**The Blue Marble: A Single System**

**ABSTRACT**

Earth is a dynamic planet. Complex and interconnected processes make up the Earth system. This Earth system is made up of smaller subsystems/components: the geosphere is the land, the air is the atmosphere, life is the biosphere and the hydrosphere is all forms of water, including a smaller subsystem of the cryosphere which is ice. These smaller systems interact together and create change. Most events on Earth are going to involve more than one sphere. Let's look at a fairly simple example to begin like volcanoes. Volcano eruptions are events in the geosphere because this is both rock being pushed out from under the surface as well as a change in the surface land itself. Volcanoes also spew a lot of gas and particulate matter into the atmosphere, as well as send hot lava flowing down mountainsides, disrupting the biosphere. Water will condense around that particulate matter in the atmosphere, so now we've involved the hydrosphere as well.

Astronaut photographs taken during the Apollo missions provided full-color images of Earth, and fostered a greater awareness of the need to understand our home planet. Photographs of Earth taken from space show that our planet is a single system. When students observe Earth from this perspective, they can readily see oceans, clouds, and continents that are lit by sunlight, and the energy that supports life on Earth. They will understand that photographs reveal features and events that would be impossible to detect with other means of analysis.

**BACKGROUND INFORMATION FOR TEACHERS**

Images of Earth from outer space can transform how people view our planet and our society. Images of Earth taken from space show our planet as a single system.

Photographs produce a fantastic record of the Earth and its surroundings from hundreds of miles away. These photographers have to find out the best ways to take pictures of the Earth and are able to make discoveries about the types of things that can be viewed or identified from space. Taking photos in space is not just done for artistic merit, nor is it anything like taking them from the ground. For example, photographers have to snap at speeds of almost eight kilometers per second.
Essential Questions

- What do photographic images of Earth from space tell us?
- What clues do you see in the photograph images of Earth from space that can help you understand Earth and its components?

Instructional Objectives

Students will:
- Identify and locate evidence from NASA photos that shows Earth and its water, land and atmosphere components from space.
- Interpret their evidence and explain their ideas in writing.
- Analyze NASA photos and organize their conclusions in their science notebooks.
- Present their findings orally to their class.

Key Vocabulary

- Perspective
- Single system
- Interaction

Materials

- Internet Access
- Discussion “Writing Frame” Worksheet for each photo.
- “Final Analysis” Worksheet
- NASA photos
- Camera for “Engage” activity
- Objects from home for student photographs
- Photos 1, 2, and 3.

Resources

NASA:
- The Blue Marble Screenshots: https://archive.org/details/SVS-2683
- Apollo 17 Archives: http://visibleearth.nasa.gov/view_cat.php?categoryID=1484&p=3
- The Next Generation Blue Marble: http://www.nasa.gov/vision/earth/features/blue_marble.html

Bishop Museum:
- Science on a Sphere Programs: http://www.bishopmuseum.org/planetarium/sos.html
- GRADES 4 - 6: Destination Solar System http://www.bishopmuseum.org/education/science_programs.html
Session One:

1. Using the questions below, engage students in a discussion. Students share ideas in small groups then discuss these ideas with the whole class. Record student ideas on the board for future reference.

   - What is a photograph?
   - How is it useful?

2. Introduce the elements of photography with students, including proper use of materials and vocabulary. Areas of discussion include:

   - Camera Care: Keep camera clean, dry and protect from fall.
   - Picture Quality: Pixel - (Picture Element) The smallest element of a digitized image. One small dot of light among the many dots that make up an image on a computer screen. Megapixel - A unit equal to one million pixels. The higher the resolution, the more pixels in an image and therefore the greater the image quality. An image file that is 1 megapixel (MP) can make a realistic photo print of 5 x 7 inches; a 2 MP file can make an 8 x 10-inch print; a 3 MP file can make an 11x14-inch print.
   - Resolution -The number of pixels in an image. A higher number correlates to a higher quality image.
   - JPEG format: JPEG is a standardized format used by many digital cameras for storing images. This format is also commonly used for images on the web and images attached to e-mail messages. JPEG, which stands for Joint Photographic Experts Group, is one of the most widely used formats today.
   - Developing Photos - A stand-alone computer-run system can allows users to edit and print pictures from negatives, prints, or digital files on a picture card, CD, or disk.
   - Photoshop Elements_Software installed on a personal computer designed to develop digital photography. Features include: Editing, cropping, color enhancements, red-eye reduction, erasing, touch-up.

3. Show other camera options such as iPhones and iPads. Ask students what kinds of cameras they have used with their families. Allow students to explore and practice for a couple of days with equipment.

4. Model photography skills by choosing a subject and take a series of photos. Create a three photo series, beginning with close-ups (zoom in to where the item might become unrecognizable) and then gradually pulling the frame out to where viewers can see part of the object, and then the final object with its physical placement with background.

5. Share these with the students. Have students write about these photos. They will also work with a partner to sketch the three perspectives of the photos.

6. Students will now take their own photographs of either an item in the classroom or outside the classroom. It can be anything from the blackboard to a flower. Have students examine the distances and different focus with their cameras. Then, have them print their own series of three photographs, beginning with close up, partial, and the final object.

7. Students will work in small groups and will explain their three perspectives by starting with the most close-up shot, partial (part), and the final object. Discuss the following ideas with students:
• Observations: Using your five senses, you must be specific and accurate, not relative, so that it means the same to everyone. Example: The burning bag smelled similar to rotten eggs or the burning bag smelled bad.
  - Which is a better observation and why?

• Inference: A possible explanation or thought based upon an observation. Example: When I left the movie theater and saw that the ground was wet, I inferred that it rained. When I left the movie theater, I smelled rain in the air.
  - Which is an observation?
  - Which is an inference?
  - How do these ideas relate to our photography activity?

8. Students will select one person from each small group to share back with the class. The student presenting will gradually show the images with different distances and perspectives until the class identifies the object.

9. For each presentation, have students who identified the object correctly share what clues helped them to make their identification. Was it a specific detail that suddenly became visible? Was it a better view of the background or surroundings? Was it a change in your perspective? How was it a change in your perspective?

10. Was your information based on an observation or an inference? Revisit the ideas of an observation and an inference. What are the similarities and difference between an observation and an inference?

11. Have a follow-up discussion on perspective:
   - What is it and how does it determine the way one gets information?
   - What physically changed from image to image? Is your information based on observation or inference?
   - How were the close ups different from the final shot?
   - Is your information based on observation or inference?
   - How can these ideas relate to photographs of our planet from space?

EXPLORE

1. Photo 1. Close Up View - Ask students to tell more about this photo.
   • What do you notice?
   • What does the image look like?
   • Where do you think it was taken from?
2. Have students use “Discussion Writing Frame” worksheet, then discuss their ideas in small groups.
   
   - What Earth components do you see in the photo?
   - What clues do you see that can help you understand more?

3. Photo 2. Partial View - Now ask students to tell about this photo using the same questions and procedure.

4. Photo 3. Full View - Finally, ask students to tell about this photo.
Image courtesy of NASA’s Earth Observatory.

- What do you notice?
- What does the image look like or where do you think it was taken from?
- Have students use “Discussion Writing Frame” worksheet, then discuss in small groups.
- What is the subject of this photo?
- What does the image look like or where do you think it was taken from?
- What Earth components do you see in the photo?
- What clues do you see that can help you understand more?

EXPLAIN

1. Since the agency’s creation almost 50 years ago, NASA has been a world leader in space-based studies of our home planet. Our mission has always been to explore, to discover, and to understand the world in which we live from the unique vantage point of space, and to share our newly gained perspectives with the public. That spirit of sharing remains true today as NASA operates 18 of the most advanced Earth-observing satellites ever built, helping scientists make some of the most detailed observations ever made of our world.

2. In celebration of its ‘great observatory in the sky,’ NASA is pleased to share the newest in its series of stunning Earth images, affectionately named the ‘Blue Marble.’ This new Earth imagery enhances the Blue Marble legacy by providing a detailed look at an entire year in the life of our planet. In sharing these Blue Marble images, NASA hopes the public will join with the agency in its continuing exploration of our world from the unique perspective of space.

3. Photographs produce a fantastic record of the Earth and its surroundings from hundreds of miles away. These photographers have to find out the best ways to take pictures of the Earth and are able to make discoveries about the types of things that can be viewed or identified from space. Taking photos in space is not just done for artistic merit, nor is it anything like taking from Earth. Photographers have to snap at speeds of almost eight kilometers per second. Share more about each photograph to students. They can read more at each website.

- Photo 1: Blue Marble: Close up of the Grand Canyon Region
- Photo 2: Blue Marble: Partial View highlighting many of the most popular photos taken during this mission. The photo (#AS17-148-22727) was taken on Dec. 7, 1972 from the Apollo 17 command module.

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• Photo 3: Astronaut photographs taken during the Apollo missions provided full-color images of Earth, and fostered a greater awareness of the need to understand our home planet. In 1972, from a distance of about 45,000 kilometer, the crew of Apollo 17 took one of the most famous photographs ever made of the Earth. This original 'Blue Marble' inspired later images of the Earth compiled from satellite data. In 2000, NASA data visualizers compiled an image of the western hemisphere using data from the National Oceanic and Atmospheric Administration including GOES-8 imagery, the NOAA's Advanced Very High Resolution Radiometer, and NASA/Orbital Science's Sea-viewing Wide Field-of-view Sensor.
• In 2002, NASA produced the Blue Marble, the most detailed true-color image of the Earth's surface ever produced. Using data from NASA's Terra satellite, scientists and data visualizers stitched together four months of observations of the land surface, coastal oceans, sea ice, and clouds into a seamless, photo-like mosaic of every square kilometer (.386 square mile) of our planet. In October 2005, the creators of the Blue Marble released a new version of the spectacular image collection that provides a full year's worth of monthly observations with twice the level of detail as the original. The new collection is called the Blue Marble: Next Generation.

**EXTEND**

1. Have students find a powerful photograph that changed their personal perspective on something and present their findings back to the class. Ask students why they selected their respective photo and share how this relates to people's first impressions of Earth from outer space.

2. Showcase students' photo projects as an art show in your school. You could display the series of photos of Earth (from close-up to the whole planet) with a description of the activity.

3. Have kids create watercolor images based on NASA's incredible satellite photos of the planet as a book titled "Earth as Art".

**EVALUATE**

1. Students work can be used to evaluate their ongoing progress and learning in meeting the objectives of this lesson. These include teacher observations and the “Discussion Organizers” for the photos in this lesson.

**ASSESSMENT OPTIONS**

**Formative Assessment**

• Students work may be used to evaluate their ongoing progress and learning in meeting the objectives of this lesson. These include teacher observations and the “Discussion Organizers” for both the teacher photos and the student photos in this lesson.

**Summative Assessment**

• Student learning during this lesson can be demonstrated in their completion of the “Final Analysis” worksheet and in their classroom discussion sharing of evidence and ideas.
CULTURE CONNECTION

Papahulilani

Papahulilani is the space from above the head to where the stars sit. It is inclusive of the sun, moon, stars, planets, winds, clouds, and the measurement of the vertical and horizontal spaces of the atmosphere. It is also a class of experts who are spiritually, physically, and intellectually attuned to the space above and its relationship to the earth.

The Polynesians of old conceived of the sky as a dome or inverted bowl resting upon the rim of the hemispherical earth. One legend compares the universe with a calabash, the cover of which formed the sky, while the bowl was earth, land, and sea, the juice became rain, and the seeds were metamorphosed into sun, moon, and stars.

DIFFERENTIATION

Emerging Learners

- Some students may need help with responding to discussion and analysis questions. Emerging learners may use more pictures and diagrams to show their understanding of the questions.

Advanced Learners

- Students may wish to create visuals and/or use technology to show their understanding of photographs. They may create and share presentations with other classes. These could include posters, flyers, newsletters, and/or PowerPoints.

English Language Learners

- Students may need help with the key vocabulary and might benefit from creating pictorial vocabulary notecards to use throughout the lesson. They may have more illustrations and diagrams with labels for sheltered English language development. Students may be given the option to share their findings verbally rather than in written form.

EXTENSIONS

© Bishop Museum, 2015.
• Have students find a powerful photograph that changed their personal perspective on something and present their findings back to the class. Ask students why they selected their respective photo and share how this relates to people’s first impressions of Earth from outer space.

• A megapixel is equal to one million pixels. The higher the resolution, the more pixels in an image and therefore the greater the image quality. An image file that is one megapixel (MP) can make a realistic photo print of 5 x 7 inches. How many pixels are there in one megapixel? How many pixels are there in two megapixel?

**STANDARDS**

**Next Generation Science Standards**

Crosscutting Concepts:

• Scale and Proportion - In grades 3-5, students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume.

• Patterns - In grades 3-5, students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions. Patterns can be used as evidence to support an explanation.

Science and Engineering Practices:

• Asking questions (for science) and defining problems (for engineering).
• Developing and using models.
• Planning and carrying out investigations.
• Analyzing and interpreting data.
• Using mathematics and computational thinking.
• Constructing explanations (for science) and designing solutions (for engineering).
• Obtaining, evaluating, and communicating information.

Disciplinary Core Ideas:

• 4-ESS2-1 Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.

**Common Core**

• RI.4.4 Craft and Structure - Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.

**Hawaii Content & Performance Standards III**

• SC.4.1.2 Differentiate between an observation and an inference.

**General Learner Outcomes**

• Self-directed Learner
• Community Contributor
• Complex Thinker
• Quality Producer
• Effective Communicator
• Effective and Ethical User of Technology

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ADDITIONAL RESOURCES

- *Earth as a System:*
  http://www.windows2universe.org/earth/ess1.html
- Hawaiian Astronomical Concepts:
  http://pvs.kcc.hawaii.edu/pdfs/Hawaiian_astronomy_I.pdf
- Perspective definition - Merriam-Webster:
  http://www.merriam-webster.com/dictionary/perspective
- NASA WaterColor Satellite Images:
  https://www.google.com/search?q=nasa+earth+as+art&espv=2&biw=1536&bih=777&tbm=isch&tbo=u&source=univ&sa=X&ei=ZVjjVKD9IIIL0oAS11YCoAQ&ved=0CC0QsAQ&dpr=1.25
- Student Dictionary:
  http://www.wordcentral.com/cgi-bin/student?book=Student&va=perspective

REFERENCES

http://www.edithkanakaolefoundation.org/current-projects/papaku-makawalu/


**Discussion Organizer**

**Writing Frame - Photo 1**

<table>
<thead>
<tr>
<th>Question</th>
<th>Think</th>
<th>Because</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the subject of this photo?</td>
<td>I THINK ….</td>
<td>BECAUSE ….</td>
</tr>
<tr>
<td>What does the image look like or where do you think it was taken from?</td>
<td>I THINK ….</td>
<td>BECAUSE ….</td>
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<td>What Earth components do you see in the photo?</td>
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<tr>
<td>What clues do you see that can help you understand more?</td>
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<td>BECAUSE ….</td>
</tr>
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</table>
**Discussion Organizer**  
**Writing Frame - Photo 2**

<table>
<thead>
<tr>
<th>Question</th>
<th>I THINK ….</th>
<th>BECAUSE ….</th>
</tr>
</thead>
<tbody>
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<td>I THINK ….</td>
<td>BECAUSE ….</td>
</tr>
</tbody>
</table>
## Discussion Organizer

**Writing Frame - Photo 3**

<table>
<thead>
<tr>
<th>Question</th>
<th>I THINK ....</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the subject of this photo?</td>
<td>BECAUSE ....</td>
</tr>
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<td>What does the image look like or where do you think it was taken from?</td>
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<td>BECAUSE ....</td>
</tr>
<tr>
<td>What clues do you see that can help you understand more?</td>
<td>BECAUSE ....</td>
</tr>
</tbody>
</table>
Photo 1

Image courtesy of NASA Ames Research Center.
Photo 2

Image courtesy of NASA/Goddard Space Flight Center Scientific Visualization Studio.
Image courtesy of NASA's Earth Observatory.
**Final Analysis**

What is perspective and how does it determine the way you get information?

How were the close-ups different from the final shot?

What physically changed from image to image? Why were the close ups different from the final shot?

How can these ideas relate to photographs of our planet from space?