SEEING LIKE AN ASTRONOMER

grades 4–6

Objective

Students will begin to understand the role of observation as a means of gathering scientific data and will experiment with ways of looking (with the naked eye, under different circumstances and from different perspectives, and with aides such as binoculars and a digital map).

Introduction

There are many different kinds of scientists, and many different ways to conduct scientific studies. Some scientists, like chemists, conduct experiments to help them make new discoveries about the particles and chemicals that everything is made of. Other scientists, like geologists, study the forces and materials that make up the Earth and learn by exploring water and rocks and also by digging into the ground. Astronomers are a little bit different. Because they study the sky and objects that are very far away, they cannot conduct the same kinds of experiments nor can they dig into things. They have to learn about stars and other objects in the sky by observing. They look very carefully and try to learn as much as they can, often just by what they can see.

In this activity, students will become familiar with the idea that some scientists (such as astronomers) use observation as a primary means to explore the world and pursue the answers to questions. By conducting their own observations under a variety of conditions, they will learn about the different tools and strategies that astronomers employ to enhance their powers of observation.

Requirement

The American Museum of Natural History's "Digital Universe" program, including the Partiview software and Milky Way Atlas data set. The software can be downloaded at http://www.haydenplanetarium.org/hp/vo/du/index.html.

Additional Materials

Binoculars
LCD projector (optional)
Printouts of pictures of observatories and telescopes (see pages 7-10 for samples)

Additional Resources for Educators

Other astronomy activities are available in the "Resources for Learning" section of the American Museum of Natural History Website:
http://www.amnh.org/education/resources/index.html.

Procedure

Part One: Looking with the Naked Eye

1] Introduce the idea that different kinds of scientists use different kinds of tools and methods to collect data in order to learn more about the subject they are studying.

Explain: Today you are going to learn to think like astronomers — scientists who study the sky and the universe and learn through observation.

2] Arrange students on one side of the classroom, having them look out on another part of the room (or out of a window onto something off in the distance). Bring their attention to a "still life" or scene that you have set up and then covered with a "veil" so that it cannot be seen until you uncover it. The still life should be an observable scene made up of multiple objects. For example, you could set up a pair of chairs at an angle to one another, a mug full of pens on one of the chairs, a bowl of fruit on the other, a pair of shoes under the chair, a rolled-up map leaning against the other, etc. Situate the still life in a setting that is difficult to observe for a number of reasons. Students should be able to see the still life, but with certain obvious handicaps stemming from its being:
a) far away;
b) poorly lit; and
c) obscured by intervening objects.

[The students' viewing of the still life may be done in a number of ways. Students could be across the classroom from the still life; the still life could be placed at the end of the hall and students could stand just outside the classroom door; the entire activity could be conducted in the schoolyard, etc. The only requirement is that students be sufficiently far away from the still life — and that here be sufficient difficulties posed by lighting and intervening objects — so that students will understand some of the challenges involved in gathering data through observation.]

3] Make sure each student has a pen or pencil and a piece of paper.

4] Tell students they have three minutes to describe all they can see of the still life on paper.
Explain: Include as much detail as possible in your descriptions; for example, include color, size, shape and texture of the items.

5] Unveil the still life and time students' observation period. When the three minutes have elapsed, tell students to put their pens and papers down.

6] Have students return to their seats to discuss the results of the first round of observation. (This could be a whole-class discussion or students could break into groups to compare observations.)
Ask: What did you see? What were you able to see compared to what others in the class observed? Who saw the most? What kinds of details did you include in the items you listed? Who saw something that nobody else saw?

7] Now, as a class, discuss the following prompt: Describe what you would need to change in order to observe more detail.
Ask: What handicaps would you have to remove in order to record more detail? What would have enabled you to see more? Among the possible answers: "if we were closer to the still life

we were observing," "if there was more light on the still life," "if we had more time to observe," and "if we had binoculars."

8] Based on student suggestions for ways to improve their powers of observation, develop a set of concrete options from which they will choose for the next round of observations. Each option should represent **one** improvement from the first round of observations. For example, students might be able to choose between standing three feet closer to the still life, observing the still life for twice as long, having an additional lamp placed near the still life to better illuminate the objects, or using binoculars. The options should be balanced so that they seem likely to confer approximately the same advantage (so, standing right next to the scene for 10 minutes should not be an option).

Part Two: Looking with Modified Observation Techniques

9] Have students choose one of the new observation options (encouraging a roughly equal number of students for each one).
Explain: Each group is going to observe a second still life comprised of different objects. This time, each of your groups will get to use one of the special observation options we discussed as a class. Group A will get to stand 10 feet closer than any other group; Group B will get to shine a light on the still life while they observe. Group C will have twice as much time as the other groups; etc. Your job is to compile a complete list of all that you see, noting as much detail as possible.

10] Give each group a turn to observe the new still life (Ideally, this second still life is located outside of the classroom allowing only one group to view it at a time.) After each group completes its observations, the students can meet and compile a list of everything they saw while the other groups take their turns.

11] Once all the groups have taken a turn, have each group present its observations to the class. Write each group's list on the board so that everyone can see what data each group collected.

12] Conduct a class discussion on the ways that the different observation options affected what students saw.
Ask: What kinds of things did each group see, and what advantages were conferred by each group's modification? What did it mean to have more time, more light, to be closer with fewer intervening objects, or to have a tool that magnified objects as you were viewing?

Part Three: How Astronomers Work

13] Begin a conversation about astronomers and what they do in the course of their work.
Explain: Each of the modifications that the different groups employed represents an element of the strategies that real astronomers use to help them gather more and better information about the stars. Like the group that used binoculars, astronomers use tools, such as telescopes, that allow them to see more, and better, than they can see with just their eyes. Although astronomers cannot put a lamp in outer space to see the stars better, they do try to gather the light that stars produce. The longer they look at a star, the more of its light they can see. Like the group that moved closer to the still-life, astronomers sometimes put their telescopes on

mountains or even in space (e.g. the James Clerk Maxwell Telescope in Hawaii and the Hubble Telescope) to reduce the obstructions created by light pollution, clouds, and the Earth's atmosphere.

14] Show students a view of the "night sky" in the Digital Universe. (If possible, project the computer screen onto a wall using an LCD projector.) Turn on the constellation lines [constel] and look around the sky by flying with the left mouse button. Point out some familiar constellations and the Milky Way.
Explain: This is a view of the night sky, showing the same stars you would see if you were to go outside on a clear night (and away from city lights).

15] Return to the beginning position and point out the constellation Taurus. Turn off the constellation lines [constel] and turn on the open clusters [oc], pointing out the Pleiades.
Ask: What do you see (while pointing to the Pleiades)?
Explain: This little grouping of stars is called the Pleiades and is located about 380 light-years from Earth. The stars are also known as the "Seven Sisters," from Greek Mythology. Many of the world's cultures have stories about the Pleiades. To see these stars for yourself, go out on a clear night when Taurus is up and look for a small, faint clustering of stars. With today's light pollution, most people can only see six stars; to see the seventh, you need darker skies. If you are in an area where sky is really dark, you may eight or nine stars.

16] Show students a picture of a terrestrial telescope. [See page 7.]
Explain: This is an example of a telescope that scientists use — just as one groups used a pair of binoculars. This telescope is located in Flagstaff, Arizona.
Ask: What do you know about telescopes?

17] Show students a terrestrial telescope's view of the Pleiades. [See page 8 for a sample.]
Explain: If scientists use telescopes they can see a lot more than if they only look with their eyes. A small telescope reveals that the Pleiades contains many hundreds of fainter stars. You also see the remnants of the nebula in which the stars formed. This image was taken over an 85-minute period.
Ask: How is this picture different from what we see on the screen?

18] Fly toward the Pleiades in the Digital Universe software and show students a picture of the Hubble Telescope. [See page 9.]
Explain: Scientists also have put a telescope into space, which helps them get a clearer view.
Ask: What do you know about the Hubble Telescope?

19] Show students an image of the Pleiades taken by the Hubble telescope. [See page 10 for a sample.]
Explain: If scientists look at the Pleiades with a telescope that's outside the Earth's atmosphere, they can see even *more*. According to the Hubble Site news center, "NASA's Hubble Space Telescope has caught the eerie, wispy tendrils of a dark interstellar cloud being

destroyed by the passage of one of the brightest stars in the Pleiades star cluster. Like a flashlight beam shining off the wall of a cave, the star is reflecting light off the surface of pitch black clouds of cold gas laced with dust. These are called reflection nebulae." (Additionally, an animation of multiple images of the Pleiades is available at http://heritage.stsci.edu/2000/36/supplemental.html#animation.)
Ask: How is this picture different from the others?

20] Return to the view of the Pleiades in the Digital Universe software, and fly out towards the Pleiades and directly into the cluster of stars.
Explain: Astronomers can learn a lot about the universe using the light we observe. This model was created using what we were able to measure and figure out about the brightness of stars and their distances from the Earth by studying the light that we receive here on Earth. So, even though we have never traveled outside of our own solar system, astronomer were able to build a model of what the galaxy would look like if you were to fly to the Pleiades.
Combining what we can see in the light from the stars with what we know about how things work in laboratories on Earth, astronomers can also answer questions like "How big are the stars in the Pleiades?" , "How old are they?" and "What are they made of?" And the more new ways they find to observe things — like you have done in this activity — the more they will learn about the stars.

Relevant Standards

From the National Science Education Standards: Science Content Standards: 5-8

Content Standard A: Science as inquiry.
As a result of activities in grades 5–8, all students should develop: abilities necessary to do scientific inquiry; understandings about scientific inquiry…. Fundamental abilities and concepts that underlie this standard include:

- [Ability to] use appropriate tools and techniques to gather, analyze, and interpret data.
- [Ability to] think critically and logically to make the relationships between evidence and explanations.

Content Standard E: Science and Technology.
As a result of activities in grades 5-8, all students should develop understanding of: abilities of technological design.

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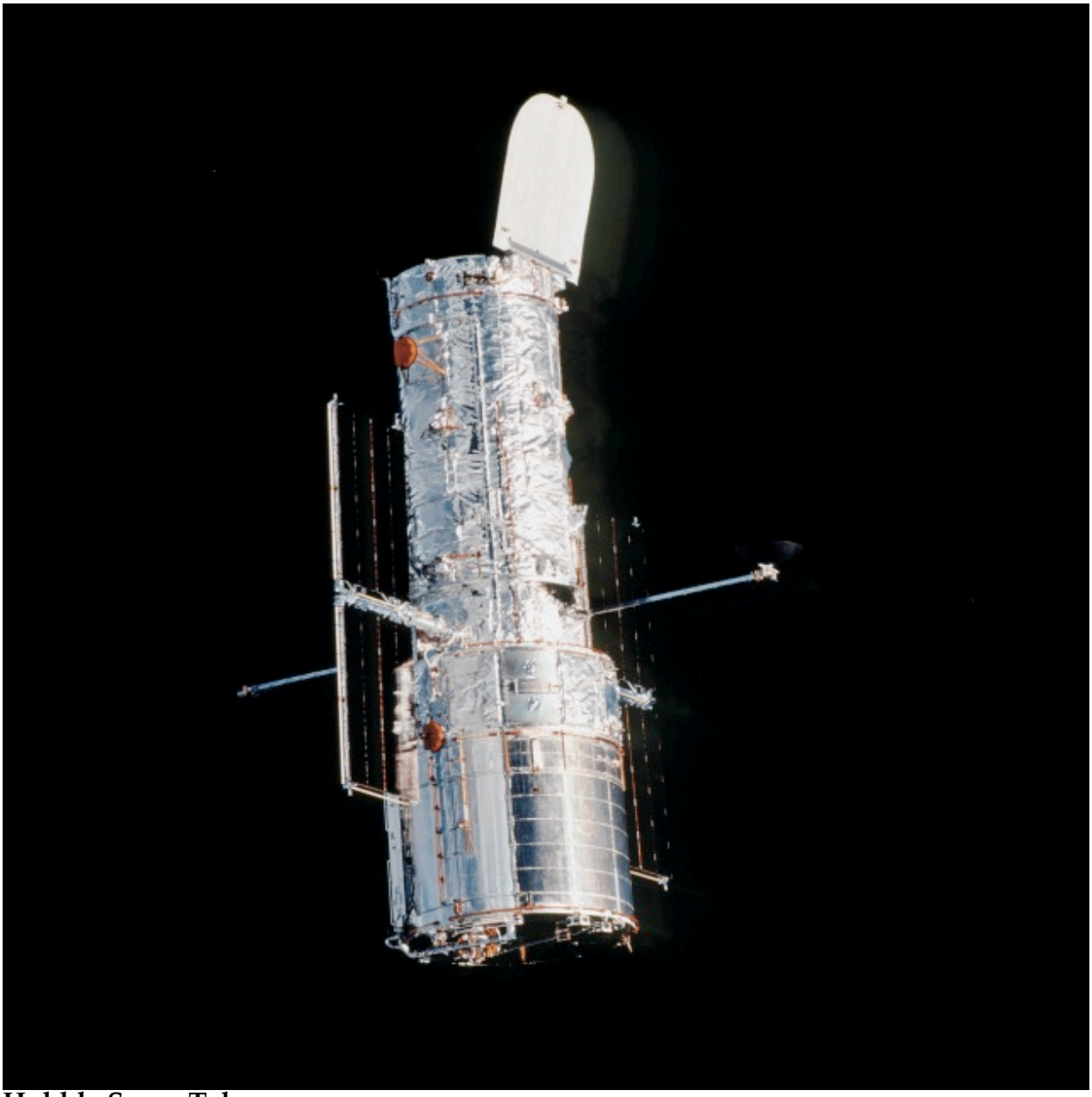
0.9m Telescope at Kitt Peak National Observatory
Image credit: NOAO/AURA/NSF
Available at: http://www.noao.edu/image_gallery/html/im0280.html

The Pleiades
Taken with the 0.9 m telescope at Kitt Peak National Observatory
Image Credit: NOAO/AURA/NSF
Available at: http://www.noao.edu/image_gallery/html/im0136.html



Hubble Space Telescope
Taken by astronauts on board the space shuttle after the 2002 servicing mission.
Image Credit: NASA
Available at: http://spaceflight.nasa.gov/gallery/images/shuttle/sts-109/html/sts109-730-027.html

Reflection Nebula in the Pleiades
Available at: http://hubblesite.org/newscenter/archive/2000/36/image/a