Satellite Eyes
Lesson Plan

Overview

In Satellite Eyes, students will explore the ways in which satellite images provide details of the Earth's surface. By using lenses, satellites are capable of taking digital images of the Earth from space that vary in detail (i.e. resolution) and breadth. In this activity, the action of satellites is explored, as cameras are used to zoom in on a plot of ground without changing the distance between the camera and the ground. Students will build upon previous understandings of lenses, surface area and field of view developed in the lessons Playground Zoom and Scenes of the Earth. Students will learn about the use of lenses as a means of magnifying the field of view seen by a satellite.

Suggested Lesson Sequence	Please see the Global Visions module description.
Lesson Level	Intermediate
Science Connections	· Students will explore the use of lenses as a way to magnify images
Math Connections	· Students are introduced to the notions of similarity, proportional reasoning, and scale factor as they examine image magnification
Technology Connections	· Students will be introduced to the ways in which cameras magnify images · Students will be introduced to digital cameras · Students will participate in the saving, downloading, retrieval, and computer manipulation of digital images taken from a digital camera · Students will observe actual satellite imagery in which magnification had been used to provide greater depth of detail
Lesson Assessment Tools	· Assessment and Standards Table (Word) · Assessment Activity Description · Authentic Assessment

Materials

Powerpoint Reader (Windows / Mac) and Adobe Reader
Satellite Eyes activity slideshow (Powerpoint)
Satellite Eyes assessment slideshow (Powerpoint)
Magnifying glasses
Digital camera (desirable) with computer download capability OR a film camera with a zoom lens (not as desirable, but can be used if a digital camera is not available)
Computer (projection device for showing images is desirable)

About the slideshows: These slideshows are not meant for students to read through on their own. They are intended to be viewed together, to outline and illustrate a discussion of the lesson's themes, led by the teacher. You might have a different student read each slide's text.

Vocabulary

Resolution: a characteristic of an image which dictates whether or not objects can be resolved. Objects can be resolved easier when image resolution is high.
Resolve: the ability to visually separate two or more objects on an image.
Scale: As a verb, to increase or decrease the size of something according to a fixed ratio.

Vocabulary Note: students will likely be unfamiliar with other vocabulary presented in this lesson. This is done intentionally, to spur additional conversations and discussion about these words and their meanings. Encourage your students to ask about words they may be unfamiliar with.

Procedure

I. Assessing Prior Knowledge

The Playground Zoom and Scenes of the Earth lessons are excellent precursors to this lesson. Begin a classroom discussion that refreshes students' memory about the fundamentals of topics such as lenses, viewing area, and detail. You may also wish to ask students to discuss their previous experience with using a camera, taking note to ask whether students have ever used the "zoom" feature on a camera to take close-up photos of a particular landscape or object.

II. Contextual Preparation

This lesson explores the concept of how well objects can be detected, or resolved, using images made by our eyes or by a camera. To set the context of this lesson, and with your back

to the class, make two extremely small marks on the board—so small that the students cannot tell that there are two marks. Now, step aside and have the class imagine that they are flying in a hot air balloon and that the board is their view of the ground. Ask if the students can see the marks, and if so, how many marks are there. Now, draw two new marks, approximately 10 times bigger than the first two and separated by about 10 times more space. Tell students that if they were an eagle flying next to the balloon, this is what they would see on the ground! If those were two small mice, the eagle might have just found its lunch!

Birds such as eagles, hawks, and owls have fantastic eyesight that is 8-10 times more powerful than humans. As a result, they can *resolve* objects on the ground surface 8-10 times better than humans. They must have excellent eyesight in order to survive. Now mention that using special lenses, humans can also look at the ground to a certain level of detail, or *resolution*, from outer space. Scientists, weather forecasters, military generals, and even real estate agents use these images for many purposes, including how to understand patterns on the Earth and how these patterns change through time. Like birds, different satellites have "eyes" of different resolution.

Now, use a computer (with projector if possible) to view the Satellite Eyes Slideshow Activity as a class. In this slide show activity, students view a series of images of land areas that were taken by various satellites. Now, ask the students to discuss how satellites might be able to gather such images at different resolution.

III. Student Activities

1. After sharing ideas from the discussion, inform the students that satellites (like cameras) use lenses to take pictures of the Earth. Some satellites are like "eagles", with high resolution cameras, and some have lower resolution cameras. Students should be given an opportunity to informally explore how lenses work by using a magnifying glass. After passing out magnifying glasses, students should be instructed to "zoom-in" on a particular object on the floor (perhaps a penny, pencil, paperclip, etc.) by looking through the glass. Students should discuss the ways in which the magnifying glass alters the appearance of the image under investigation. If possible, magnifying glasses of different strengths should be distributed and discussed.

2. Because cameras also use lenses to magnify images, they can be used to mimic the operation of a satellite. To model this, the class should be taken outside and allowed to select a particular plot of ground that may have some defining feature that could become the focus of a series of pictures (a flower, stone, plant, etc.). Once the plot of ground has been chosen, the teacher or student should take two or three pictures without changing the position of the camera. On each successive picture, zoom in on the object. (You should use the zoom feature of the camera. With some cameras, you may need to attach an additional lens to the exterior of the camera to magnify images.)

3. As an additional or alternative activity to going outside, you and your students may also take a picture of a class globe. Hold the camera about 0.5 meter from the globe, focus on a region, and snap a picture. Without moving the camera, zoom in on the same region and snap another picture. This activity will simulate a satellite taking photos from space.

4. The images should then be downloaded to the computer (or taken to a film processing shop to be developed) and either projected or printed for analysis and discussion. Referring to the questions below, students should discuss what they see in each picture.

Questions for Class Discussion:

1. How do the pictures compare? Are there details that are visible in one picture but not the other? What effect does decreasing the field of view have on the amount of detail visible in the photo? Which photo has the highest resolution?

   Students should be able to see more details in pictures that are taken with higher magnification. However, the field of view in magnified pictures is smaller. Photos with the highest resolution have the highest amount of detail that can be seen.

2. Does the actual size of the photograph change?

   No. Although the size of the photo is the same, the field of view and objects in the magnified image are scaled proportionally. The field of view decreases, while the resolution of the image increases.

3. Does the surface area in the field of view (picture) change? How might you approximate the amount of area captured in each of the pictures?

   Yes, the field of view gets smaller as the camera zooms in. You could use yarn or a computer-drawn rectangle to outline the perimeter of the field of view for each magnification and compute the area with tiles, as in Scenes of the Earth.

4. How do satellites "zoom in" on particular features on the surface of the Earth?

   Satellites use digital cameras to take images of the Earth. Satellites have different lenses on their cameras to achieve various resolutions and zoom in on particular features.

5. When a satellite does achieve a closer look at the Earth, what happens to the amount of surface area captured in the image compared to a satellite that takes images in less detail?

   The surface area or field of view that is imaged is smaller when the detail increases.

6. What happens to the level of detail that can be observed and described when the camera

zooms in on a particular area?

The level of detail increases.

7. What are some possible uses of these more detailed satellite images? Why might scientists want to zoom-in on a particular region of the Earth? Why might scientists want to examine the whole Earth in less detail?

   With more detailed, high resolution, images, scientists can learn about changes that happen over smaller areas, such as when a new house or building is built, or to understand how the water level of a lake may be changing. However, because high resolution images are small in extent, it takes longer for the entire Earth to be imaged. Several weeks (at 30m resolution) to several months (at 4m resolution) are required for a satellite to image the entire Earth at high detail. However, the Earth can be imaged several times per day at lower (250m) resolution.

Through this discussion, students will learn that various satellites can be used to examine the Earth in higher or lower resolution, depending upon the type of camera they possess. Students should be able to explain how lenses can duplicate the effect of moving further away or closer to an object. Students should also understand that although the area *of the image* produced by the camera (satellite) can remain the same, the amount of surface area (the actual land area of the Earth that appears in the picture) may have changed.

IV. Assessment

Show students the Satellite Eyes assessment slideshow on a computer. This slide show gives examples of two satellites that image the Earth, along with examples of images from each. The IKONOS imager takes images of very high (1-4m) resolution, but it would take many months for this satellite to cover the entire globe with images. The Landsat satellite takes images of good (30m) resolution and it takes 16 days for it to image the entire Earth.

Lesson Extensions for Authentic Assessment

· Students could be encouraged to explore more deeply issues of similarity and proportion in relation to the magnification of objects. In particular, students could explore how magnification preserves proportionality. Students could create a shape (triangle, rectangle, or something more complex) and then measure various attributes like the length of sides and the measures of angles. The object can then be placed on the overhead projector. When turned on, the projector will cast a shadow on the overhead screen that is larger than, as well as proportional to, the original object.

  Students can then measure the corresponding attributes on the projection on the screen – lengths and angle measures. They will find that the angle measures are the same, but the

lengths have become notably larger (fundamental elements of similar figures). Ratios and proportions can be used to determine the scale factor of the projection.

The overhead can also be moved closer or farther from the screen to alter the scale factor. Students might be asked, for example, to find the distance from the screen that causes the projected image to be three times that of the original. (That is, if the length of one of the sides of the original figure is 5 inches, the same side projected on the screen should be 15 inches in length.) This activity can be used to discuss the magnification power of the lenses on cameras and satellites.

- A computer screen can show many kinds of images. To explore the connection between resolution and the amount of detail that can be seen, change the resolution of your computer screen. This can usually be done in the "control panel" of your computer, under "display settings". Make the screen resolution its poorest, and examine the amount of detail that can be seen in typed words on the screen. Students will find that the higher the resolution, the smoother the letters will appear, because the square picture elements (or "pixels") used by the computer are much smaller. Letters appear "blockier" as the resolution is lowered.