Eye on the Skies: Man's Quest for the Stars

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Introduction

I have loved the stars too long to be fearful of the night--Galileo

Long before the creation of NASA, the International Space Station or SpaceX, humans looked to the skies with curiosity and awe. Long ago, the farmers in the fields looked up for signs of rain, many cultures created stories about rulers of the heavens, clocks and calendars were set by them, and inventors dreamed about tools to help them see the stars more clearly. What caused this fascination with the objects we see in the sky each night? And when we were able to achieve space flight, despite the proven dangers, what could it hold that could possibly be worth the risk? Today we are exploring Mars and beyond, using a team approach between countries on the International Space Station and private industries like SpaceX here in the United States. This unit was designed with these questions in mind. What is it about space that has held man's fascination for thousands of years?

Rationale

When I first heard about this seminar focusing on Ancient Inventions, I was in the midst of preparing a group of my 5th grade students for their first Science Olympiad ever. As we matched students with the events, it became apparent that although they were interested, their general science knowledge was lacking. However, because of their excitement, they were highly motivated to learn what they needed to know to be successful. I felt determined to allow my students to have time to pursue their interests, and to integrate more science into my curriculum. So initially, I wanted to create a unit about Leonardo Da Vinci, since his life and times offered such a rich opportunity to explore many topics.

Around the same time as our early seminars, I received notification that I had been accepted to this year's NASA Lift Off program for educators in Houston, Texas. As the only Delaware teacher chosen, I was able to spend a week deeply immersed in the NASA culture and history with 45 other teachers from across the country. As I met astronauts and mission control specialists and toured the NASA facilities, I was struck by the history around me. As I listened to people like Flight Director Gene Kranz and Astronaut/Pilot Fred Haise talk about their experiences with Apollo 13, I wondered: what is it about space that, despite the risk, makes us continue to strive for space flight and exploration? Why are we so fascinated and driven to explore the heavens?

And so, I changed my vison for my unit to trace this quest for knowledge from ancient times (and the devices used) until the present (and beyond!). I am now certified to borrow authentic moon rocks and other items from NASA and will integrate them into

my unit. Students will have the opportunity to research and create multi-media presentations about significant contributors to space exploration. Current events such as the MARS exploration and the International Space station can be accessed through the many opportunities to Skype with professionals and NASA's teacher resources.

While in Houston, I found myself feeling a mild academic jealousy towards the teachers from Texas—they have such rich opportunities for their students because they lived so close! Astronauts and tours are readily accessible for them and they can borrow space suits and artifacts with little difficulty or expense. However, I returned determined to provide my students with the background knowledge and at least some of the great opportunities that NASA can provide.

This unit will begin with a look back at ancient astronomers and thinkers, then will explore space exploration of the more recent times, and then will look beyond, to the future of space exploration and possible colonization. Students will have the opportunity to conduct their own research, create their own versions of astronomical tools and will interact with authentic professionals working in the field.

Objectives

This unit was designed for my fifth grade Advanced Academics students. Their classroom Science standards include those related to Earth's place in the universe (5-ESS1) and the Earth and the solar system (5-ESS1-1). However, this unit will extend beyond these standards for fifth grade, I feel that it is appropriate for their intellectual curiosity and enhancement of their overall scientific knowledge. With this in mind, at the end of this unit, students will understand that *Man has been fascinated by the stars and space since ancient times, that people in different cultures and at different times in history have made contributions to the advancement of man's knowledge about space, that space exploration changes as new knowledge is acquired and previous ideas are modified and that technology expands our knowledge of the solar system.* They will also have an understanding about space exploration projects that are currently being undertaken.

Because the activities in this unit are cross curricular in nature they will also address several Common Core standards in *Literature* (Rl5.1) Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text, (Rl5.2) Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text, (Rl5.3) Explain the relationships or interactions between two or more individuals, events, ideas or concepts in a historical, scientific, or technical text based on specific information in the text, (Rl5.4) Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area, (Rl5.5) Compare and contrast the overall structure (e.g. chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts, and (Rl5.6) Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably) *Literacy: Speaking and Listening* (SL.5.1.A) Come to discussions prepared, having read or studied required

material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion, (SL.5.1.B) Follow agreed-upon rules for discussions and carry out assigned roles, (SL.5.1.C) Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others, (SL.5.1.D) Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions, *Presentation of Knowledge and Ideas* (SL.5.4) Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace, (SL.5.5) Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes, (SL.5.6) Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation.

The unit will be guided by the following **Essential Questions**: *How have people used the process of science to investigate questions about the Earth and outer space? How have these ideas changed over time? How did ancient inventors create intricate machinery without the benefit of sophisticated tools and technology? How does technology extend human senses and understanding? Is there a possibility of living on planets other than earth? How and why does Man strive to find and explore habitable planets?*

At the conclusion of this unit, my students will understand the following:
Enduring Understanding: Ancient inventors made meaningful contributions to modern society and technology
Enduring Understanding: Inventors of the Renaissance time period are still considered to be some of history's most influential individuals
Enduring Understanding: Man's continued exploration of life beyond Earth includes the real possibilities of living in space and colonizing Mars.

Demographics

Thurgood Marshall Elementary School is a large suburban elementary school located in Newark, Delaware. Our District is the largest in the state, (15,553 students last year) with an extremely diverse student population. This year, Marshall has approximately 785 students in grades kindergarten through fifth. It is a Title I school with 28% of our students receiving free or reduced lunch. Racial demographics are as follows: African American 34%, White 30.8%, Asian 20.8%, Hispanic 8.5%, and Multi-Racial 5.8%. The low income percentage is 20.8 and the percentage of Special Education students is 7.7%.

In recent years, our population has increased in diversity and it was said that last year, there were 27 different languages being spoken by our families. To support this need, we have two full time teachers for English Language Learners and a full time paraprofessional to assist them. Our current reported percentage of ELL students is 12.1%.

My role is to serve the top academic students, with a program focus on students in grades three through five as the Advanced Academics Teacher. I have been in this role for the past 10 years. My classes are roughly 10 percent of each grade and students come to my room during Intervention time, when other students might be getting support while others remain with the classroom teacher. My curriculum is largely Advanced Math and Reading but I use my DTI units and more to be more cross-curricular in nature. For instance, my previous DTI unit was created as an extension to the fifth grade (science) Ecosystems unit and incorporated math, science, art, writing and a field trip experience**.** Once identified for my program, many of my students are with me for several years. This offers rich opportunities to include students' interests and allows me to get to know them well.

Content: The First Computer?

When I asked my students who built the first computer, they looked at me with that "that's so easy" look and exclaimed "Bill Gates!" Imagine that look disappearing when I told them that the first computer was actually called the Antikythera Mechanism and it is believed to have been built 2000 years ago by the Greeks!

Believed to be an astronomical calculator, this device was found in pieces by sponge divers and recovered from the Antikythera wreck from 1900 to 1901. After spending 2000 years in salt water, there were three flat pieces of bronze. A cursory glance might look like corroded rocks, but a closer inspection will reveal traces of amazing technology: clock like gears and a ring divided into degrees, much like a protractor. Now being housed at the National Archaeological Museum in Athens, it has been called "an ancient Greek computer"[1]. Investigators in the 1970s and 1990s used Xray imaging to attempt to decipher it and concluded that it must have been created to replicate the movement of the stars and planets. When held in the hand, it could track pathways of the Sun, Moon and planets with surprising accuracy.

Then in 2006, with the advent of new technology, interest in the device was renewed and the pieces were CT scanned. These procedures revealed more precise inner images and what appeared to be hidden inscriptions. Intrigue was reignited in this mysterious ancient object. Investigators now believe that it was originally about the size of a mantel clock and it was found with splinters of wood, perhaps an encasement. It seems that there was once a large, round clock-like face with rotating hands. It also is apparent that there was a winding mechanism on the side. Turning the knob caused the movement of interlocking gearwheels that moved at least seven hands at different increments. Rather than telling time in minutes and hours, this mechanical piece had hands that told celestial time: one hand for the Sun, one for the Moon, and one for each of the five planets that could be seen without instruments (Mercury, Venus, Mars, Jupiter and Saturn). It also identified the phases of the Moon with a black and silver ball. The rising and setting of stars were explained by written inscriptions. Other dial systems included a calendar and the timing of lunar and solar eclipses. And this was created with only the tools available 2000 years ago!

But where was this amazing creation made? Based on the inscriptions and language used, it is theorized that the Antikythera originated in or around Corinth and its colonies in Northwest Greece. Since it was found on a sunken ship, it is possible that it was en-route to somewhere else. It is not known exactly who built it, but active research is still being conducted on this amazing piece today.

The implications of such a find proves that the ancient Greeks used complicated tools and gears to represent their understanding of nature and the earth's properties. Perhaps they saw nature as a machine, operating in precise and predictable ways, which could be not only observed, but harnessed and used to their benefit.

And what better way to catch my students' attention than to introduce them to a 2000 year old computer that survived despite being submerged in salt water for thousands of years?

What are Medieval Robots?

If you can believe that scientists around 80 BC built the programmable machine called the Antikythera that predicted astronomical events and tracked the movements of the stars, you might also be interested in medieval robots! Our seminar was fortunate enough to spend an evening with Ms. Elly R. Truitt, a distinguished scholar currently at Bryn Mawr College in Pennsylvania. Her specialty is Medieval Renaissance Studies and puts forth the idea that robots were "ubiquitous throughout the medieval world"[2]. She began her talk with the term "automata": man-made machines with self-contained methods of motion. Many of these inventions were moving statues, mechanical clocks and flowing fountains. They all had two things in common: they were self moving and mimicked natural forms like animals and humans.

Truitt's work traces these amazing machines that appeared in history between the ninth and fourteenth centuries. One easily identifiable example is found in Homer's Illyiad, written over 25,000 years ago, and contains descriptions of sentient golden handmaidens whose presences served two purposes: to perform labor and for pleasure. They were a sort of early artificial life, capable of speech and thought. Such manmade handmaidens can also be found in Sanskit writings; serving wine and spraying scented water from their eyes, nipples and fingernails.

Perhaps some of the most astounding mechanical marvels were the brain children of al-Jazari, an early 13th century engineer. He designed a mechanical female wine servant that was truly amazing. A reservoir held wine that slowly trickled into a basin that then tpped when it was full, spilling the wine into a wineglass in the girl's hand. She would then roll down an inclined plane toward the thirsty guest, holding the glass in one hand and a napkin in another.

"it is impossible to over-emphasize the importance of Al-Jazari's work in the history of engineering….The impact of these inventions can be seen in the alter designing of steam

engines and internal combustion engines, paving the way for automatic control and other modern machinery"[3]

Keeping Time

Time is something we never seem to have enough of in our modern day life. We are constantly keeping schedules, appointments and watching the clock. Perhaps we yearn for a simpler time, before we were ruled by the clock on the wall, wrist or phone. But when, exactly was that? There is historical evidence that clocks have existed for at least four thousand years, with varying degrees of accuracy. The Egyptians were the first time trackers, making star-clock charts that calculated time by the rising and falling of the stars. They then contrived ancient versions of sundials for timekeeping, often called shadow clocks. Instructions for such a device was found in the tomb of Pharoah Seti I, who ruled around 1300 B.C.[4]

Most of the first clocks were not so much chronometers as exhibitions of the pattern of the cosmos … Clearly the origins of the mechanical clock lie in a complex realm of monumental planetaria, equatoria, and geared astrolabes" [5] -Lynn White Jr., medieval researcher

Next came Water Clocks, or *clepsydra* around 1500 B.C. According to the inscription on his tomb, the inventor was an Egyptian court official named Amenemhet. The mechanism worked using gravity and water flow: a container was filled with water, and as it flowed out (usually via a small hole near the base) the passage of time was measured by the lowering water level as it moved past hour markings. This time of time measurement spread through the ancient world and became popular in larger towns, similar to a "town clock". Remnants of such a clock were found and dated to around 350 B.C.

In Greece, more complicated water clocks were developed, including one built around 270 B.C. by the inventor Ctesibius of Alexandria. An ancient ancestor of a cuckoo clock, the water flow went through a series of stopcocks, which caused all sorts of rotating movements including ringing bells, moving puppets and singing birds. Even then, people were being influenced by time passing: Plato (writing around 360 B.C.) wrote that lawyers were as "driven by the clepsydra…never at leisure" [6] layers today would probably concur! Other important uses for the water clock include timing for races in Roman games and at the Greek and Roman courts, when speeches were timed, so as to prevent long winded speakers from monopolizing the court's time.

If we move forward in time (pun intended!) to Ancient China, an amazing medieval clock was constructed by the astronomer Su Sung at the request of Emperor Ying Zong and completed in 1090 A.D. It was an astronomical clock with a tower that measured over thirty feet high. It is referred to as the 'Cosmic Engine". At its peak was a prodigious instrument for observing the stars that was constructed of bronze and which drew its energy from water. At the front of the tower, which stood five floors high!) were

a series of doors, each sheltering wooden puppets that emerged at regular intervals throughout the day and night, to perform a variety of actions like ringing bells and playing intricate instruments. This amazing device ran from 1090 until 1126, at which time it was taken apart and moved to Peking, where it continued to run for several more years.

In 1500, humans were confined to the earth's surface. They could build towers and climb mountains, but the sky was reserved for birds, angels and deities. On 20 July, 1969 humans landed on the moon. This was not merely a historical achievement, but an evolutionary and even cosmic feat. During the previous 4 billion years of evolution, no organism managed even to leave the earth's atmosphere, and certainly none left a foot or tentacle print on the moon. [7]

"Failure Is Not an Option"

As mentioned earlier, I was lucky enough to be chosen to attend Lift Off 2016 in Houston Texas. This summer conference for educators is an exciting opportunity to meet teachers from across the country and get a privileged look behind the scenes at NASA and the Johnson Space Center. During this weeklong summer institute, I had the chance to meet and talk with famous space experts and to tour locations such as the Command Center, the Neutral Buoyancy Lab and the Johnson Space Center.

I think my favorite speaker was Gene Kranz, the Director of the Command Center during Apollo 13. As he shared his personal experiences and history, I was struck by the importance of creative thinking: These professionals and astronauts had to brainstorm and think of their tools and equipment in absolutely novel ways in the crisis in order to survive. Otherwise, they never would have made it back to earth alive. They persevered as a team and refused to give up. As he said, failure was not an option.

I do tell my students the importance of perseverance, collaboration and critical and creative thinking, but this is an absolutely fabulous authentic example. Gene Kranz was kind enough to share his presentation slides with us and I have edited mine for this exact reason; to share with my students. He also autographed his book and I plan to share selections from it.

Collaboration on the World Scale: The International Space Station

The idea of a space station floating just above the earth may seem like science fiction, but it has been fact since construction began in 1998. It is a United States orbiting laboratory that is found in low orbit: two hundred and forty miles above the earth. Built and assembled in stages, it is the size of a football field today. Born of an international partnership between the USA, Russia, Europe, Japan and Canada, each country manages and runs the hardware it provides. This includes construction (in orbit), launch support, mission operations support and all the facilities necessary. Construction continues today and it has been visited by astronauts from 18 countries. It has been said that "The ISS has been the most politically complex space exploration program ever undertaken."[8]

Since we no longer have a shuttle program, currently all astronauts and cosmonauts are transported to the ISS via a Russian Soyuz vehicle. They always launch from Baikonur, Kazakhstan, and can now reach the space station in about six hours. Crews are made up of two three person sub-crews. At this time, a Soyuz is launched every three months and each sub crew stays about six months, overlapping by three months.

Today, the ISS can actually be seen by the naked eye. It is the third brightest object in the sky and may appear like a fast moving plane that is brighter and travelling thousands of miles faster! In fact, it orbits our beautiful planet 15.4 times each day. You can sign up for alerts about its whereabouts at http://spotthestation.nasa.gov.

The Future and the Private Sector: Mars and SpaceX

"You need to live in a dome initially, but over time you could terraform Mars to look like Earth and eventually walk around outside without anything on... So it's a fixer-upper of a planet." - Elon Musk[9]

You might be surprised that at this time, dozens of missions have launched to the big Red Planet, Mars. Some were "flybys" (collecting information in quick bursts), while others orbited literally for years. Perhaps most interesting are the landers—some that remain stationery and some that rove the planet, taking samples and sending back all sorts of data. While at NASA, I toured the Robotics laboratory, which houses all sorts of mock ups and prototypes. It was truly amazing!

Since the earliest flybys in 1965, four organizations have made the trip successfully: NASA, the Soviet Union, the European Space Agency and the Indian Space Research Organization. Others, including Japan and China have also made attempts, although they were unsuccessful. The discovery of traces of ancient water evidence sparked a renewed interest in travelling to Mars, and today rovers such as the Mars Odyssey (launched in 2001) have returned volumes of data from the planet, including fascinating images.

Although unmanned, these space exploration missions are extremely risky and expensive. Many robots do not even reach their targets and keeping them operational there is a tricky business. NASA is now operating on a drastically reduced budget today, which has opened the door not only to foreign interests but also to American private investors. SpaceX was founded in 2002 by Elon Musk, with a mission to design, manufacture and launch advanced rockets and spacecraft, with the ultimate goal of colonizing other planets. They currently have three vehicles and employ over four thousand people. It is the only private company ever to return a spacecraft from low earth orbit and regularly shuttle supplies to the International Space Station.

The National Geographic Channel recently launched an awesome TV show that blends real science and science fiction called "MARS". Set in the year 303, the cast of actors portrays many of the real and perceived challenges of colonizing the "Red Planet". This fiction is interspersed with real documentary style interviews with cutting edge thinkers

and experts in the field of Mars exploration. It is definitely worth a look and will no doubt provide inspiration and discussion starters for research and discourse. The site www.makemarshome.com even offers virtual reality games for players to experience what life on Mars might really be like. This is a great Segway into the Andy Weir novel, "The Martian" as well if you choose to use that in your activities.

Ancient Inventor: Leonardo Da Vinci 1452-1519

Leonardo Da Vinci is an excellent inventor to begin with for several reasons. The first is that he is a name that most students will recognize. Another great reason is because he was so multi-talented. Not only was he an extremely talented artist, but he had a very keen curiosity and was driven by a desire to discover the secrets of the natural world. In many ways, he was a man before his time.

Although often thought of as the quintessential "Renaissance Man", Da Vinci's ingenious designs did NOT revolutionize his time. Rather, they were left behind as sketches and diagrams in his many handwritten notebooks. None of his big inventions were built during his lifetime and it seems that they were mostly unknown until after his death. Our seminar was fortunate enough to be able to view some replicas of the great inventor's notebooks from the University's Special Collections and the detail and form were truly astounding.

Modern engineers have discovered that although never constructed by Da Vinci, his works were truly ahead of his time. Most of his inventions actually work! He is credited with a very long list of game changing inventions including the creation and use of the ball-bearing, the parachute, the birdlike winged ornithopter, an early rapid firing weapon, an underwater diving suit, an armored tank, a self-propelled cart (could it be an original robotic vehicle?) and a robotic knight. He is a great "hook" for students, as they are fascinated that he could come up with these ideas so very long ago, and without benefit of modern tools and machines.

Inventions aside, Da Vinci is usually first and foremost known for his artistry. Depending on the age group of the students, his work such as the Vitruvian Man, the Mona Lisa, The Last Supper, and the Virgin of the Rocks offer wonderful opportunities to integrate the Arts into this unit. There are many, many resources available to teach about this amazing historical figure and some can be found in the Teacher Resources section of this unit.

Modern Inventors: Elon Musk: "the Greatest Living Inventor"

The Atlantic featured Musk on its cover with the above label and traced his extraordinary life thus far as an inventor and entrepreneur. The author even suggests that he may be this century's Thomas Edison. In researching this titan of industry and technology, I was astounded by the number of inventions that bear his name. In fact, he was an active inventor before he was a teenager and continues to influence our everyday life today with his concepts and inventions.

Musk is the perfect example of blending invention and space exploration. Born in South Africa in 1971, this young lover of science fiction sold his first invention at age 12: a video game called "Blaster". Educated in the United States, Musk then went on to found his first corporation called Zip2, an online city guide which he sold to a division of Compaq Computer Corporation.

Most people today probably recognize Musk as the billionaire funding SpaceX, but he is also the founder of Tesla Motors. This electric car company is so successful that they have a difficult time keeping up with orders and has seen its stock value increase seven hundred times in the last two and a half years. He founded SpaceX in 2002 with his invention of the Falcon and Falcon 9 rockets that are designed to be reusable, and as mentioned earlier has contracts to supply the International Space Station with the transportation of supplies and hopefully, people, in the future. Other companies and inventions that are credited to Musk include what we now know as Paypal (the online payment system that was eventually sold to EBay), and Solar City (the country's second largest solar power company). He is also one of the innovators interviewed on the National Geographic show "MARS", as mentioned earlier.

Strategies: Inquiry Based Learning

Inquiry based learning is a great way to get students thinking on their own. Rather than giving the information to students, this teaching strategy puts students in charge of their learning. Lessons are designed around student driven questions. This encourages students to be active, rather than passive thinkers, to pursue their curiosity and take ownership in an authentic way.

The process all begins with questions. What do the students already know? What do they want to know more about? Rather than simply providing the answers, students are taught to be more self -directed and must work with the teacher and their peers to discover their answers. This strategy will be used throughout this unit. Resources about this strategy can be found under "Resources for Teachers and Students".

IPads in the classroom

This year my district gave each 5th grader an iPad as an academic tool. This opens up a world of learning opportunities as students learn how best to use them at school. One application that I am excited to use in this unit and beyond is *Kahoot.* Kahoot is a fun online activity that can be used in a variety of ways. It can be used to introduce a topic or to assess learning along the way. Kahoots can be teacher created or teachers can access the hundreds of Kahoots already prepared by others. As the teacher projects the questions, students are all engaged and actively participating. The results are then shown and the results discussed. Not only is it fun, it is a way to make students feel comfortable making mistakes, because it does not matter if the question is answered correctly, it is the discussion that follows that counts!

Another application that I will use in this unit is Quizlet. This is an awesome site that can be accessed on personal devices and computers to review material. Students can create their own lists to study or use those assigned to their class by a teacher or discovered on their own. Having my students bring their iPads to class again means that everyone is engaged and active and self -directed.

Socratic Seminars

Socratic Seminars can allow students the opportunity to achieve a deeper understanding about the ideas and values in a text. Text selection can include documents, speeches, literature, essays, art, music, poetry, etc. Pieces should be short, or an excerpt could be assigned. Participation in a Socratic Seminar helps students construct meaning through disciplined analysis, interpretation, listening, and participation.

Integrating the Arts: Thoughts about STEM to STEAM

Leonardo Da Vinci is a fabulous example of the integration or art into the sciences. He is just as well known for his art as he is for his science and his work is best viewed through the lenses of both. I try to integrate the Arts whenever possible and there is plenty of research to support this. Allowing students to express what they have learned in their chosen manner can produce fantastic results and is a great way to differentiate. Whether looking at a piece of artwork or an invention, good questioning techniques can help students look more critically at an object and make increasingly sophisticated observations. Research from Sandra Kaplan and Project Zero offer activities and helpful tips for Artful and Visible Thinking.[10]

A Further Note about this Unit

Since the main focus of Advanced Academics curriculum is on ELA and Math, the activities of this unit will be implemented throughout the year; it is a theme. The following are a few of the activities that will be used.

Introductory Activity: Kahoot

As mentioned Kahoot is a whole class activity that students can access on their iPads. If you are unfamiliar with it, there are tutorials online at https://www.youtube.com/watch?v=pFFv6_6was4 and many public Kahoots that you can use rather than making your own. I created a Kahoot that introduces the concept of ancient inventions and thinkers and it is a wonderful springboard for discussion. After each question is responded to, the screen will show the number of responses to each choice. Students enjoy both being right, and being wrong! This stimulates discussion and serves as a pre-assessment of student knowledge on the topic. It also will get students hooked on inventors and inventions that they may want to use in their research.

Activity: Ancient Timelines

After introducing the topic in the classroom with Kahoot, a jigsaw timeline activity is a great way to get families involved and for students to further connect with the topic. I created a timeline of inventions and important historical inventors from ancient time to today, *but without dates*! This timeline is then cut apart and students are challenged to put them in order. They are encouraged to talk with others about their perceived order and to return to class with the assignment. In class, they will compare their thoughts with those of their peers. Extra copies will be made available so that students may correct their misconceptions.

The following is an extensive list of dates and inventions. The intent is to make students think about and discuss the relative times and historical context, not to be perfect! Pick and choose events, depending on your class and focus. Remember to mix them up and remove the dates!

1450: Johannes Gutenberg pioneers the modern printing press
1610: Galileo Galilei makes the first telescopic observation of the night sky, discovering Jupiter's moons, lunar craters and the different phases of Venus
1687: Sir Isaac Newton proposes his three laws of motion and the motion of the solar system
1701: English farmer Jethro Tull begins the mechanization of agriculture by inventing the horse-drawn seed drill.
1757: John Campbell invents the sextant, an improved navigational device that enables sailors to measure latitude
1827: Joseph Niepce makes the first modern photograph.
1840 the first clear telescopic photo of the Moon is taken
1849: James Francis invents a water turbine now used in many of the world's hydropower plants
1867: Joseph Monier discovers reinforced concrete
1876: Alexander Graham Bell patents the telephone
1877: Thomas Edison invents his sound-recording machine or phonograph—a forerunner of the record player and CD player
1895: German physicist Wilhelm Röntgen discovers X rays
1907 Leo Baekeland develops Bakelite, the first popular synthetic plastic.
1920s: Philo T. Farnsworth invents modern electronic television
1921: Karel Capek and his brother coin the word "robot" in a play about artificial humans.
1927 the Society for Space Travel formed
1930s: Maria Telkes creates the first solar-powered house.
1938: Chester Carlson invents the principle of photocopying (xerography
1942 First rocket launched to reach 100 km above the earth's surface
1947 Fruit flies sent into space to study the effect of space travel on humans
1949: Bernard Silver and N. Joseph Woodland patent barcodes—striped patterns that are initially developed for marking products in grocery stores.
1958 NASA (National Aeronautics and Space Administration) founded
1962 John Glenn is the first American to orbit earth

1966: Stephanie Kwolek patents a super-strong plastic called Kevlar
1969 Apollo 11 makes first landing on the moon
1969: Long before computers become portable, Alan Kay imagines building an electronic book, which he nicknames the Dynabook.
1971 American astronauts drive Luna Rover on the moon
1973: Martin Cooper develops the first handheld cellphone (mobile phone)
1981: Space Shuttle program begins
1989: Tim Berners-Lee invents the World Wide Web.
1990 The Hubble Space Telescope released into orbit
1991 the Mars Pathfinder probe lands on Mars
2000 First permanent crew arrives at the International Space Station
2001: Apple revolutionizes music listening by unveiling its iPod MP3 music player.
2004 Two rovers land on Mars, sending back images of the Martian surface
2004: Electronic voting plays a major part in a controversial US Presidential Election
2007: Apple introduces the first iPhone
2012 NASA Curiosity Rover lands on Mars in search of signs of life
2016: Three nanotechnologists win the Nobel Prize in Chemistry for building miniature machines out of molecules

Introduction to a Modern Day Genius: Elon Musk

Introduce students to this man and his brilliant mind but either using excerpts from books, an online biography, or video (see Teacher and Student Resources). In groups, students will be given an area of his work: solar energy, Tesla motors, SpaceX, Rapid transit. They will become familiar with this part of Musk's industry and its implications for our lives today. They will then create a presentation for the class about their topic: PowerPoint, Kahoot, poster, etc.

I was fortunate enough to obtain a grant from a local company to purchase a Pitsco kit that will enable each student to build their own solar car. This hands on activity will follow the student presentations and discussion of the importance of alternative energy possibilities.

Socratic Seminar: Is Space Exploration Worth the Risk?

Students will be assigned an article detailing disasters such as the Challenger Disaster, and failed Apollo missions. Another alternative would be excerpts from "Failure is Not an Option" by Gene Kranz, as a positive outcome of a near disaster. Following the Socratic Seminar protocol that my students are familiar with, a Socratic Seminar should bring out many of the salient points on this topic. Appendix A is a worksheet that students will complete prior to the Socratic seminar in order to facilitate the discussion.

The Martian: "Necessity is the Mother of Invention"

There is an abridged version of "The Martian" and I learned at NASA that the majority of the science in this book is correct. Begin the lesson with a reminder to students that they

many amazing ancient inventions presented were created without any sophisticated instruments or tools. Rather, it was the need for a solution to a problem that initiated their inventions. This is not unlike the situation at the beginning of "The Martian". The main character is faced with a disaster that leaves him alone on Mars and it's either problem solve or die. Excerpts can be used or if students are interested, the entire novel can be used as an assigned reading or Literature Circle activity. There are many resources available for teaching this novel that can be found in Teaching Resources at the end of this unit.

S.T.E.A.M. Activity: Life on Mars

To prepare for this activity, assign a challenge to find science fiction stories or pictures about life on other planets. Some are outrageous, others are not. Then show real pictures of the Mars environment (resources can be found at the end of this unit). Spend enough time with visuals and information that students understand the extremes of this planet: this activity is a creative application of this knowledge. Then give the following challenge and organizer to groups or individuals:

Create Your Own Martian!

You are hereby charged with creating your own Martian! Now that you know the extreme environment found on the Red Planet, use your creativity and imagination to construct a creature that could survive on Mars. Don't forget the ecology of Mars: it's dry, barren, with extremes of temperatures and strong winds, frequent dust storms and no other plants or animals to eat! If you are stumped, you might consider taking a look at organisms that survive in extreme environments on earth. How have they adapted?
Your project must include the following information:
Name of your Martian, Habitat/Climate description, Locomotion (how it moves), Food Sources, Natural Predators, Defensive Mechanisms, Protective Adaptations and Other Interesting facts.
Be prepared to share your thinking!

Visible Thinking Strategy Activity: The Elaboration Routine and Da Vinci's Art

This routine can be a good starting point for writing. Using *Landscape Drawing for Santa Maria Della Neve*[11] (or a similar piece) and dividing students into groups of four, allow students time to examine this intricate drawing. Then follow this routine:
One person identifies a specific section of the artwork and describes something he or she sees. Another person elaborates on the first person's observations by adding more detail about the section. A third person elaborates further by adding yet more detail, and a fourth adds yet more. This thinking routine can then move to another part of the piece if desired. By asking students to describe and elaborate, they will distinguish between what they see and what they interpret. A bubble map or similar graphic organizer can be helpful to the group as they build on each other's ideas.

Teacher and Student Resources

https://www.edutopia.org/practice/wildwood-inquiry-based-learning-developing-student-driven-questions?utm_source=twitter&utm_medium=socialflow This is a great place to start for Inquiry Based learning

http://www.livescience.com/1166-scientists-unravel-mystery-ancient-greek-machine.html Information on the Antikythera device

https://www.youtube.com/watch?v=UpLcnAIpVRA YouTube video on the Antikythera device discovery

http://spaceplace.nasa.gov/make-do-pdf/en/ Hands on Space Activities:

http://www.antiquetelescopes.org/before.html Astronomy before the telescope

https://youtu.be/GWpwokOOQIQ, https://www.youtube.com/user/everyelonmuskvideo Elon Musk videos

https://www.ted.com/talks/elon_musk_the_mind_behind_tesla_spacex_solarcity?utm_source=tedcomshare&utm_medium=referral&utm_campaign=tedspread Elon Musk TED Talk

https://www.youtube.com/watch?v=Xpmg9b-5B84 Animated DaVinci Inventions video

http://www.da-vinci-inventions.com/ Great site for all that is DaVinci

http://www.geniusstuff.com/blogs/10-leonardo-da-vinci-inventions.htm Top 10 DaVinci inventions

http://wnpr.org/post/west-haven-teachers-use-martian-create-lessons-across-classrooms Resources for using "The Martian" in class

http://listverse.com/2015/09/13/10-incredible-astronomical-instruments-that-existed-before-galileo/ Neat resource for ancient instruments

http://blog.ed.ted.com/2015/09/22/the-science-of-the-martian-5-ted-ed-lessons-to-help-you-understand-the-film/ TED talks about the novel "the Martian" and Mars

https://www.ted.com/talks/anjali_tripathi_why_earth_may_someday_look_like_mars Another TED talk that could be used with Mars activities

http://mars.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf activities for teaching about Mars

https://www.youtube.com/watch?v=pFFv6_6was4 YouTube video on creating your own Kahoot classroom activity

http://www.nytimes.com/learning/general/onthisday/big/0127.html#article NY Times article after Apollo disaster for Socratic seminar

http://listverse.com/2014/03/17/10-horrific-disasters-of-the-space-program/ Presentation on Space Disasters

Appendix A

Socratic Seminar Prep Sheet

Read your article and don't forget to annotate and make connections!

!- I love this!

?-I don't quite understand this

??-I need to talk about this

Write 3 of the most important phrases or sentences from the article.

1._____

2. _____

3._____

Focus: Write 3 higher order thinking questions for discussion.

1._____

2._____

3._____

Possible responses:

1._____

2._____

3._____

Appendix B

Standards to be addressed in this unit

This unit has the potential to be cross curricular in nature and cover a variety of standards.

Reading: Literature:

Rl5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

Rl5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
Rl5.3 Explain the relationships or interactions between two or more individuals, events, ideas or concepts in a historical, scientific, or technical text based on specific information in the text.
Rl5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area
Rl5.5 Compare and contrast the overall structure (e.g. chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.
Rl5.6 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

CCSS.ELA-LITERACY.SL.5.1.A
Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
CCSS.ELA-LITERACY.SL.5.1.B
Follow agreed-upon rules for discussions and carry out assigned roles.
CCSS.ELA-LITERACY.SL.5.1.C
Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
CCSS.ELA-LITERACY.SL.5.1.D
Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

Presentation of Knowledge and Ideas:
CCSS.ELA-LITERACY.SL.5.4
Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
CCSS.ELA-LITERACY.SL.5.5
Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.
CCSS.ELA-LITERACY.SL.5.6
Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation.

PS2.B: Types of Interactions
The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5- PS2-1)
ESS1.A: The Universe and its Stars
The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)
ESS1.B: Earth and the Solar System

The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)

Patterns
Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2)
Cause and Effect
Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)
Scale, Proportion, and Quantity
Natural objects exist from the very small to the immensely large. (5-ESS1-1)

Analyzing and Interpreting Data
Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. (5-ESS1-2)
Engaging in Argument from Evidence
Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).
Support an argument with evidence, data, or a model. (5-PS2-1),(5-ESS1-1)

National Core Arts Standards
Creating:
Anchor Standard #1: generate and conceptualize artistic ideas and work
Anchor Standard #2: organize and develop artistic ideas and work
Anchor Standard #3: refine and complete artistic work
Responding:
Anchor Standard #7: perceive and analyze artistic work
Anchor Standard #8: interpret intent and meaning in artistic work
Connecting:
Anchor Standard #10: synthesize and relate knowledge and personal experiences to make art
Anchor Standard #11: relate artistic ideas and works with societal, cultural and historical context to deepen understanding

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http://space.about.com/od/astronomyspacehistory/a/timelinea.htm.

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see chapter 7 for Mars activity

Bradbury, Ray. *The Martian chronicles*. Garden City, NY: Doubleday, 1958.
May be used for the Mars activity

"Experience the Mission to Mars!" Make Mars Home. Accessed January 10, 2017. http://www.makemarshome.com/.
Awesome resources for teaching about the exploration and colonization of Mars

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See chapter 17 for Mars activity

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Notes

1 http://www.smithsonianmag.com/history/decoding-antikythera-mechanism-first-computer-180953979/?no-ist (accessed November 16, 2016)

2 Seminar, November 14, 2016, University of Delaware.

3 http://www.muslimheritage.com/uploads/Automation_Robotics_in_Muslim Heritage.pdf. p. 1 (accessed November 21, 2016)

4 James, and Thorpe, *Ancient Inventions*, 2015

5 http://cosmic-watch.com/history-of-astronomical-instruments/

6 P. 125, Ancient Inventions

7 Harari, *Sapiens: a brief history of humankind*, 248.

8 https://www.nasa.gov/mission_pages/station/cooperation/index.html (accessed October 31, 2016

9 http://www.brainyquote.com/quotes/quotes/e/elonmusk567205.html (accessed December 19, 2016)

10 http://pzartfulthinking.org/?page_id=2 (accessed December 21, 2016)

11 http://www.wga.hu/html_m/l/leonardo/11nature/01landsc.html (accessed December 21, 2016)