Hubble Space Telescope
9th-12th grades, 45 to 60 minutes

Notice

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Objectives

Students will learn:
- Why the HST was put into orbit;
- Some facts about the HST;
- Some developments and new information gained by the HST; and
- What scientists plan for the next orbiting telescope (the James Webb, a.ka. The Next Generation Space Telescope or NGST).

Materials needed

- Flashlight
- Light and laser pointers
- Earth on a stick (globe with handles at north and south poles to represent axis)
- Altered goggles to simulate Earth's atmosphere *(Note: Cut pieces of a shower curtain liner and attach them to the lenses, or smear the goggle lenses with a thin layer of petroleum jelly. Cover the petroleum jelly with plastic wrap, then tape the plastic wrap in place.)*
- 16 laminated HST quiz sheets
- 16 Vis-a-vis pens or other water-soluble, thin-tipped markers
- At least one unlaminated copy of HST quiz sheet with correct answers circled
- Digitarium® planetarium system set for the current date and time, with atmospheric effects and landscape turned on

I. Introduction *(10 minutes)*

A) Inform students that you'll be learning about the Hubble Space Telescope (HST) today. What do the students already know about the Hubble?

B) Inform students that they'll be taking a short quiz about the Hubble. It will not be graded, and they will be working with a partner. There are eight questions, and they will have about five minutes to respond. Pass out quizzes and water soluble markers, and make partnerships. ***[****The quiz follows the body of this lesson; answers are on the final page of this lesson plan.****]***

C) When all are done with the quiz, review the answers. ***[****Be sure to review/define the term 'atmosphere,' since it will be important later on.****]*** Did any of the answers surprise them? Inform students that you're leaving a copy of the quiz and the answers with their classroom teacher.

D) Inform students that you'll be going inside the planetarium to learn more about the HST. Review rules and expectations, then enter.

II. The Current Night Sky *(5 to 10 minutes)*

A) *[When all are in and seated, speed up time to let the sun set—point out that Earth's atmosphere gives us the brilliant sunset colors--then turn off atmospheric effects and landscape.]* Inform them that they're seeing the sky as it would look at about ____ p.m./a.m. tonight. What do they notice? Do they see constellations they know? Interesting objects?

B) Tell students that it will be easier for everyone to figure out which direction to look in if we know where the directions are in the planetarium. When you're observing the sky of the northern hemisphere, there's one star in particular that will help you find your directions: Polaris, the north star. Allow a student to point out the Big Dipper with a light pointer, then show how to use the 'pointer stars' to find Polaris.

Polaris always shows us north due to its being in line with Earth's north pole ***[****hold up Earth on a stick with the north pole pointing toward Polaris****]***. Once we know which way is north, we can figure out the other directions. *[Review the directions, then turn on the cardinal points.]*

III. Distortion by Earth's Atmosphere *(10 to 15 minutes)*

A) Ask students to remind you why the HST ***[****show image of HST from Lesson Media DVD or USB drive****]*** is in orbit and not on Earth. You'll be doing an activity to simulate how Earth's atmosphere distorts what we see. You'll

show an image on the zenith, and then a volunteer will describe what s/he sees while looking through 'Earth's atmosphere.' Earth's atmosphere will be simulated by a pair of lab safety goggles with altered lenses. Those who aren't looking through the 'atmosphere' are not allowed to give hints to the person who is.

Ask for a volunteer to look and describe, have him/her put on the goggles, then display the slide. *[There are images for use with this activity in the folder labeled 'Atmosphere images' in the HST directory on the Lesson Media DVD.]* Ask questions such as, 'What colors do you see? Any shapes you recognize? Can you tell what it is?' When the student is done describing the image, have him/her take off the goggles to see the image clearly. Repeat one or more times with different students and images. Discuss any challenges the students had with this activity.

B) Ask students if they have ever noticed stars twinkling. Do they know why that happens? Right, Earth's atmosphere bends the light from the stars. More accurately, shifting pockets of gases in Earth's atmosphere bend the light. Because the HST is outside of Earth's atmosphere, it doesn't have to deal with the distortion that ground-based telescopes do, which allows it to image objects so clearly. Our atmosphere also absorbs some kinds of light, such as gamma rays, x-rays, infrared light, and a great deal of ultraviolet light. The HST has instruments that use some of these types of light for imaging. ***[****Show the image of the electromagnetic spectrum in the How_Do_We_Know folder and briefly discuss the relationship between wavelength and energy level.****]***

IV. Some HST Discoveries *(15 to 20 minutes)*

A) One of the main tasks of the HST is to help scientists determine the age of the universe. How can it do that? By studying light from objects billions of light years away. The HST imaged some very distant galaxies in 1996, in an image known as the Hubble Deep Field (HDF). The HST was focused on what appeared to be an empty patch of sky here, near the handle of the Big Dipper ***[****make sure DSO labels are turned off and point to the location of the HDF****]***. This is what the HST found there ***[****turn on DSO labels and zoom in on the HDF****]***. Some of the galaxies in this image are over 10 billion light years away.

Another way to think about that is that when the HST images something 10 billion light years away, it's actually looking back in time 10 billion years. Why is that? Because in order for something to go a certain distance, it has to put in time. Even though light travels faster than anything else we know of, it still needs time to leave its source and end up somewhere else. How can looking back in time over 10 billion years help us learn about our universe?

B) Choose as many other images as you have time for, showing the relevant part of the sky and a close-up picture of the object. ***[****Alternatively, you*

can use the HST Images folder on the Lesson Media DVD or USB drive.] Ask students for and/or explain the significance of the discovery. *[See separate documents for information on pictures in the database, as well as where to find more HST pictures, discoveries, and information.]*

C) Discuss the future of the HST, including factors involved in the decision whether or not to continue its maintenance. If the students had to decide whether to continue servicing the HST, what would they do? Introduce the James Webb Telescope, scheduled for launch in 2013 *[show the image].* Discuss how it will be different from and similar to Hubble. See background for information resources.

D) **OPTIONAL:** Discuss the other three telescopes currently or recently in space, showing the slides of each. These images are found in the "Space_Telescopes" folder in the "How_Do_We_Know" directory. Why would we need all these different telescopes instead of just one?

E) Prepare students for exiting the planetarium.

V. Conclusion *(5 minutes)*

A) Review the concepts of the lesson, including: why the HST is in orbit; some significant discoveries; etc. Encourage students to keep an eye out for news about the HST.

Hubble Space Telescope (HST) Student Quiz

Circle one answer for each question.

1) How far above Earth does the HST orbit?

a) 50 miles b) 375 miles

c) 1,000 miles d) 2,500 miles

2) When was the Hubble launched?

a) June, 1966 b) September, 1971

c) April, 1990 d) December, 1982

3) The HST is the largest telescope ever built.

True False

4) How does the Hubble Space Telescope help us look farther than ever before?

a) with mirrors b) with lenses

c) with mirrors and lenses

5) What is the primary reason the HST was put into space?

a) to be beyond Earth's atmosphere and its distortion/light absorption

b) to avoid daylight on Earth

c) to get closer to objects it's imaging

d) to save money on staffing costs

6) The HST can detect objects how many times fainter than the human eye can?

a) 1,000 b) 100,000

c) 10,000,000 d) 10,000,000,000

7) The Hubble Space Telescope left Earth inside a space shuttle.

True False

8) How big is the HST? About the size of...

a) a Volkswagen beetle b) an oven

c) a school bus d) a football stadium

Answers to HST Quiz

1) **B**

2) **C**

3) **FALSE**

4) **A**

5) **A**

6) **D**

7) **TRUE**

8) **C**