scores/Rubric

Scores of 2, 1, or 0 should be applied based on the following criteria:

2 = student has included an appropriate new title; two to three detailed

events from text are used to effectively support the title change; sentences

are well constructed and thorough understanding is conveyed

1 = student has included an appropriate new title, one key event from

the text has been used to effectively support the title change;

sentences are generally well constructed; basic understanding is conveyed

0 = none of the above criteria are demonstrated; lack of understanding conveyed

Evaluation

Confer with students to review writing results based on achieved rubric score. Where necessary, have student revisit the story, highlighting key events. Have student edit and revise title and supporting events where necessary. Retain writing samples in student folder for future student self-evaluation, and to generally monitor student progress.

Open Ended Writing Prompt #3 - You're The Expert

Pretend you are a guest lecturer standing before a classroom of students who know little about the Sun. Based on your classroom and independent readings, YOU are our Sun expert! You have been asked to explain TWO KEY concepts about the Sun. Use information from the text to support your answer. Come on! You can do it!

Objective

To select, synthesize, and use relevant information to convey understanding of subject matter.

Requirements

This prompt serves as an informational writing/comprehension exercise. It should be used after having read Seymour Simon's ***The Sun*** and supplementary information as previously noted. Students are required to identify this literary work by genre and include the title of the work and name of the author in their response. Students should generally state two facts cited in the text, elaborating on those facts with support statements taken from the text and supplementary readings. Cited facts will vary, ranging from *why our Sun appears to be larger than other stars seen in the night sky* to the *components of the Sun and their function* . (CMT Writing Prompt C3)

Scores/Rubric

Scores of 2, 1, or 0 should be applied based on the following criteria:

2 = student has included two general statements and has provided

accurate background details from text and related readings to support

both generalizations; sentences are well constructed and thorough

understanding of subject matter is conveyed

1 = student has included one general statement and has provided

accurate background details from text and related readings to

support the generalization; sentences are generally well constructed;

basic understanding is conveyed

0 = none of the above criteria is demonstrated; lack of understanding conveyed

Evaluation

Confer with students to review writing results based on achieved rubric score. Where necessary, have student revisit the story, identifying key points. Have student edit and revise key points and/or supporting events where necessary. Retain writing samples in student folder for future student self-evaluation, and to generally monitor student progress.

Writing Prompt #5 - Narrative Writing Assignment

Long, Long, ago, people across cultures created myths and/or folklore to explain things that happen in nature. Pretend you are a person who lived long, long ago. Create a story to explain why the Sun rises and sets. We want to feel, taste, see, and hear your story! Come on! You can do it!

Objective

To create a descriptive fictional work that includes structure and organizational patterns.

Requirements

Students will use their imagination to create their own folkloric tale. The story creation should include an engaging beginning, a well-defined setting, characters consistent throughout, a well-described series of events/problems, an engaging conclusion/resolution, and an attention-grabbing closing statement.

Scores/Rubric

Scores of 6, 5, 4, 3, 2, or 1 should be applied based on the following criteria:

6 = student has included an engaging beginning; sentences are well constructed;

organization, elaboration, and fluency are well developed; overall storyline is well defined.

5 = student has included a somewhat engaging beginning; sentences are generally well constructed; organization, elaboration, and fluency are evident; overall storyline is well defined.

4 = student has included a descriptive beginning; sentences are somewhat descriptive but inconsistent throughout; organization, elaboration, and fluency are conveyed

3 = student has included a simple beginning, middle, and end; sentences are minimally descriptive but generally well constructed; organization and fluency are evident

2 = student has not included the beginning, middle, and/or end; sentences are minimally descriptive and unorganized; fluency is minimally evident, storyline is vague

1 = no storyline is conveyed

Evaluation

Confer with students to review writing results based on achieved rubric score. Where necessary, have student revisit the story, editing and revising where required. Final product can be formally typed and illustrated by student for display. Retain original writing samples in student folder for future student self-evaluation, and to generally monitor student progress.

Writing Prompt #6 - My Trip to the Sun!

You are on board a special spacecraft en route to the Sun. Tell us all about your travel adventureincluding all you discover when you reach your destination. We want to see, touch, taste, and feel your excursion. Give it your best! Come on! You can do it!

Objective

To create a fictional work grounded in factual information

To create a literary piece that includes structure and organizational patterns.

Requirements

Students will use their imagination to create their own Sci-Fi adventure. The story should be written in the first person. It should include an engaging beginning and a well-defined setting. Descriptive language should be used throughout, coupled with a well-defined series of events. Accurate information concerning attributes of the Sun and related concepts should be included. An engaging conclusion reflective of the return to planet Earth, and an attention-grabbing closing statement should be included.

Scores/Rubric

Scores of 6, 5, 4, 3, 2, or 1 should be applied based on the following criteria:

6 = student has included an engaging beginning; sentences are well constructed;

organization, elaboration, and fluency are well developed; includes eight to

ten accurately depicted pieces of factual information; overall storyline is

well defined.

5 = student has included an engaging beginning; sentences are well constructed;

organization, elaboration, and fluency are well developed; includes six to

seven pieces of accurately depicted factual information; overall storyline is well defined.

4 = student has included a descriptive beginning; sentences are somewhat

descriptive and well constructed; includes four to five pieces of accurately

depicted factual information; organization, elaboration, and fluency

are conveyed; overall storyline is well defined.

3 = student has included a simple beginning, middle, and end; sentences are

minimally descriptive but well constructed; includes three pieces of

accurately depicted, factual information; organization and fluency

are evident; overall storyline is generally well defined.

2 = student has presented story in an unorganized way; no descriptive words

are used throughout; one factual piece of information is contained therein;

sentences are not well constructed; fluency is not evidenced; overall

storyline is undefined.

1 = no storyline conveyed

Evaluation

Confer with students to review writing results based on achieved rubric score. Where necessary, have student revisit the story, editing and revising where required. Final product can be formally typed and illustrated by student for display. Retain original writing samples in student folder for future student self-evaluation, and to generally monitor student progress.

Pacing Calendar (Appendix A)

(Note: One or two questions per day serve as daily topics of study. Lessons should be implemented 3 days per week at 45-50 minutes per session; the time frame can be extended or lessened as required.)

Week 1 – Questions 1-3

Objectives

Students will speculate the attributes of our Sun.

Students will learn the general attributes of a star, recognizing that our star is the Sun.

Students will examine non-fictional and fictional literary works to learn more about our star.

Select Reading: **Our Solar System** by Seymour Simon

Recommended Closing Activities

Sing Along: Oh Mr. Sun/Zipadeedoodah!

View Eyewitness Film – 1st half - The Planets

Independent Research Project – Celestial Bodies in

Our Solar System

Week 2 – Questions 4-6

Objectives

Students will conceptualize the distance of our Sun from planet Earth.

Students will grasp that distance impacts our perception of size.

Students will conceptualize differential rotation.

Students will recognize that the Sun is the center of our solar system.

Select Reading : **Our Solar System** by Seymour Simon

Recommended Closing Activity

View Eyewitness Film – 2nd half - The Planets

Continue Independent Research Project – Celestial Bodies in Our Solar System

Week 3 – Questions 7 - 10

Objectives

Students will conceptualize the causes of night and day.

Students will conceptualize why the Sun appears to disappear on cloudy days.

Students will learn about Ptolemy, Copernicus, and Galileo and prevailing thoughts about Astronomy during their era.

Students will compare and contrast Ptolemy's and Galileo's views.

Select Reading: The Starry Messenger/Any of the three Folkloric Tales

Recommended Closing Activities

Open-Ended Writing Prompt - Summarize This

Independent Research Project – Astronomers Past and Present

Venn Diagram (to compare Ptolemy versus Galileo's lives and view of solar system

Week 4 – Questions 11-14

Objectives

Students will learn about the Sun's inner region and outer atmosphere, with emphasis on the core and radiative zone.

Students will recognize that the Sun's temperature varies throughout.

Students will conceptualize the convection process.

Select Reading : **The Sun** by Seymour Simon

Recommended Closing Activity

Create 3-D Diagram of our Sun

Sun Puzzle Quiz (see Enchanted Learning website) and Sun Questionnaire (see Appendix B)

Week 5 – Questions 15 -19

Objectives

Students will learn about the photosphere and chromosphere.

Students will conceptualize the transferal of heat and light energy.

Select Reading: Any of the three folkloric tales noted herein.

Recommended Closing Activity

Trip to the Yale Observatory

Open-Ended Writing Prompt – Rename It

Week 6 – Questions 20 - 24

Objectives : Students will continue study the Sun's atmosphere, particularly the corona.

Students will conceptualize the transferal of heat and light energy.

Select Reading : **The Sun** by Seymour Simon

Recommended Closing Activity

Open-Ended Writing Prompt – You're The Expert

Week 7 – Questions 25 - 28

Objectives

Students will continue study of the Sun's atmosphere, with emphasis on the corona, sunspots, and solar flares.

Students will observe, chart, and statistically record the Sun's rotation.

Select Reading : **The Sun** by Seymour Simon

Recommended Closing Activity

Monitor and graph movement of sunspots.

Refer to http://solar-center.stanford.edu/solar-images/solar-images.html#need website. Sun image contained herein will be observed daily.

Week 8 – Questions 29 -32

Objectives

Students will conclude study the Sun's atmosphere.

Students will observe, chart, record, and conclude observation of Sunspot movement.

Select Reading : **The Sun**

Recommended Closing Activity

Graph movement sunspots. Create final report concerning monitored observations. Refer to http://solar-center.stanford.edu/solar-images/solar-images.html#need

Use this website image to complete graphing/monitoring activity.

Week 9 – Excursions

Objectives

To conclude our study with an experiential activity.

Select Reading : **Planetarium** by Barbara Brennar

Recommended Closing Activities

Culminating visit to the Rose-Hay Planetarium in NYC, providing an interactive, hands-on experience for our young stargazers **.**

"Thank You Letter" to Rose-Hayden Planetarium contact

Week 10 – Optional Additions

Objectives

To convey our understanding of the Sun through fictional storywriting.

To share our literary creations with others.

Select Reading: Revisit previously read folkloric and non-fiction selections.

Recommended Closing Activities

Narrative Writing Prompt # 6 – My Trip To The Sun!

Author's Tea (to showcase our final narrative product)

Sun Questionnaire (Appendix B)

My name is _____.

I KNOW ABOUT THE SUN!

Look at the incomplete sentences below. Color in the oval next to the best answer to accurately complete the sentence. Come on! You can do it!

(1) The photosphere, chromosphere, and corona comprise _____.

0 the Sun's core 0 the Sun's atmosphere 0 the Sun's radiative zone

(2) The Sun is approximately _____ years old.

0 4.5 million 0 4.5 billion 0 4.5 thousand

(3) Thermonuclear fusion takes place in the Sun's _____.

0 chromosphere 0 core or innermost part 0 corona

(4) The temperature of the Sun _____.

0 is 10,000 degrees Fahrenheit

0 differs depending upon the section of the Sun your are observing

0 is extremely hot

(5) The color of the Sun and other stars help us to determine _____.

0 their different sizes 0 their distances from Earth 0 their surface temperature

(6) Plasma that emanates from the Sun and moves all around are known as _____.

0 sunspots 0 solar winds 0 solar flares

(7) The Sun _____ within our Milky Way galaxy.

0 only rotates 0 only revolves 0 revolves and rotates

(8) Sunspots are located in the Sun's _____ and are caused by the Sun's _____.

0 photosphere, heat 0 chromosphere, magnetic fields 0 corona, solar flares

(9) The Sun and the planets comprise our _____.

0 galaxy 0 universe 0 solar system

(10) The Sun is _____ away from planet Earth.

0 93 million miles 0 93 thousand miles 0 93 hundred miles

Teacher Book Resources

Arny, Thomas T. *Explorations: An Introduction to Astronomy* . McGraw-Hill, New York (2003). Great resource for the layperson in astronomy; easy to understand concepts.

Couper, Heather and Herbert, Nigel. *The Guide to the Galaxy.* Cambridge University Press (1994). A handy pictorial resource highlighting galaxies and star groupings therein.

Freedman, Roger A. and Kaufmann III, William J. *Universe (Sixth Edition)* W. H. Freeman and Company (2004). A phenomenal must-have resource that includes all aspects of astronomy.

Stannard, Russell. *Our Universe, A Guide to What's Out There,* LaRousse Kingfisher Chambers, Inc., New York (1995). Handy reference book highlighting the solar system and other areas of astronomy.

Wolkstein, Diane. *Sun Mother Wakes The World* . Harper Collins, New York (2004). An Australian creation story.

Children's Book Resources

Branley, Franklyn. *The Planets in Our Solar System* . Harper Collins, New York (1998). _____. *The Sky Is Full of Stars* , Harper Collins, New York (1981) Good informational resources for primary grade level students. Complement with updated info on our solar system and stars available at www.nineplanets.org.

Brennar, Barbara. *Planetarium,* Bantam Books, New York (1993). A planetarium-in- book-form highlighting aspects of the solar system. Targeted at primary grade level students.

Bruchac, Joseph. *Native American Stories - From Keepers of the Earth* Fulcrum Publishing, Golden, CO (1991). A fantastic collection of myths, legends, and folklore handed down in the Native American tradition throughout North America. Stories from over 20 Native American cultural groups are represented.

Dayrell, Elphinstone **. *Why the Sun and the Moon Live in the Sky: An African Folktale*** Scholastic, New York (1996). A beautifully illustrated and engaging Nigerian folktale.

Kerrod, Robin. *The Children's Space Atlas: A Voyage of Discovery for Young Astronauts* , Millbrook Press, Brookfield, CT (1993). Divided into five sections, this handy student resource highlights everything from our solar system and space travel.

Mitton, Jacquieline. *Discovering the Planets,* Troll Associates, New York (1991). Targeted at young readers, a good source of general background information concerning planets in our solar system.

Moore, Patrick. *The Universe for the Beginner* , University of Cambridge Press, New York (1992). A user-friendly student resource highlighting astronomers' view and understanding of stars, star systems, and our overall universe. Questions and answer section included.

Reigot, Betty Polisar. *Astronomy Today: Planets Stars and Space Exploration - A Book About Planets and Stars* , Scholastic Inc., New York (1988)

Rand McNally Discovery Atlas of Planets and Stars, Rand McNally for Kids, USA, (1993)

Simon, Seymour. ***The Sun.*** Harper Collins, New York (1992)

_____. ***The Solar System*** . Harper Collins, New York (1992)

_____. ***Stars*** . Harper Collins, New York (1986)

These titles serve as good resources for elementary grade level students, however, complement with updated planet/star provided at www.nineplanets.org.

Sis, Peter ***. The Starry Messenger.*** Scholastic, New York (1997). A Caldecott-Honor book, it highlights the life of mathematician/scientist/astronomer Galileo Gallelei.

Sullivan, George. *The Day We Walked on the Moon: A Photohistory of Space Exploration* Scholastic, Inc., New York (1990). Targeted at elementary grade levels three through five, this is conventional history of space exploration past and present. Includes highlights of space shuttle flights, biographic sketches of astronauts, engaging photos, and paintings.

Van Cleave, Janice Pratt. *Astronomy for Every Kid: 101 Easy Experiments That Really Work,* John Wiley and Sons, Inc., US (1991). Space and astronomy related questions are answered using hands-on experiments. Good science experiments; complement with updated information available at www.nineplanets.org.

Internet Resources

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http://www.badastronomy.com Refutes misconceptions and often-espoused inaccurate facts concerning astronomical studies, thus the title.

http://www.enchantedlearning.com/subjects/astronomy/ Great student-friendly resource. Provides general background information on our solar system and the components therein. Worksheets and activities provided, targeted at primary grade students

www.enchantedlearning.com/subjects/astronomy/activities/radiobuttonquiz/Sunpz.shtml An interactive fill-in quiz accompanied by a picture puzzle; perfect assessment for young learners.

http://www.kidsastronomy.com/our_sun.html Informative website, providing info re: our solar system; includes a wonderful interactive "Make A Solar System" web page.

http://www.nasa.gov/home/index.html Official National Aeronautics and Space Administration with specific websites targeted at all grade levels. Provides background, where to find it information concerning all aspects of astronomy studies.

http://www.nineplanets.org A multimedia tour of our solar system providing up-to-date, fascinating information about our solar system and other heavenly bodies therein.

http://nmp.jpl.nasa.gov/st5/SCIENCE/sun.html This website provides a diagram of the Sun's layers, along with detailed information regarding each section.

Sun Printout/Coloring Page: EnchantedLearning.com 3-D diagram and/or coloring page of the Sun.

http://science.nasa.gov/ssl/pad/solar/sunturn.html A terrific website where students can observe actual view of sun rotation.

http://www.sacred-texts.com/afr/fssn Stories retold by folklorist Elphinstone Dayrell with an introduction by author/scholar Andrew Lang. Note the introduction (written in 1910) stereotypically makes reference to aspects of aboriginal Australian and West African culture. Outside of this, a valuable collection of folkloric tales from Nigeria is contained therein.

Related Excursions

Rose-Hay Planetarium, NYC – (212) 769-5200

Yale Observatory, New Haven, CT – (203) 4312-3890

Stargazing Atop East Rock Park, New Haven, CT (203) 946-6086

Southern Connecticut State University Planetarium

501 Crescent Street, New Haven 06515