Mission: Hubble
Equipping the Next Generation of Explorers!

Grade Levels: 6-12

Focus Questions: How does the Hubble Space Telescope add to our understanding of our universe? What are the characteristics of the astronomical phenomena detected by Hubble and how is this data attained through technology?

Instructional Objectives:

1. Students will learn that the universe is a system and that different parts of the system interact to form all that we observe in the universe.
2. Students will understand and describe the factors that contribute to star, galaxy, and nebula formation.
3. Students will analyze data from the Hubble Space Telescope.
4. Students will communicate their understanding by developing short stories outlining the lives of an astronomical phenomena.
5. Students will learn how technology contributes to our understanding of our universe.

National Standards:

Science:

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Understanding about science and technology
- Understanding of transfer of energy
- Understanding of motion and forces
- Understanding of origin and evolution of the universe
**Mathematics:**

- Understand patterns, relations, and functions: represent, analyze, and generalize a variety of patterns with tables, graphs, words.

- Use mathematical models to represent and understand quantitative relationships.
- Analyze change in various contexts.

- Understand measurable attributes of objects and the units, systems, and processes of measurement.

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

**Technology:**

*Social, ethical, and human issues:*

- Students will develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

*Basic Operations and Concepts:*

- Students are proficient in the use of technology.

*Technology Research Tools:*

- Students use technology to locate, evaluate, and collect information from a variety of sources.

*Technology Research Tools:*

- Students use technology tools to process data and to report results.

**Language Arts:**

- Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, and video) to gather and synthesize information and to create and communicate knowledge.

- Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts.

- Students use a variety of strategies to read for perspective.
**Geography:**

*The world in spatial terms:*
- How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.

*The world in spatial terms:*
- How to analyze the spatial organization of people, places, and environments on Earth’s surface.
INTRODUCTION

Mission: Hubble! YOUR STUDENTS can become researchers, NASA scientists and authors all at the same time!! NASA is the premier organization for detection and analysis of the objects that make up our universe and NASA researches stellar, galaxy, and quasar formation. This challenge integrates many curricular areas to ensure a complete understanding of Hubble discoveries, analysis of data, understanding of technology, and effective communication of understanding to others. The challenge contains appropriate scaffolding so that each task builds upon the previous task.

Your students will complete a month-long journey that includes consulting with a NASA scientist, assessing what they already know, generating questions, finding ways to answer those questions, analyzing NASA data, and then communicating their understanding.

The culminating activity allows students to demonstrate their understanding of a Hubble discovery by telling its story! Students will become a galaxy, nebula, quasar, or other object and describe their lives in the form of a story. As educators know, the best way to demonstrate understanding is to communicate and teach others. Classmates will be enthralled as each student relates their life as a Hubble discovery. They will have the chance to hear and discuss the lives of the other Hubble objects in the class. Students will also develop a unique method to present their stories to others outside of their class.
Mission Requirements

Pre Mission Requirements:

1. **Student Pre-Assessment:** Students will complete the “Hubble pre-assessment” that is attached or the online quiz at http://amazing-space.stsci.edu/news/archive/2008/03/think.php

2. **Student Engagement:** Show the NASA e-clip, “Our World: Changing Theories-The Scientific Method in Action” and have your students complete a Hubble KWL graphic organizer. http://www.nasa.gov/audience/foreducators/nasaeclips/ourworld/playlist.html

Objectives

**Objective One:**

- **Students can participate in the NASA Digital Learning Network, “Astronomy: Bringing the Past to Light”.** In order for students to understand the factors that affect Hubble discoveries, it is essential that students understand the timeline of astronomical history and telescope development. [http://dln.nasa.gov/dln/index.jsp](http://dln.nasa.gov/dln/index.jsp)

- Prior to participating in the videoconference, ask students to define a “telescope”. An effective strategy is work in groups of 3-4 and generate a definition of a telescope and three examples of objects detected by telescopes.

- While participating in the videoconference, students will continue to add to their Hubble KWL.

- Ask students to pay particular attention to the questions that they generated on their pre-activity KWL. As the NASA scientist facilitates the videoconference, are there any questions on their KWL logs that can be addressed?

**Objective Two:**

- **Students will use their KWL to complete a web-quest through the website “Telescopes from the Ground Up”,** [http://amazing-space.stsci.edu/resources/explorations/groundup/](http://amazing-space.stsci.edu/resources/explorations/groundup/)

- This is a student-directed web-quest. Students are in charge of their own learning. As students look for ways to answer questions on their KWL, think about what how telescopes contributed to our understanding of the universe. Also, they should think about how technology is used to gather data about our universe.

- As students answer their own questions, they will again have more questions. They will continue to fill out the KWL with evidence of their learning and with questions that they generate.
Objective Three:

- **Compare and contrast galaxies by using the NASA resource:** “Exploring with Light and Color. Specifically, students will complete Activity 2: Classifying Deep Field Objects

- **From the guide:**
  “Next, have students refer to the HUDF image provided on page 18. Students should take note of the numbered objects if they have not already done so. Ask students to describe the numbered objects and predict what they might be. Challenge students to devise a way of grouping or classifying the objects based upon observed similarities in their characteristics. Each student should create their own unique categories, and sort the 16 numbered objects into their categories accordingly”

- [http://www.nasa.gov/pdf/274682main_Light_and_Color_Educator.pdf](http://www.nasa.gov/pdf/274682main_Light_and_Color_Educator.pdf)

- Students will develop bar graphs based on the variables they used to classify the objects. Examples might include color, size, shape, and location.

- Hold a class discussion during which students share their findings with the rest of the class. Students can tape their graphs to the wall and compare the characteristics that they used for sorting with those of their classmates. Hold a class discussion around the methods that scientists use in defining classification systems.

Objective Four:

- **This is the culminating activity:** Students “adopt a Hubble discovery” and become that discovery! Students will write a short story from the perspective of an object using the knowledge that they gained in Objectives 1-3. Students will include a description of their life from birth to death. For example, a story might start, “I was born 10.5 billion years ago when the universe was relatively young. Conditions were just right for my conception as planetary dust and gas swirled and coalesced….“ Students should include scientific data, an analysis of that data, a timeline of their “life”, what humans know about them, and the unknowns of their life.

- The Hubble Discoveries website provides a plethora of information and images outlining Hubble discoveries:
  [http://hubblesite.org/hubble_discoveries/](http://hubblesite.org/hubble_discoveries/)

- Other websites include:
  [http://www.nasa.gov](http://www.nasa.gov)
  [http://www.nasa.gov/worldbook/artificial_satellites_worldbook.html](http://www.nasa.gov/worldbook/artificial_satellites_worldbook.html)
Hand out the “Adopt a Hubble discovery” instruction sheet to students. Allow two weeks for students to conduct research and synthesize their story.

Post Mission Requirements:

1. **Post-assessment:** Once the activity is complete and students have written their “life story”, hand out a post-assessment.

2. **Sharing of stories:** As a class, the students will devise a way to share their stories. This can include reading the stories to younger students, engaging in a literacy circle, forming a readers' theatre, designing science fair boards, or many other methods of scientific communication. The important thing to remember is that accomplished scientists not only analyze the data, but must also be able to communicate their thinking to others.

3. **Peer evaluation of stories:** You may either use the “Praise, Polish, Praise” model described below\(^1\) or use your own method of peer evaluation.

4. **Teacher evaluation of stories:** Use the attached rubric to select one story for submission to the challenge.

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\(^1\)The “Praise, Polish, Praise” model of peer evaluation allows students to give constructive feedback while validating the strong points of another student’s story. After a student has shared their story in the format that they choose, the audience raises their hands to offer feedback. The presenter calls on a student for feedback. The student presents their feedback by starting off with something that they felt was strong in the presentation, offers a suggestion for improvement, and ends with a positive validation of another portion of the story. An example may sound like this: “I think that you clearly explained all of the size and shape components of the galaxy, I was a little unclear as to how scientists determined your age, and I think that your visuals really helped me understand the difference between the categories of galaxies.” The final feedback is done by the presenter on their own presentation. The presenter will share feedback with the class about their presentation in the same “Praise, Polish, Praise” format.
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
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<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>First paragraph has a &quot;grabber&quot; or catchy beginning.</td>
<td>First paragraph has a weak &quot;grabber&quot;.</td>
<td>A catchy beginning was attempted but was confusing rather than catchy.</td>
<td>No attempt was made to catch the reader's attention in the first paragraph.</td>
</tr>
<tr>
<td><strong>Accuracy of Facts</strong></td>
<td>All facts presented in the story are accurate.</td>
<td>Almost all facts presented in the story are accurate.</td>
<td>Most facts presented in the story are accurate (at least 70%).</td>
<td>There are several factual errors in the story.</td>
</tr>
<tr>
<td><strong>Focus on Assigned Topic</strong></td>
<td>The entire story is related to the assigned topic and allows the reader to understand much more about the topic.</td>
<td>Most of the story is related to the assigned topic. The story wanders off at one point, but the reader can still learn something about the topic.</td>
<td>Some of the story is related to the assigned topic, but a reader does not learn much about the topic.</td>
<td>No attempt has been made to relate the story to the assigned topic.</td>
</tr>
<tr>
<td><strong>Components of the Report</strong></td>
<td>All required elements are present and additional elements that add to the report (e.g., thoughtful comments, graphics) have been added.</td>
<td>All required elements are present.</td>
<td>One required element is missing, but additional elements that add to the report (e.g., thoughtful comments, graphics) have been added.</td>
<td>Several required elements are missing.</td>
</tr>
<tr>
<td><strong>Background sources</strong></td>
<td>Several reputable background sources were used and cited correctly. Material is translated into student's own words.</td>
<td>A few reputable background sources are used and cited correctly. Material is translated into student's own words.</td>
<td>A few background sources are used and cited correctly, but some are not reputable sources. Material is translated into student's own words.</td>
<td>Material is directly copied rather than put into students own words and/or background sources are cited incorrectly.</td>
</tr>
<tr>
<td><strong>Hubble Discover Analysis</strong></td>
<td>The relationship between the Hubble Space Telescope and the discovery is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if these factors were changed.</td>
<td>The relationship between the Hubble Space Telescope and the discovery is discussed and trends/patterns logically analyzed.</td>
<td>The relationship between the Hubble Space Telescope and the discovery is discussed but no patterns, trends or predictions are made based on the data.</td>
<td>The relationship between the Hubble Space Telescope and the discovery is not discussed.</td>
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<tr>
<td>Data</td>
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<tr>
<td>Professional looking and accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.</td>
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<tr>
<td>Accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.</td>
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<tr>
<td>Accurate representation of the data in written form, but no graphs or tables are presented.</td>
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<tr>
<td>Data are not shown OR are inaccurate.</td>
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<table>
<thead>
<tr>
<th>Scientific Concepts</th>
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<tbody>
<tr>
<td>Report illustrates an accurate and thorough understanding of scientific concepts underlying the mission.</td>
</tr>
<tr>
<td>Report illustrates an accurate understanding of most scientific concepts underlying the mission.</td>
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<tr>
<td>Report illustrates a limited understanding of scientific concepts underlying the mission.</td>
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<tr>
<td>Report illustrates inaccurate understanding of scientific concepts underlying the mission.</td>
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Mission: Hubble! Pre-assessment

Please complete the following to your best ability. Your answers will not reflect upon any part of the scoring of your final project.

1. What conditions must exist for humans to image accurate pictures of astronomical phenomena?

2. Name and describe the categories of galaxies.

3. Describe how is technology used to study astronomical phenomena?

4. Briefly describe the history of telescopes.

5. How is Hubble different from past telescopes?
**Mission: Hubble! Post Assessment**

Your pre-assessment will be handed back to you. Review your earlier answers and then complete each of the following items.

1. Analyze your pre-assessment answers. What parts of your original answers indicated clear understanding of the concept addressed?

2. Write additional information for each answer based on the knowledge and skills you obtained during the challenge.

3. Construct a diagram for each question that shows visually that you understand the concept.

4. What further questions could you ask based on your new knowledge?
**Mission: Hubble! Inquiry KWL**

As you probably already know, KWL stands for K = “What I already know”; W = “What I want to know”; and L = “What I learned”. Before watching “Our World: Changing Theories-the Scientific Method in Action”, think about what you already know about telescopes. Jot these facts down in the “K” column of your KWL. As you watch the video, write down new information that you learn in the “L” column. Undoubtedly, you will have further questions as you watch the video. Good science always generates more questions! Write down questions that you have about telescopes and Hubble in the “W” column. You will continue to fill out your Hubble KWL as you complete this challenge.

<table>
<thead>
<tr>
<th>K = What I already know</th>
<th>W = What I want to know</th>
<th>L = What I learned</th>
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Be the discovery—Feel the power!!!

This is your chance to shine! You will write a story about a Hubble discovery’s life as if you were that galaxy, star, nebula, quasar, or ?. Think like your object….you will need to include the following information in your presentation:

1. Who are you? When were you born? Where were you born?
2. What factors contributed to your birth?
3. When were you imaged by Hubble?
4. What data is significant? Include things like distance from Earth, chemical composition if known, nearby objects, conflicting data.
5. What is your category (if you are a galaxy) and what does that mean?
6. Who are your brothers and sisters (objects formed around the same time)?
7. Analyze the factors that contributed to your existence. Be sure to quote specific data. What might have happened if any of those factors changed?
8. What technology enabled people to learn about you? How was this technology used?
9. What path did your life take?

You will need to use at least one graph and one picture in your story.

Be scientifically accurate and most of all have fun! Remember, you ARE the Hubble discovery!
Extensions

Teachers will find that students will desire extensions and additional opportunities to explore Hubble and mapping the universe. Possible extensions include:

1. Compare and contrast other telescopes with Hubble. Choices may include Spitzer Space Telescope, WISE Telescope, Chandra Telescope, and Compton Gamma Ray Observatory. These telescopes utilize different wavelengths and together, provide a comprehensive view of the universe. Students can place the telescopes along a wall-size electromagnetic spectrum chart. The possibilities are endless—ranging from researching discoveries made by each telescope, to building models of the telescopes, to comparing areas of overlap. Several websites are of use for this extension:


http://wise.ssl.berkeley.edu/mission.html

2. Utilize a lithograph of Hubble Space Telescope to construct a question and answer game for students at the end of the entire Hubble Mission! Lesson. Teachers are familiar with game-show formats and can use their favorite format. Possibilities include a concentration style game, Jeopardy, or Pictionary. The lithograph can be found at:

http://amazing-space.stsci.edu/resources/print/lithos/hst_litho.pdf

3. Advanced students can download images taken by Hubble and compare these to images taken by other telescopes utilizing different wavelengths of light. For example, many of Hubble’s spectacular images are in visible light. Other telescopes utilize different wavelengths that give a different, yet complementary picture. Students can download a Hubble image and “blink” it with an image of the same object viewed through a different telescope and describe the differences. Advanced students can use graphical analyses programs such as ImageJ to measure phenomena captured in each image. The following website contains many Hubble images:

http://hubble.nasa.gov/multimedia/astronomy.php

4. Students can build a model of Hubble by referring to the following site:

http://hubblesite.org/the_telescope/hand-held_hubble/