

Final Assignment: Electronic Portfolio

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### Abstract

This paper represents an aggregate of lesson plans, rubrics, formative assessments, case studies and student artifacts that fulfill the objectives of the NASA Endeavor Astronomy and Space Science course. This collection is archived in an electronic portfolio contained on the author's website, [sharonmistretta.com](http://sharonmistretta.com) within the Portfolio menu option and the [Lesson Plans webpage](#). This portion of my teaching portfolio outlined within this document seeks to demonstrate the effective implementation of NASA astronomy data while improving content knowledge in astronomy and space science. Additionally, the three dimensions of the Next Generation of Science Standards (NGSS) are taken into consideration while lessons have been planned. The Nature of Science (NOS) matrix and the Nature of Math (NOM) matrix as outlined by NGSS are used in lesson strategies.

## Electronic Portfolio

### **Introduction**

A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas defines technology as, "...any modification of the natural world made to fulfill human needs and desires" (Quinn, 2012). As a technology teacher, I have had to continuously seek out content that is engaging and substantive in order to hold my students' attention. While I am teaching my students how to program and utilize various computer applications, I am not tied to any one subject area and it has been difficult to come up with lessons that provide enough authentic data and content to make the lesson engaging. The NASA data and lesson plan websites offer a wonderful collection of material that teachers can utilize in order to "make meaning" in the classroom. The Framework definition of technology essentially embodies the NASA missions. Data from the natural world is gathered, examined and explained. Modifications, in the form of space telescopes and explorations, gives us real world examples of technology in action.

During the NASA Endeavor Astronomy and Space Science course, I have discovered a wealth of data and ideas that I can build into my lesson plans. The course objectives list two major areas of concentration. The first is the effective implementation of NASA astronomy data. The second is to improve content knowledge in astronomy and space science. My school does not have Astronomy in the curriculum. The science curriculum is based on Physical Science in the form of Chemistry and Physics, and Life Science in the form of Biology. Astronomy topics are not covered in Physics. We do not have Earth Science or Astronomy and Space Science in our curriculum. I have taken the NASA Endeavor Astronomy course because of a lifelong

interest in NASA's space missions. As I had described in the Introductions Discussion Board of my Astronomy course, I was glued to the TV set during the Apollo 11 lunar landing and saved every newspaper clipping that I could find on the subject. During the Apollo 13 mission, I did my own "reconstruction" of the "fix" that the astronauts needed to do to remove carbon dioxide from the Lunar Module "lifeboat". While my model did not actually work, I brought it into school and my seventh grade teacher allowed me to describe why it was needed. The lunar landing was not even taught by my school as a "teachable moment" and I am finding that Astronomy and Space Science are sadly neglected in practice in schools where I have taught. If it is "not needed to get into college", it is not included within the curriculum.

I have developed two lesson plans that utilize NASA data and improve the content knowledge of students in order to fill a void that I am discovering in the Science curriculum of present pedagogy.

### **Content Knowledge - Make a Digital Camera - Color the Universe Lesson Plan**

The NASA Project-Based Learning Programs offer a unit plan entitled, "Hubble Sight/Insight: Color the Universe" (NASA, 2014). The Color the Universe plan is divided into six activities. The first activity of Color the Universe contains a lesson plan to "Make a Digital Camera". Using this NASA plan, I have developed a 5E Lesson to show that a teacher can improve content knowledge in astronomy and space science by demonstrating how pixels are utilized to create images.

**Three Artifacts to Demonstrate Improving Content Knowledge****Sharon Mistretta Lesson Plans Webpage**

(active link above or copy and paste <http://www.sharonmistretta.com/#!/lesson-plans/c181x> into browser window)

1. 5E Lesson Plan
2. VoiceThread Rubric
3. Sample Student VoiceThread Project

Most high school students are very familiar with digital cameras. The culture of smart phones places a digital camera in the hands of teenagers practically every waking moment. Since I will be covering iOS App Writing in my Programming course, this is a valuable lesson plan to conduct with my students. Before they produce code activating the iPhone and iPad cameras and judge the resulting pictures, I want them to know the scientific and engineering aspects of the camera that they are using. The “5E” instructional model introduced in the NASA Endeavor STEM Methods course and reinforced in the Astronomy and Space science course is being utilized in all of my lesson plans. While conducting this lesson plan, I will have each team of students take pictures of each step with their iPad cameras. This will facilitate the “evaluation” phase of the 5E instructional model.

**Engage:** The purpose for the ENGAGE stage is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding. The Hubble Space Telescope’s Wide Field Camera 3 (WFC3) charge-coupled device (CCD) is a 16 megapixel array. The WFC3 instrument has two “channels”, one for ultraviolet and visible light, the other for “near infrared” light. The first channel contains silicon similar to the students’ iPhone cameras.

The second channel contains a material called “mercuric cadmium telluride” (HgCdTe). The combination of these two channels gives Hubble a wide range of light wavelengths. (spacetelescope, 2014).

An iPhone 5S contains an 8-megapixel camera based on silicon material (Apple, 2014). The Hubble’s CCD is a photon detector comprised of a thin silicon wafer that is organized into an array of light-sensitive regions that capture light and store image information (Spring, 2014).

The “engage” step presented to the students can be made by drawing a correlation between what they use on earth to take pictures, the iPhone and iPad, and the images that are taken of the universe by Hubble.

**Explore:** The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding. At this explore step, images of the Hubble Gallery can be viewed by the students to gain a perspective of the scope of what we are receiving from Hubble (NASA, 2014). Students will choose Hubble images, download copies and record image credits for later use in the evaluation stage. During this step, the NASA Color the Universe lesson plan suggests that the students make a their own “digital camera”. This will allow the students to construct knowledge about photons, charged coupled devices (CCD) and pixels.

**Part 1: Capturing Photons** In step 1 of this part of the explore stage, the students will build their own single pixel “digital camera” using paperclips hanging from plastic tape over a plastic cup. The paper clips represent electrons potentially collected in the plastic cup that represents an “electric potential well”. Step 2 expands on this concepts by having the students

drop a pencil (incoming photon) onto the tape that will cause paper clips to drop into the cup and model electrons being collected in the “electric potential well”.

**Explain:** The purpose for the EXPLAIN stage is to provide students with an opportunity to communicate what they have learned so far and figure out what it means. The students should now have questions about each of the components of the model. A “think, pair, share” can be conducted so that students can process what they have observed and then collaborate in groups to deepen their understanding of the photons, electrons, and pixel “electric potential wells”. Once the teacher reconvenes the class, definitions can be developed and recorded.

**Elaborate/Extend:** The purpose for the ELABORATE/EXTEND stage is to allow students to use their new knowledge and continue to explore its implications. The Color the Universe now gives the student the opportunity to expand their “camera” to nine pixels and simulate an object being photographed.

**Part 2: Capturing an Image** In this part of the elaborate/extend stage, the students will expand their model to nine “pixels” by placing nine cups in a tight array of 3 by 3. This time, the tape is removed and a paper “filter” provided with the lesson plan is used to simulate bright and dark spots on an object being photographed. Small holes are cut out in the paper filter to simulate dark spots and large holes to simulate bright spots. The filter is held above the 3 by 3 array and the paper clip “electrons” are poured above the paper falling through to the array below. Correlations can be made by the students of light from “celestial wonders” being photographed and the amount of electrons being collected for the resulting “image”.

**Part 3: Reading Out the Camera** In steps 1 and 2 of this part of the elaborate/extend stage, the students will designate a “readout” pixel, in position (1,1) of the cup array, and count

the paper clip “electrons” to create a data table of the “electrons” collected in each pixel cup. Based on a formula provided within the lesson, students will color a diagram (using [giphy.com](http://giphy.com)) with a 3 by 3 array of nine circles, using graduating colors of white, light gray, dark gray and black. Cups with 11 or more paper clips in it remains white - most electrons, cups with 0 to 3 paper clips is completely black - least electrons. Two counts in between represent light and dark gray. The students have now created their first “image”.

**Part 4: How Do We Capture Color?** In this part of the elaborate/extend stage, students must now speculate as to how the Hubble Space Telescope captures color images. The teachers’ guide of the Color the Universe lesson plan suggests that the students visit the webpage, “The Meaning of Color in Hubble Images” (NASA, 2014). This website explains that Hubble images are actually a combination of two or more black and white images to which color has been added using red, green and blue filters.

**Evaluation:** The purpose for the EVALUATION stage is for both students and teachers to determine how much learning and understanding has taken place. The students have been taking pictures using their iPads throughout each step of this project. VoiceThread is a podcasting subscription website that I utilize extensively as an assessment tool. VoiceThread allows the students to upload images, create “voiceovers” for each slide, annotate slides using a virtual white board and record voice messages on each other’s projects. As a team, the students will choose the best pictures to represent the steps, upload the pictures to a VoiceThread project and complete “voiceovers” and virtual white board annotations on each slide. Each team will view each other’s projects and record a voice message on other teams’ VoiceThreads about the project.

## **NASA Astronomy Data - Exoplanet Transit Hunt Lesson Plan**

The NASA Kepler Space Telescope website provides a wonderful interactive tool called “Exoplanet Transit Hunt” to give students the opportunity to learn the mathematical calculations used by Kepler scientists to determine if the telescope has discovered an exoplanet orbiting a star. This 5E Lesson plan takes the student through an exoplanet hunt by having them examine a star, record calculations and draw conclusions using collected data.

### **Three Artifacts to Demonstrate Effective Implementation of NASA Astronomy Data**

#### Sharon Mistretta Lesson Plans Webpage

(active link above or copy and paste <http://www.sharonmistretta.com/#!lesson-plans/c181x> into browser window)

1. 5E Lesson Plan
2. Quicktime Rubric
3. Example of Socratic Formative Assessment Question

**Engage:** When asked, “How many planets are there?”, most students will respond nine, while some might remember the “demotion” of Pluto and answer eight. Much to their surprise, Kepler has confirmed 977 planets with 4,234 “candidates”. Using the Socratic online student response system, the teacher can review NASA data such as:

- ✓ Socratic - Our sun is:
- ✓ What temperature? 5,780 K  
(5,504.85 Celsius)  
Kelvin = Celsius + 273.15
- ✓ How many miles from earth?  
92,960,000 miles

(149,600,000 km)

(1mi = 1.6093440 km)

✓ Diameter of earth?

7,918 miles (12,742 km)

✓ Diameter of sun?

864,000 miles

(1,390,473.22 km)

This engage step gives the students an opportunity to construct knowledge about the dimensions of our earth, distance of earth to our sun and the use of Kelvin as a measure of temperature in space.

**Explore:** Using Socratic, the students are asked, “Are all stars the same size and temperature as our sun (Y/N)? Most students answer no and this is further confirmed by displaying a Hertzsprung-Russell diagram-schematic and reviewing the seven main letter designations of stars (Australia Telescope National Facility, 2014). The teacher can then demonstrate the Kepler Exoplanet Transit Hunt interactive tool and defining the terms:

✓ telescopic view

✓ transit

✓ star type data “spectral type”

✓ “star’s mass”

✓ “star’s radius”

✓ star’s temperature in Kelvin

✓ orbital period

✓ percentage of brightness drop

✓ distance of planet from its star in AU (astronomical units)

✓ exoplanet surface temperature

✓ exoplanet radius

**Explain:** In the explain stage, the teacher can give the students the opportunity to communicate what they have learned and to ask questions. A demonstration is made using a light bulb and a ball on a string to simulate a planet transiting in front of a star. The students are

invited to describe what they see. NASA has another interactive webpage entitled, "[Planet Quest Interactive: 5 Ways to Find a Planet](#)." The explanations contained on this webpage will further construct students' knowledge of transits.

**Elaborate/Extend:** In this stage, students are assigned a specific star on the Exoplanet Transit Hunt Interactive Webpage to investigate. The students will take a "screen shot" of their resulting star data chart and enter the data in a Numbers spreadsheet. This is in preparation for conducting the same investigation for a "screen recording" in Quicktime. By doing this twice, students will have the opportunity to try out the process before doing a screen and voice recording. They can also study how the calculations are made in order to explain with confidence in their Quicktime assessment.

**Evaluate:** During the evaluation stage, the student will produce a Quicktime screen capture video with student "voiceover" as they explain the process of measuring their star and potential exoplanet. The video is compressed and the data tables are submitted in a Numbers spreadsheet and screen shot of star data table.

### Conclusions and Further Study

The opportunity to investigate NASA data and to increase my own content knowledge of astronomy has been very valuable. I am now able to develop very meaningful lesson plans using the resources that NASA provides. To me, this is more valuable than any textbook.

Additionally, learning about Astronomy and Space Science has deepened my lifelong interest in the space program. I am in the process of converting all of my lesson plans to the 5E Model which I believe enables teachers to assist their students in successfully constructing their

knowledge of a subject area that is often pushed aside for the “college prep” process that emphasizes other categories of science.

## References

- Apple. (2014, 2014). "Compare iPhone." Retrieved June 16, 2014, from <http://www.apple.com/iphone/compare/>.
- Australia Telescope National Facility. (2014). "The Hertzsprung-Russell Diagram." Retrieved July 22, 2014, from [http://www.atnf.csiro.au/outreach/education/senior/astrophysics/stellarevolution\\_hrintro.html](http://www.atnf.csiro.au/outreach/education/senior/astrophysics/stellarevolution_hrintro.html).
- NASA. (2014). Hubble Sight/Insight: Color the Universe Retrieved July 16, 2014, from <http://www.agl-initiatives.org/SI/Home.html>.
- NASA. (2014). "Hubble Gallery." Retrieved July 17, 2014, from <http://hubblesite.org/gallery/>.
- NASA. (2014). "The Meaning of Color in Hubble." Retrieved July 17, 2014, from [http://hubblesite.org/gallery/behind\\_the\\_pictures/meaning\\_of\\_color/](http://hubblesite.org/gallery/behind_the_pictures/meaning_of_color/).
- Quinn, Schweingruber, Keller, (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, The National Academies Press.
- spacetelescope. (2014). "Hubble's Instruments: WFC3." Retrieved July 16, 2014, from <http://www.spacetelescope.org/about/general/instruments/wfc3/>.
- Spring. (2014, 2013). "Introduction to Charge-Coupled Devices (CCDs)." Microscopy Retrieved June 17, 2014, from <http://www.microscopyu.com/articles/digitalimaging/ccdintro.html>.