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Our Sun: Through Scientific, Cultural, and Artistic Lenses

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Introduction

All through our lives we spend time under the Sun. We get sunburned, our clothes and curtains get Sun bleached, and it can definitely make us too hot. Alternately, we often delight in the Sun on our skin, we appreciate sunrises and sunsets, and bask in its warmth on a cold day. Growing up we learn not to stare at the Sun because it can blind us. We also learn that the Sun is the star at the center of our solar system which our planets rotate around. If we are paying attention, we learn that the rotation around the Sun is due to its gravitational pull and that sunlight makes our plants grow through photosynthesis. However, not many people can scientifically explain what our Sun is actually doing out there in space and how it got there to begin with. Most people do not fully understand the affects the Sun has on us and our planet, or the part it played in the creation of our solar system. I have heard people say, "We are stardust," but I wonder how many of them really understand that everything on this planet literally came from star dust. Humans have strived to understand and rationalize the sun's existence and purpose throughout history through study and observation, but also through stories, legends, and the creation of gods to explain its purpose and importance. Monoliths have been built, gods have been worshipped, and stories and beliefs have lasted through many millennia. Yet, with all the technical and scientific study, so many still don't know how a star like our Sun is born and how it can possibly assist in the creation an entire solar system.

By studying the Sun's formation, what it is made of, and how it created the planets we will clear up misconceptions of what students know, or think they know, about that magnificent ball of gas in the sky. The *Kepler* and TESS missions discovered many planet candidates and 4500 of those have been confirmed, all while looking out into a very small fraction of our sky. Doug Hudgins, of NASA, says that "Prior to the *Kepler* mission, we knew of perhaps 500 exoplanets across the whole sky…This tells us that our galaxy is positively loaded with planets of all sizes and orbits."[1] . This also tells us how fast our science is moving forward in the study of stars in our galaxy and beyond! The study of our solar system is advancing so quickly in this current age of science and technology that new knowledge and understanding is gained by leaps and bounds each year, paper bound textbooks simply can't keep up.

After gaining a better understanding of our Sun scientifically we will look at the Sun stories from cultures that have worshiped and feared the Sun for thousands of years, such as the Egyptians who worshiped Ra, Helios of Greece, Liza of West Africa, or the use of the Aztec Sun Stone to name a few. Students will then imagine and

brainstorm a planet much like our own, revolving around a different star in our galaxy and discuss the intelligent beings and that would occupy the planet. After creating a "culture", students will create Sun stories and mythology this new home planet might have. The culminating art piece will revolve around the new planet, its inhabitants, and their mythology. With this unit, students will experience the Sun and stars in a fun, engaging way (a long way from the dreaded "Sun in the corner" artwork). I see this unit as an opportunity for students to think inside and outside of the box simultaneously. The time span for this project may vary. It is my intention for this to take approximately 15-20 class hours, most of which will be taken up with the art piece, though several class periods will be used for opening activities.

Demographics: School and Student Background Information

Our school is a magnet college, high school, and middle school (grades 6-12) all wrapped up into one campus with around 1600 students and 100 teachers. The student population comes from all over the city as a magnet school, from all economic and social backgrounds, but a large percentage of our students comes from the area around the school due to feeder pattern schools. While the school is quite culturally varied, it is largely Hispanic. There are 17 athletic programs and 24 extra-curricular offerings. We have a strong fine arts department with choir, orchestra, band, drama, and studio arts.

In my Art I classroom I integrate art and core subjects with each lesson. Students get to learn and use a wide variety of art mediums in different ways so that they do not get tired of "just drawing" (as told to me by past students). In past lessons I have taught watercolor, chalk pastel, and oil pastel techniques while simultaneously teaching about the physical features of planets and moons or the constellations in the sky. Students also learned about 3D art through Sci-Fi in literature and movies. We read a novel, watched the movie based on the novel, discovered how a movie creates a world based on a book, and then wrote about and created our own worlds in 3D form.

Oklahoma 8th grade Science standards of "Our Place in the Universe" guide this unit for the scientific portion and 8th grade Art standards for the Art portion.[2] The unit will build on the 7th grade Geography standards about the Sun and solar system, as well as basic knowledge garnered in previous science classes. By the 8th grade my students should already have prior knowledge regarding the seasonal effects of the sun on Earth because of tilt, rotation, and revolution, as well as knowledge of atoms and molecules which is important for understanding how stars form and create planets. However, before we begin, we will review everything we have learned about the sun (this will help activate prior knowledge, as well as catch up students who may honestly not know). Students often do not realize how much they learn each year and that they build on knowledge from previous years. In our district kindergarteners learn that the Sun warms our planet and that plants need the sun to grow. First graders learn about the patterns of the sun, moon, and stars, as well as seasonal patterns of sunrise and sunset. So, from the very beginning of their education, students are gaining knowledge of the Sun and building on that knowledge each year. As teachers, we know it is not uncommon for students to "learn" information in one grade and forget it the next year, so that activation of prior knowledge is essential. Though I will be focusing on 8th grade Oklahoma science standards, I will use it with some modifications for my other classes in grades 6 through 12, as well. After all, with the advances in technology and research, some of the things they learned last year may be outdated already! Other teachers could alter the assignment to easily tie in standards in reading, literature, and writing, as we will be

undertaking activities in these areas, but it is not necessary for the purpose of this particular unit, for me.

Anticipated Summative Outcome

This unit will be a study of the Sun through a scientific, cultural, and artistic lens. You may be asking yourself why you would want to teach science in the art room, or art in the science room, and with this unit you may be using it in language arts! As I have said earlier, I am a strong believer in arts integration in all grades and subjects. Arts integration, when done correctly, requires a lot of differentiation to meet students' needs. Integration also pairs perfectly with various visual tools and student-led inquiry based instruction for effective learning. Using these teaching strategies, students become more engaged and invested in their own learning, often without even realizing it! Additionally, the activities I provide (about the Sun, Sun stories, and the final art project) will tie together for a complete integrated learning experience.

My goal, and the importance of this unit for my students, is to cross the right and left brain so my students will retain more information about the subject matter going into high school and beyond. It is my hope that students will gain a new respect for our Sun, the star that makes all life on Earth possible. As mentioned previously, students have been learning about the sun since they were children learning to wear a hat and put on sun screen to keep from getting sun burned. With this unit I'm not so much filling a gap in science as adding a bridge with handrails to help students traverse the scientific, and often complicated, landscape of the Science of the Sun and the solar system and how humans have viewed it through history. As for our Art outcomes students will view, read, and understand cultural art and stories of the past, practice or further experiences with various mediums, and students will express themselves and explore their own creativity.

Unit Content Objectives

The Sun

The Sun from a scientific perspective is the first step in this three-part unit. This portion of the unit will be heavily based on our two-week intensive work sessions in the seminar, "The Sun, the Solar System, and Us," with Dr. Sarbani Basu, Professor of Astronomy at Yale University along with graphics, photos, and information from various NASA websites. In this section of the unit, students will gain knowledge and understanding of the Sun's beginnings and how the dust around it created the planets in our solar system. How the Sun affects us and our planet is an important thing for students to understand and while I think that most do so on a basic level, we will push that forward for deeper understanding. Students will also need to have a basic understanding of why we are a "Goldilocks Planet" and what keeps it that way. What would have to occur for there to be another planet like ours in a distant galaxy? Or even not so far away? What if this other planet were bigger or smaller, would it need to be closer to or farther away from the Sun? What if the other sun were more or less powerful? These are some of the questions we will discuss as a class based on the knowledge we gain in this section of the unit.

Basic Background

According to NASA, our Sun is approximately 4.6 billion years old. In relation, the Earth is about 4.54 billion years old, approximately a mere 60 million years younger than the Sun. Our Sun is about as "average" as a star can get in most aspects, being average size and middle aged. It is "a run of the mill star", as stated by our seminar leader. Whereas some other solar systems may have two stars (or more), we only have one, as do most other solar systems. Note: It was previously thought that *most* solar systems *did* have more than one star, thus making binary solar systems more common than single star solar systems. As mentioned before, the science, technology, and knowledge of our universe is changing so rapidly, it really is essential to find the most up to date information as possible and vet your resources. As you read this and use the information in your own class, you should probably check into the latest data, just in case, because in a year from now (i.e., July 2021) the discovered and confirmed planets and exoplanets will surely have doubled, tripled, or more! However, our knowledge of the general properties of the Sun has not changed much in the last 20 years, according to Astrophysicist and Professor, Dr. Basu. Barring any major new discoveries, the basic information about the Sun itself should not change.

The Sun is in a constant battle of the outside pressure in due to gravity and the inside pressure out due to heat. However, it is a "reasonably stable thermostat" according to our seminar leader. This is a good thing considering that nuclear fusion is constant in the Sun's core where hydrogen is converted to helium. This happens when the high temperatures at the core of the Sun cause the positively charged hydrogen nuclei to move faster, and they are able to fuse and form helium. This fusion reaction releases energy, the energy then makes its way to the outer surface of the Sun. Figure 1 shows the surface of the Sun to the upper atmosphere in different wavelengths of light. The wavelengths show off features related to the heat radiating from each layer. The surface of the Sun on the left is about 6,000 degrees Celsius or 10,832 degrees Fahrenheit. The outer atmosphere, much like the core, are much hotter than the surface. The outer atmosphere is about 10 million degrees Celsius or 18 million degrees Fahrenheit! The core (not shown in this image) comes in at about 27 million degrees Fahrenheit.

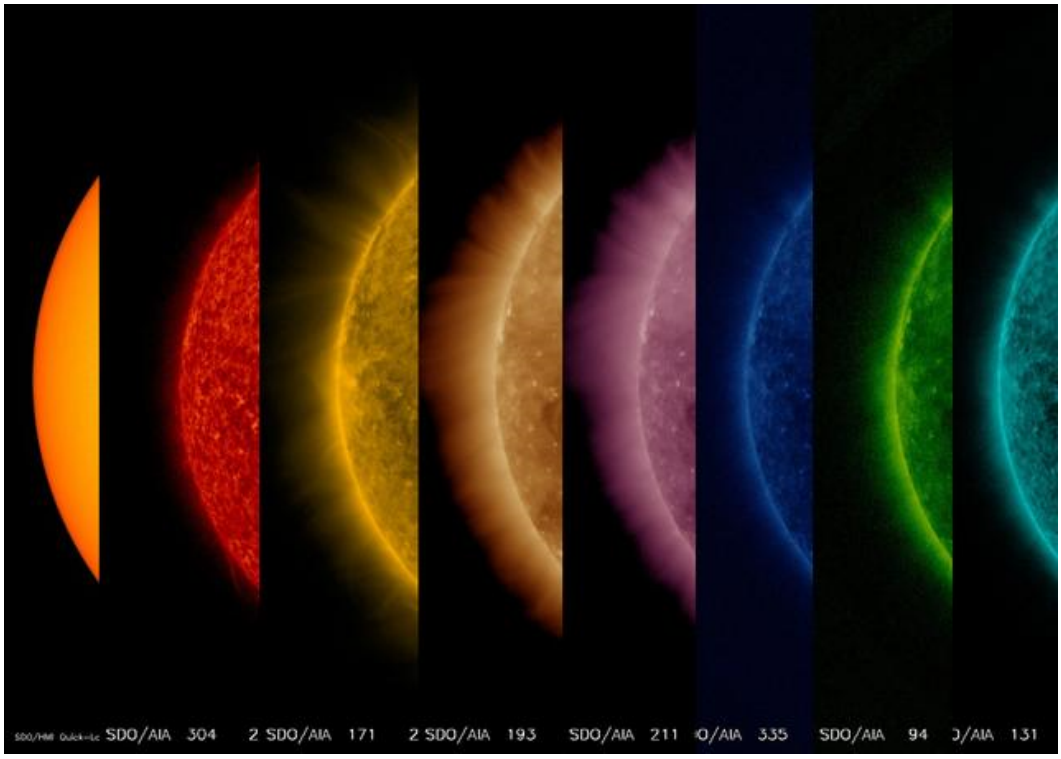

Figure 1. From Hot to Hottest. The Sun from its surface to its upper atmosphere. https://images.nasa.gov/details-PIA22055

It is hard to say with *exact* precision how far we are from the Sun, unless you specify a specific moment in time. This is because the Earth and the other seven planets (yes, only seven others- Pluto has been declared a dwarf planet since 2006) revolve around the Sun in orbits that are ellipses, not perfect circles. Additionally, the Sun is also rotating and wobbling and revolving in its own ellipse as it is moving in its orbit around the spiral of the Milky Way galaxy, which in turn is a galaxy cluster (in which multiple galaxies rotate around the center of mass). With all this, astronomers have measured the distance and the Sun is, on average, 93 million miles away. Currently, literally today, July 20, 2021, we are 150 million km (93,205,678) miles away from the sun. Comparatively, on January 2, 2021, we were a mere 91,403,702 miles away.[3]

Helpful (and Weird) Comparisons to Earth.

The Sun is 700 Mega meters wide and weighs 2 billion billion billion tons (1.989×10^{30} kg). Thus the diameter of the Sun is 109 times the diameter of the Earth and it is 333,400 times the mass of Earth. If the Sun were a gumball machine that was filled completely with Earth sized gumballs, you would get 1.3 million Earth gumballs packed into that machine. Figure 2 shows the size differences of our solar systems planets to the Sun.

If you were to scoop a tablespoon out of the core of the sun it would be about 2 kgs, or 5 pounds. Alternatively, a tablespoon of the Sun at its surface would be practically undetectable since it doesn't have the pressure and compression that the core experiences. Obviously, it is not possible to get a scoop of solar material, but it shows that the core is very dense. Our planet's core is not nearly as dense and heavy as the Sun's core however, a tablespoon of the Earth's crust would actually be heavier than the tablespoon of the exterior of the Sun.

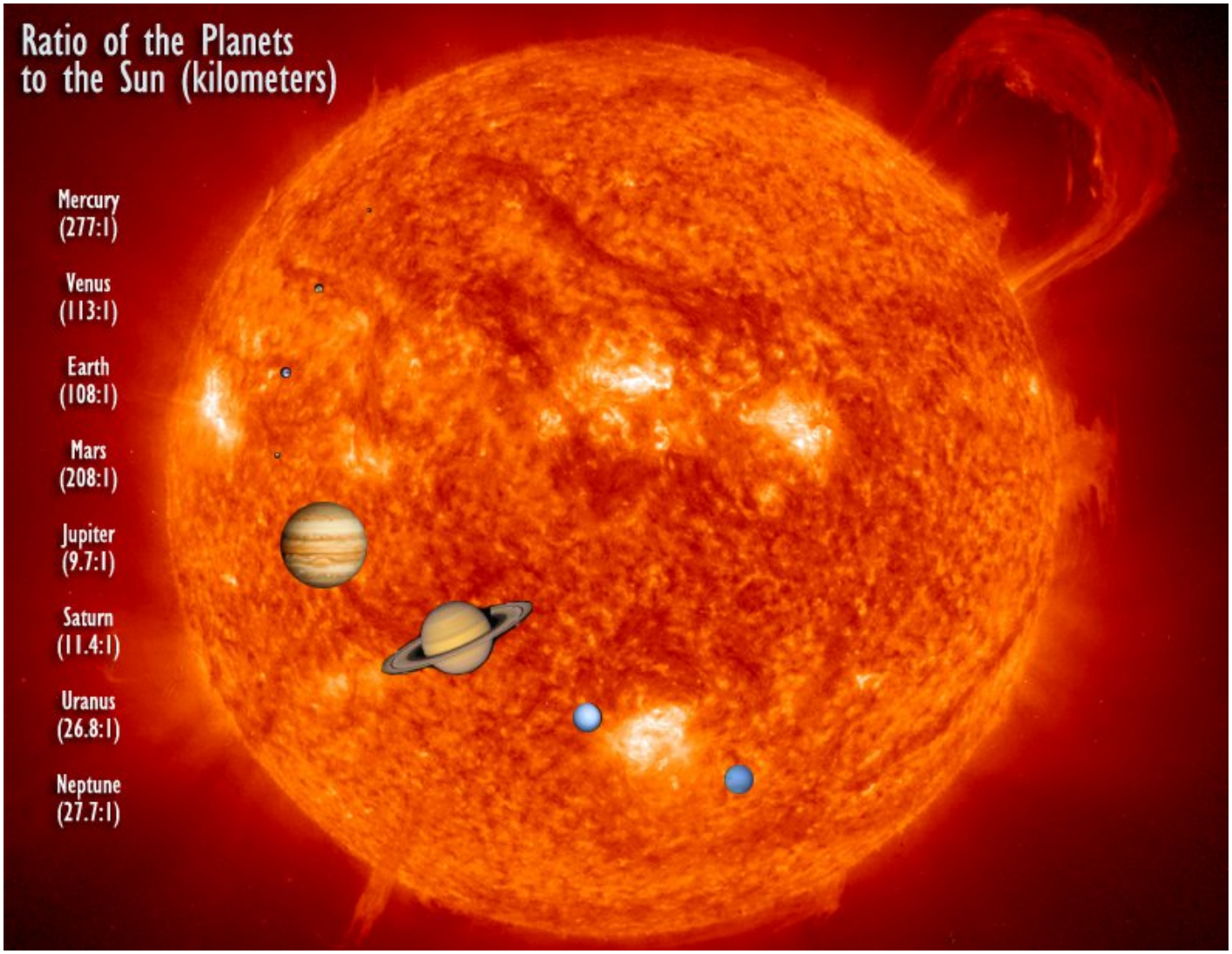

Figure 2 The planets in our solar system compared to the Sun.
https://www.jpl.nasa.gov/infographics/ratio-of-planets-to-the-sun

Birth of the Sun and Planets

Clouds of gas collapse and heat up. That could be an extremely simple explanation of what happens when a star forms, but it is definitely more than that. I will not be delving too deep into this information, but will give a little more than that. In "The Lives of Stars" the authors document the importance of sound-like density waves that compress matter in a galaxy's spiral arms.[4] The gas and dust in these arms collect into a cloud called a nebula. More than 4.5 billion years ago one of these nebulas collapsed under its own gravity with most of the material being pulled to the middle as it spun itself into a flat disk with our Sun as its centerpiece and the surrounding debris set to eventually collect, collide, and form planets. The planets closer to the Sun became heavy and rock laden while the outer planets became heavy with gases due to solar winds pushing the gasses away and heavy materials being attracted to the Sun's gravity.

In "The Nearest Star" it is pointed out that our Sun was definitely not one of the first stars in the Universe. The Universe is about 14 billion years old and our Sun is only 5 billion years old. Because of this, "it, and the planets around it, contain heavier elements formed when earlier stars became novae and supernovae".[5] Oxygen, silicon, iron, carbon, and other elements are what make organic life possible. Therefore, the oldest of

stars are not likely to have planets with life because they do not have the elements needed for life. Hydrogen is the number one most abundant element in the Universe, the second being helium. Therefore, it is no surprise that stars, which make up the mass of the mass in the Universe, would be mostly comprised of hydrogen and helium.

How the Sun Affects the Earth

Our atmosphere and our ozone layer are absolutely essential to life on Earth. Without our atmosphere we would be living (or rather not alive at all) on an ice-covered planet. It would be way too cold for life to form, as metabolism would be impossible. The Ozone layer, made up of 0_3molecules, protects us from the Sun's harmful short-wavelength ultraviolet radiation. Without ozone, "all animal life (not just humans) would be more susceptible to cancer, impaired, immune systems, and eye problems like cataracts."[6] Additionally, without the Ozone layer, life would not have been able to form in the way it did to begin with because of all the radiation from the Sun during the initial growth and evolution of organic molecules. The radiation would likely have altered or destroyed the initial growth of new life.

We have started to see what the warming of the planet is doing to our Arctic regions. As more and more permafrost melts at and near the poles, we know more and more carbon is being released from the ice, sometimes as methane, which is even worse for the atmosphere than carbon. That release of carbon and methane from the poles as the Earth warms, as well as chlorine and bromine from industry and other human activities, causes the ozone to deplete more, warming the planet more and letting in short-wavelength ultraviolet radiation. In the end, the disappearance of the ozone layer will destroy our atmosphere. With the destruction of the atmosphere, our planet will start to cool. It's a vicious cycle ending in a planet entirely too cold to survive on. Humans did respond to this issue in 1989 by banning ozone-killing gasses and have been working on cutting down emissions ever since. The ozone has been replacing itself slowly, but humans are still emitting too much CO2 and methane and the use of banned ozone-destroying gases is actually on the rise. It is debatable as to whether humans have proven to be very successful caretakers of our planet, unfortunately.

The Sun can also affect the Earth with solar flares that are sometimes paired with coronal mass ejections (CMEs). A CME is a physical discharge of plasma and magnetic field from the Sun's corona, while a flare is the release of electromagnetic energy from regions on the Sun where we see sunspots. The flare or the CME themselves are not powerful enough to affect the planet or the living things here on Earth, but their effects can harm technology. The number of sunspots on the Sun increase and decrease cyclically with a period of about 11 years. When the number of sunspots is the highest the Sun's magnetic flips, meaning the north and south poles trade places. Since CMEs occur where the sunspots are, they occur quite regularly depending on where we are in the 11-year solar cycle, but they are rarely so energetic that they affect human society, too much. We discussed in seminar an event in 1859 that produced a solar flare large enough to knock out telegraphs and cause auroras to be visible in much of the world. In May 1967 a CME jammed radars during the Cold War and the United States thought it was Soviet caused. Luckily, military space weather forecasters quickly figured out the issue and the aircraft that were prepared to launch were held back. A major war was almost triggered by the Sun! In today's world, a CME the size of the Carrington Event of 1859 could possibly knock out communications all over the world. The next expected solar maximum is in mid-2025, but we do have satellites now that warn us of large CMEs giving the satellite and the people on Earth the time to shut down the grid for long enough to miss the most harmful effects of the CMEs. The radiation from the solar ejections could also hurt astronauts doing space walks, so they have to be cautious of when the Sun is active and refrain from leaving their stations. We are fortunate that our atmosphere protects us from the major part of such dangers.

The link between solar activity and climate is not a solidly understood topic, as of yet. The Sun does drive weather systems and the Sun does have the 11-year cycle that scientist know fairly well. However, it is not to blame for rising greenhouse gases and the loss of ozone. The cycles, the sun spots, the flares, none of these can explain rare events like the winters in the 1660's, 1770, and 1850 in Europe. As if the Great Plague, the Revolutionary War, and the Crimean War were not enough during those years, winter had hit especially hard each time and these centuries combined were part of what came to be called the Little Ice Age. None of which had anything to do with the Sun or its cycle, as per our knowledge.

Goldilocks Planets

Not too hot, not too cold, Earth is considered a Goldilocks Planet because it was just right for life to form and evolve. In "Nearest Star", it is stated that "…life as we know it appears to be possible within only a narrow range of conditions…" and reflects on the need to understand our planet in order to take care of our planet.[7] In the first 60-100 million years on our planet there were only inorganic molecules. Whether it was primordial muck, a cataclysmic event, hot springs, tidal pools, or something entirely different, those first inorganic molecules changed. They became organic and they were the origin of life on our planet. Over nearly four billion years the original organisms evolved into everything living on Earth today.

We know that the Sun is key to life existing on this planet. Life on this planet is able to exist in a variety of climates and biospheres due to evolution and adaptations. However, "we are not in a good position to argue that this range of temperatures is absolutely essential for life, but it is generally necessary for the types of life that we see here".[8] As with much of what we "know" about the Universe, the theories of life's origins change as we gain knowledge. Just as new species are found or new viruses attack us here on Earth, new planets are discovered, stars are born and stars die in our Galaxy and beyond. Our understanding of the Universe is growing, but certainly not exhausted. The likelihood of other Goldilocks planets could be quite plausible. In seminar we discussed the three general schools of thought that could explain the possibility of life.

Schools of Thought on the Origin of Life

- God
- The incredibly implausible
- The unavoidable

The first school of thought is that God created the heavens and the Earth with the snap of a finger and everything just was. Most know the story in some form or another, regardless of what religion is or is not practiced. In general, this school of thought entails that there is but one planet with life, Earth, and everything on it was created by God. The second is school of thought says that life on any planet is incredibly implausible, meaning that it was a fluke for life to form on Earth. If another Goldilocks planet does exist, it is highly unlikely that it would have life at all and it was just by chance that life started on our planet. The third school of thought is that life is simply unavoidable because autocatalytic metabolisms are natural properties of complex systems. Thus, given another "Goldilocks", life would be somewhat inevitable. Life is made of chemical reactions that allow metabolism, reproduction, and evolution. It is inevitable that organic substances would exist on other planets and create some form on life adapted to a planet's atmosphere.

With consideration of the third school of thought we can look to other planets in hopes of eventually finding life elsewhere. Figure 3 shows two Kepler stellar systems that could reasonably show or produce signs of life. According to the "Unavoidable" school of thought they should in fact be capable of hosting life based on the strength of their respective stars and their distance from them. The Kepler-452 system has a star that is

somewhat brighter than our own and a planet revolves around the star in a slightly larger elliptical orbit than our own orbit around our Sun. Kepler-186 has a star that is fainter and smaller than our own, but the planet has an orbit around the star that is closer in size to Mercury's orbit (which is far too close to our Sun to have life). If most of the stars in all the Universe have one or more planets it seems inevitable for some of them to be in a habitable zone for life to evolve.

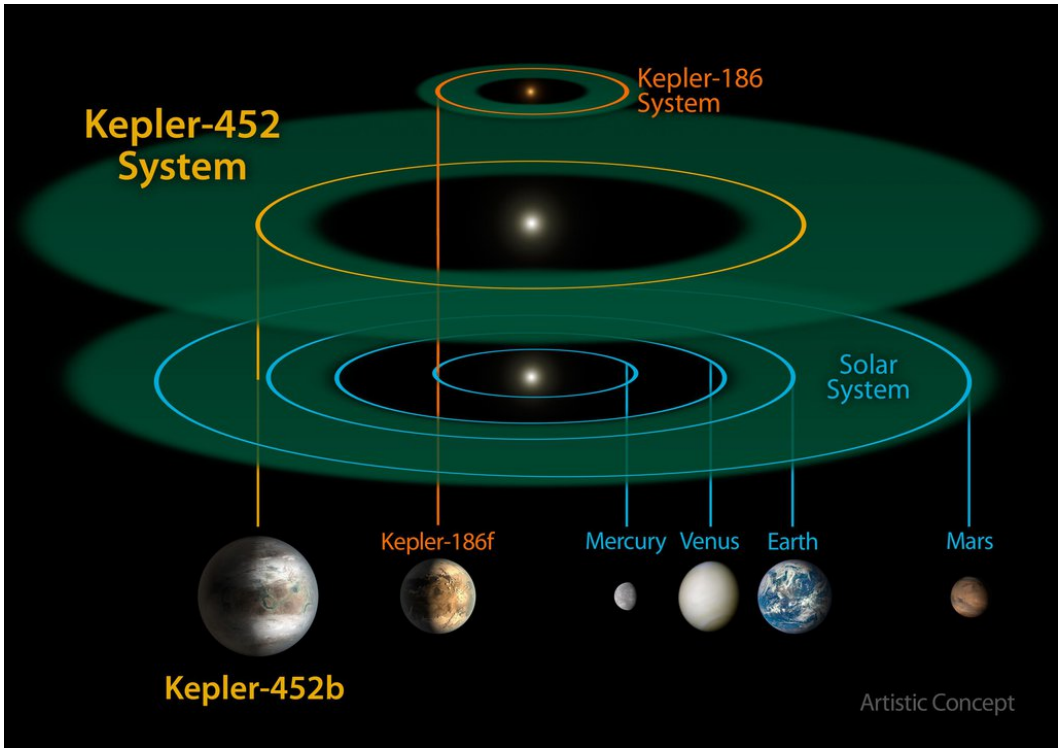

Figure 3. Kepler systems with planets in the habitable zones.
https://www.nasa.gov/ames/kepler/kepler-452-and-the-solar-system

In seminar, Dr. Basu pointed out that we are hampered by the biases of life on Earth when considering life on other planets. We expect life on other planets to follow our own rules. Here, life is determined by ordered structure, reproduction, growth and development, energy utilization, response to the environment, homeostasis, and evolutionary adaptations. However, we do have things on Earth that do follow the biases, but aren't truly alive. Consider fire, crystals, hurricanes, and computer AI, these things do in fact have all the characteristics that determine "life", but still are not alive as they do not have genetic information. With this in mind, we know that carbon is the basis for life on Earth and that life cannot exist on Earth without water and a source of energy. For us, as humans, to live on another planet we would need sources for water, oxygen, food, and shelter. It is interesting to ponder life on another planet and if intelligent life does exist, what does it look like? Do they look just like us or have they adapted to their planet differently than we have?

The Sun Stories

When students are in elementary school they hear stories about the Sun, often through Native American or African studies of culture. Stories about how the Sun got in the sky or how night and day came to be are not uncommon. Later, students may learn about Greek gods and goddesses that ruled over man, each having a realm to rule such as the ocean, the land, or the sky. In these stories the Sun varies greatly between something to be respected, worshipped, or feared. Sun worship and sun stories can be traced back through many ancient civilizations, though, according to Encyclopedia Britannica the Egyptian, Indo-European, and

Mesoamericans were the only cultures that developed actual solar religions based on a single solar deity.[9] Many other polytheistic cultures have one, if not many, sun gods and goddesses (along with other non-Sun gods and goddesses).

In our unit we will look at several Sun stories and Sun based religions from around the world so that students can understand that people all over the world, since before written history have worshipped or at least respected the Sun, and how varied these stories can be. One of our class activities will be for students to discover Sun worship and Sun stories. Information and images will be explored first, and then students will be given access to various books and suggested websites to help them explore on their own.

- Huitzilopochtli is from the Aztec religion, patron of the Mexica tribe, deity of war, sun, and human sacrifice. His name means "Hummingbird of the Left". The Aztecs believed that warriors killed in battle returned as hummingbirds. Huitzilopochtli was a very important god to the Aztecs and many humans were sacrificed in his honor. According to ancient legend, Huitzilopochtli led the Aztec people from their homeland and told them that there would appear an eagle with a snake in its mouth and that is where they were to build their capital.[10] The eagle with the snake in its mouth is now on the Mexican flag. Huitzilopochtli's image is still quite commonly seen in Mexico.
- Ra, god of the sky, the Earth, and the underworld, was believed by ancient Egyptians to be the creator of all things and is often recognized by his human body and falcon head with the Sun disc resting on top. The Egyptians believed that all other gods had aspects of Ra and even "pharaohs often connected themselves with Ra in their efforts to be seen as the earthly embodiment of the Sun God".[11]
- Helios was the god of and personification of the Sun in Greek mythology. The Greek god Apollo is considered a god of the Sun, but was actually the god of light along with music, art, archery, plague, poetry, medicine, oracles, and knowledge. Sol was the Roman equivalent of Helios. Like Sol, Helios was known to ride across the sky in a horse drawn chariot.[12]
- Bila, of the Australian aboriginal Adnyamathanha people, is the personification of the Sun. She was a cannibal and roasted her victims over a fire (the origin of sunlight) and was thrown into the sky by the "Lizard Man". She left the world in darkness, so a boomerang was used to catch her, causing her to move in an arc across the sky to light the world again.[13]
- Surya, of the Hindu religion, is another god that rides through the sky on a chariot pulled by horses. Seven horses to be exact, seven represents the seven visible colors and seven days of the week. Surya, or Aditya, is considered the creator of the universe and the source of all life. He is an important figure in Hinduism and a minor deity in Buddhism.[14]
- In the Cherokee tribe, they tell of the Sun and her daughter in that the people tried to kill her daughter, but killed her instead. In her grief they find their need for her and work to make her happy. The Cherokee also have the tale of the Moon that is in love with the Sun and chases her day and night, promising her a home they can live in together. It is a tale reminding Cherokee people that they too are without a home, but that they have home for the future.[15]
- Eastern Nigerian Folktale- Cartoon like video version of the original book telling why the Sun and Moon are in the sky.[16] In the story, the Sun and water are friends who both live on Earth. The Sun visits his friend the water and invites him to his own home. The water eventually does go to the Sun's home, but floods it and the Sun and Moon flee to the sky.[17]
- Amongst the Dine' people of the Navajo Nation the stories of the past are being lost along with their language due to English in schools and at home with parents who were often forced to speak English. Some may know about the Navajo Code Talkers who used their language during World War II because it was such a complex and rare due to the language being all but lost when the US was trying to destroy

all Native culture. However, the people still revere and respect the Sun in many ways. When speaking with Elizabeth Isaac, a member of the Dine' tribe, it was told that the Sun is treated like a human among her people.[18] It is tradition to build houses with the front door facing the rising sun in the east and during eclipses the people are meant to do nothing as a sign of respect: sit, doing nothing, no eating or drinking, no TV or radio, no reading or singing. The younger generations do not follow this, but they are aware of the elders and their respect for the Sun. She did not recall any Sun stories from childhood. However, there are several stories to be found online for the Navajo people regarding the Sun.

Students may also be able to share personal cultural knowledge they have about Sun gods . It is very possible that some students will look into it on their own out of curiosity, if they don't already know. (Personally, I delved into Irish Sun gods and found it fascinating.)

The Art

The third and final aspect of this unit is the portion dealing with art. While looking at Sun stories we will also delve into the art that represents the stories, myths, and religions. It is important for students to see the variety of the art is as broad as the stories themselves. Students will see pieces shown by the teacher for example, but they will also find art that goes along with the Sun stories they discover from a chosen culture. Before starting on individual work, the class will brainstorm together to create a new planet based on one of the Kepler planets mentioned previously. Students should understand that this is part of the art project, the planning stage. Students will take into consideration whether their star is smaller and closer or farther and larger than our own Sun to determine the size of the planet and how bright the star is to the inhabitants there. They should understand intelligent life exists on the planet and may even include animals, bugs, plants, etc. What do the people there look like? We are going to go with the general human form, but students may want to add adaptations for their planet. Where do the people live? What are cultural aspects for the people such as clothing, religion, food, holidays, etc.? Then, students will each create a sun story for their chosen imagined culture. Finally, students will take on the task to create a piece of art that represents their story as a whole. The art will inevitably take longer than the lesson if it is well planned out, as well as mindfully and intentionally completed.

The Unit

Content Objectives

Investigate

1. Students will research and discover how our Sun and planets came to be.
2. Students will understand how the Sun affects us on Earth in various ways.
3. Students will read Sun stories, myths, and stories about Sun gods from all the world.

Students will gain an understanding of the Sun and its effects on our planet through a scavenger hunt. Stations will be set up around the room for students to explore and interact with. Each station will focus on a specific piece of information for students. Each station will have a specific question and the materials needed to answer the question. Stations will have books, specific websites to explore, a game to play, videos to watch, experiments, physical items to manipulate, and magazine articles. Students will be put into small

groups to work as a team and each team will be given a different set of colored Post-Its. While exploring the stations and discovering information teams will interact with each other and with the materials given. As teams collect information, they will write their answer to the station's question on a Post-It note and take it to the teacher for validation. Students' correct answers will be put on a gridded answer board, incorrect answers will be clarified and students sent back to the station to find the correct answer. The goal is for students to gain an understanding of the Sun and the life it brings on our planet in a fun and memorable way and to show their understanding by filling in their Post-It grid.

Through books and websites students will read about, and listen to, stories about the Sun. Students will be given a list of some of the cultures they could investigate and may also venture out on their own, as the list given is definitely not a complete look at cultures around the world and their stories of the Sun. Culture is such an important part of art history. Art is used to express feelings, reflect styles, promote religion, communicate desires, and so many other things, most of which are based on or influenced by culture. Art allows us to look into the lives of others in ways no other form of communication can. We see into the mind and the heart of the artist and we can be influenced and changed by what we see. Viewing artworks that go along with the Sun stories, myths, and Sun gods will allow a deeper look into the cultural virtues, ideals, and values of different cultures.

Write

1. Students will work together to write an outline for a new planet with intelligent life.
2. Students will write a descriptive Sun story based on their new planet and a culture that exists there.

Students will need a baseline for starting their own stories, hence, the class will work together to create new planet and the people that exist there. Some things that students need to consider include the gravity of the planet, the atmosphere, and distance from the planets star. Most living things on Earth are symmetrical and advanced life needs to be on land, so it would likely be the same elsewhere. (Think of the octopus, they are very intelligent, but being under water creatures they lack the environment that we do to create and build.) Things like predators, food sources, climate, and size of the planet should also be considered. Once the model for the planet is worked out and its inhabitants defined, students will create a culture for their people. Students should be as thorough as possible so that writing their story and creating their art is based on a solid understanding of their people and planet. Students will use a 4 Square graphic organizer to start their story. They will use this to come up with ideas for the story and organize their thoughts story referencing their star. The story and art piece planning may start to be a bit more fluid as students start to work and decide on details. The story does not have a specified length, per se, it just needs to be thorough enough to get a complete understanding of its purpose and work with the art piece created.

Design and Create

1. Students will design sketches of an original art piece based on their Sun story.
2. Students will create a final art piece from the sketches and descriptions they have created.

Planning for an art work is an important step for students to take so it needs to be purposeful and deliberate. Making a design plan teaches students to think about the end goal and how to get there. Planning also helps with students not getting frustrated and quitting during the final work stage for lack of ideas. It allows students to design a well thought out guide for action and avoids the frustration of the blank page and not knowing how to start. The teacher may specify a media for students to use or leave it open for students to choose.

Strategies

Differentiation

Art class should be full of differentiation. Individual student needs can be met through differentiated instruction to ensure progress for all. Not all students are on the same level in art, some being more advanced or have more "natural talent", some being fearful or inexperienced. Being proactive to address the needs of students on different levels to help them be more proficient no matter where they are in their learning or experience is the true meaning of differentiation. Teachers can differentiate in four ways: content, process, product, and environment. Content in the art room is not always meant to be information to be memorized. The goal in art is to learn to think creatively, learn to use methods and techniques, and then learn to use those methods and techniques creatively, this is differentiation of content as all students will experience these things on their own levels to reach their learning goal. Students learn to work independently, with others, as a whole class, and learn to support each other as they work. This allows for differentiation of process that allows student to take in the content and then make sense of it. In art, students should not be all be producing the same piece of art. Giving students freedom to show what they can do is differentiation of product. Students should not be producing the same piece because even at the beginning of planning and understanding content each student should be thinking independently and creatively. Finally, every art room has a tone all its own. This tone comes from the room, the music, and from teacher/student expectations. The room may be vibrant and playful, or to the point of being overwhelming. It may be organized or messy (or a little of both). The room may have art from the masters or from the students past and present. The teacher may require silence or the students are just quiet on their own or there could be music or lot of talking. Setting the tone is important in the room as it sets the tone that students will follow.[19]

For this unit differentiation will be used in all four ways of content, process, product, and environment. Students will complete a scavenger hunt to gain content area understanding of the Sun and its effect on Earth. Each station will be different and teams will work together to understand information. Students can read to each other, bounce ideas off of each other, and collaborate to understand the information. In the end, each student will have a story and art piece that will be individual products, none should be the same as they each internalize the information differently. The environment for the scavenger hunt will be much different than that of the environment when they are creating their art work. For the scavenger hunt there will be movement and talking and the room will be buzzing (with excitement hopefully). For the project students will be seated and hopefully working much more quietly, involved in their own work.

Visual Aids

Most every classroom should use visual aids in some form or fashion. Visual aids include charts, models, maps, videos, photos, and posters. These things are supposed to motivate students to learn and remember information. As well, graphic organizers are also visual aid, including, but not limited to, Venn diagrams, T charts, KWL charts, 4 square organizers for writing, and bubble charts. Visual aids will be used in every aspect of this unit. Stations for the scavenger hunt will utilize multiple visual aids such as videos, photos, models, and websites to visit. Students will collect answers to be posted on their own game boards with correct answers. While we look into Sun stories, myths, and gods students will use a visual aid worksheet. As we build a planet of our own as a class we will create a visual model of the planet and its people and a map of the planet. Students will create their people's Sun story using a 4 square guide. Finally, students will create their

art project which will act as a visual aid to go along with their story.

Student-Led Classroom (Teams that Teach)

In a student-led classroom the teacher has to relinquish a lot of control that they may be accustomed having. For the student-led classroom to work the students must also learn to step up and take ownership of learning as their education is strategically placed into their hands. This is not just the teacher stepping back and having students learn for themselves. There is a lot of planning on the teacher's part that must take place. The scavenger hunt can be an excellent introduction to the student-led classroom or used in a student-led classroom that is already in place. Students must work together and hopefully play on each other's strengths to find answers to questions and overcome challenges they encounter. The students will also work together as a class to build their new planet. This will involve student-led discussions and feedback based on what they learned in the scavenger hunt. The only "work" the teacher must do during the lesson is to check answers that students are presenting for the scavenger hunt, make sure students are be proactive in their education during the scavenger hunt, and to put the slides together to present to the class for the final voting of the new planet and peoples' physical attributes. The real teacher work is all in the planning and set-up of the activities.

Implementing Technology

Technology is meant to enhance learning experiences in the classroom and allows for flexibility in learning. Students that don't understand a topic can easily get online and do research, watch videos, use websites like Khan Academy, or contact someone for help. In our scavenger hunt and exploration of Sun stories, myths, and gods students access specific websites for some things and have freedom to do research on their own for other things. Students will also be free to use their computers to write their stories. They should, however, be asked to not use the computer to come up with ideas for their stories and art works. Technology should be a student aid, not a student crutch, especially when it comes to creativity. Sometimes, because students do have so much technology at their disposal they feel safer using the ideas of others rather than thinking or being creative for themselves. This is something that must be addressed with students.

Activities

Scavenger Hunt

Rather than lecturing about the Sun and our planet students will participate in a scavenger hunt in teams. Each team will consist of 2-4 students depending on classroom size and student population. The teacher should plan ahead and put together teams that will work well together, separate student issues, and assure that on each team there is a good reader, a good leader, and a good presenter. After teams are together the teacher should clarify that everyone should try to participate in every aspect of the Hunt. One person should not be doing everything and one person should not be left out from doing anything.

The Scavenger Hunt will consist of stations, each of which has questions that students must answer as a team. When they find the answer they will bring it to the teacher for confirmation. If the answer is correct it will be placed on their team's game board (see Figure 4). If it is incorrect, students will be sent back to the station to find the correct answer, with guidance given as needed. Each team should work independently

from each other. A small prize for the team with the board filled first will generally be enough incentive for students not to give answers to other teams and to work quickly and diligently. Each group could even be given a different set of questions for each station.

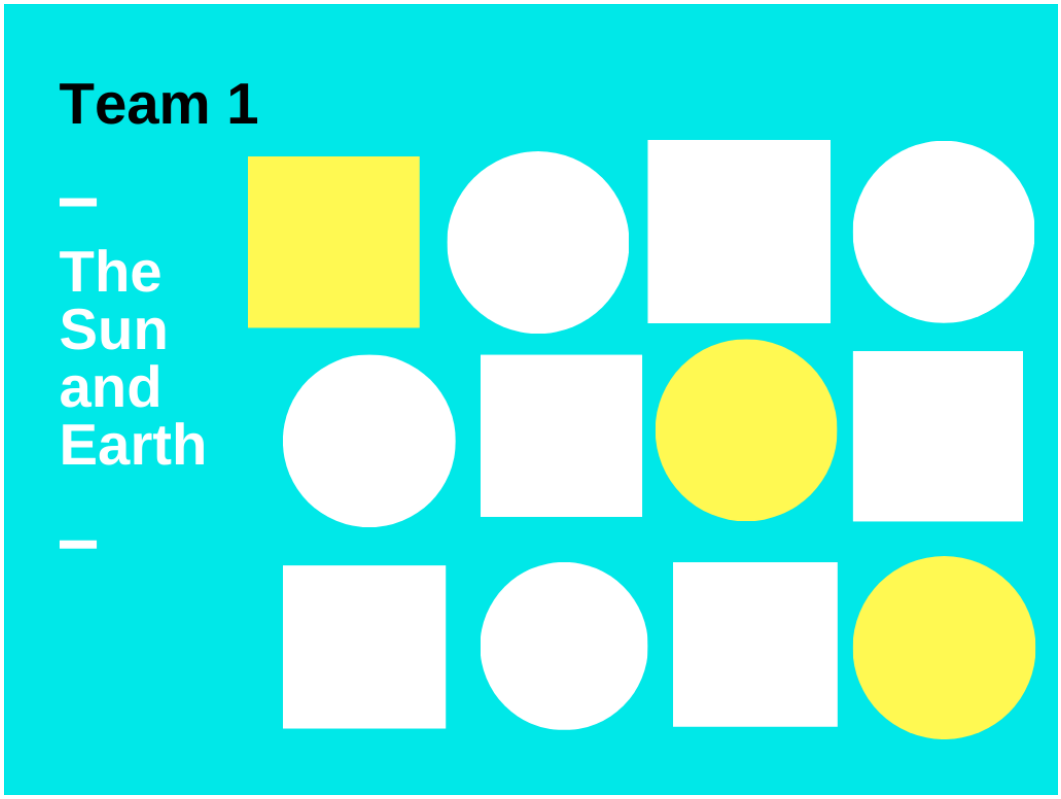

Figure 4. Game board for answers during scavenger hunt. Students can put sticky notes for each answer or the boards can be laminated for using dry erase markers. Made using Canva.com.

The stations for the scavenger hunt are meant to be fun and engaging and not just one student doing all the work. One student will read the clue out loud, one student should be able to look up the link given, go to the index to find a page in a book, or participate in the hands on experiment, and another student should write the answer and take it to the teacher. Students should switch off who does what at each station to share responsibility, but all students should be working to find the answers to the questions.

Game

A short game will be set up through flippity.net where students have to work together to reach and answer the final question in the game. This program allows the teacher to create a game easily online using the information in this unit, the website, and a Google Sheets document. Students have to play through the game to get to the last question, which is the answer they will take to the teacher to clear this station.

Online Research

There will be several online research stations set up. These stations will have a Chromebook or iPad available for students to use. There will be questions at the station that students must find the answer to. There will be cards with questions. A few examples include: How many Earths could fit inside the volume of the Sun? What specific kind of light causes us to get sunburns? What is a solar eclipse? Students will also be given websites

on tabs to use to answer the questions.

Measuring the Sun

It is very hard to imagine a tablespoon of material weighing 5 pounds, much less a tablespoon of compressed gasses. However, that is how much one tablespoon of the Sun's core is estimated to weigh. At this station, students will have a scale and a variety of items available to weigh. Each student in the group will choose and weigh items to equal 5 pounds. The group will then choose what set of items they will report in on their game board as being 5 pounds. This station isn't meant for students to be right or wrong, merely to show them how much 5 pounds really is compared to a tablespoon in size.

Book Dive

A station will be set up with books along with research questions. Students will be directed to check the indexes of the books to help them find the answers to the questions. Each student should be checking the index of a book to help the group find the answers needed. This station will be similar to the online research station. It will incorporate the books from the seminar, the science book that the students use, and other available printed resources.

Cultural Sun Stories, Myths, Legends, and Gods

There are cultures all over the world and throughout history that have created stories and myths, and the worship of gods dedicated to Sun. As a whole group, the class will look at a few stories and art pieces that go with them. For example, looking at the Navajo Dine' people can show students ancient beliefs and how they have evolved through history. There are many stories that lead up to and tell the story of the Dine' respect of the Sun. They have understood the Sun to be a life-giving force since before science deemed it so. Even though many of the stories of the past aren't being handed down from generation to generation as they used to be, the respect for the Sun as a living thing is still held in the elder generations and witnessed by the younger generations. Here are two websites for the Dine' culture. The first link tells of Ni'hodilhil, Black World, and is the story of the First World where man and woman were created in a world of darkness. The second link is for a story called "Song of the Horses". It tells of the Sun-God, Johano-ai, and how he makes his way across the sky each day on his horses of different colors. Each of these websites has stories, background, and art representing the stories.

- http://navajopeople.org/blog/navajo-creation-story-the-first-world-nihodilhil-black-world/
- http://www.indigenouspeople.net/songhors.htm

After going through multiple cultural stories and showing the artwork representing the stories students will select or be assigned a culture to research a Sun story for, without duplicating a culture in the class (so as many cultures as possible are represented). The students will then research and find a story, myth, legend, or god representing the Sun and a piece of art to visually represent the story if one can be found.

Students will create a slide representing the story and a slide for the art with websites or titles of books where the information was located. The story slide should include the title of the story or god/religion, a summary (in the students own words) of the story or brief overview of the god/religion. These will be turned into the teacher who will choose some of the slides to share out to the class upon completion of the assignment.

Whole Class Brainstorming

This activity is to imagine a new planet inhabited by intelligent life. As a class a Kepler planet will be chosen and a discussion will decide its basic make-up (size, density, and atmosphere), and a name for the planet. Students will also decide if the planet's star is called the Sun or something else. In their small groups students will work together to fill in numbered cards created by the teacher about the new planet and its inhabitants. When students are done each team will turn in their cards. The cards will be sorted by number and each small group will get one set of cards (or more depending on the number of groups and cards). With the sets of cards student groups will write the options down on a large piece of paper so everyone can see the options when they are presented. Each small group will take turns and a spokesperson will read off the category and the options and the class will take a vote on which option they like best. In this way, we will build a new planet as a class. Card questions will include physical and mental characteristics of the intelligent beings on the planet, plant life, and how advanced the beings are in terms of science and technology. Students will then work as a team to decide on their groups' cultures (this builds on 7th grade social studies skills of what a culture consists of). Reminders will be given of what culture consists of for students to go by.

Story Writing

Now that students know what planet they are on, what they look like, and what their culture is, they can start writing a story based on their star. These can be ancient Sun/star stories or myths, stories about Sun/star gods past or present, or modern-day beliefs about their Sun/star. Students should start thinking about how their art work will be reflected in their story or how their story reflects what they have already thought their art might look like. This writing piece does not have to be long, unless the student wants to put more effort into it, as some will. A short story or paragraph of explanation should suffice. This piece of writing will be displayed with their art work when finished, so the writing should be clear

Art Project

The culminating piece of this project is the art work based on their story. Students will work individually on their art work using the media of their choice from a given list (generally the media available in the classroom or chosen by the teacher). Art pieces should be in full color, at least 12"x12", and be easily explained through their writing. If specific skills are being practiced, such as layering color, this should be part of the expectations for the project. Finished pieces should be displayed with the stories and an explanation of what the class accomplished.

Appendix on Implementing District Standards

Standards for 8th grade Science and Art

8.PS2.4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

There is a gravitational force between two objects and gets larger as the objects get larger, for example: a star and a planet rotating around it.

8.ESS1.1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns

of lunar phases, eclipses of the sun and moon, and seasons.

A model will not be created in this unit, but will be observed online. The Earth-Sun-Moon system is important to understand as a new planet is developed.

8.ESS1.3 Analyze and interpret data to determine scale properties of objects in the solar system.

Scale models of different Kepler planets and their stars will be observed and discussed to determine which would be the best fit for the class project.

8.VA.P.3.1 Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of art making or design.

Students should always take risks in art and be willing to be flexible in their work. This is a complicated process and students must learn to be flexible with themselves.

8.VA.CHP.1.1 Distinguish different ways art is used to represent, establish, reinforce, and reflect cultural identity.

Students will be looking at cultural art that represents Sun stories, Sun myths, and Sun worship. The art is a representation of culture and cultural identity. Students will also be building their own cultures on a new planet and creating art to represent it.

8.VA.CHP.1.3 Identify works of art and artists in relation to specific movements, historical periods, and cultures.

Students will look at art from many different cultures from around the world and throughout history.

Notes

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[4] Leon Golub and Jay M. Pasachoff. *Nearest Star: the Surprising Science of Our Sun*. Cambridge University Press, 2014, 36

[5] Ibid, 2

[6] “Ozone in the Atmosphere” ASPIRE, University of Utah.

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[8] Ibid, 29

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