



# Pixel Mosaic Lesson Plan

## Overview

Digital photography has become a very important way to gather and share information about the Earth. Students will learn about digital photography by constructing mosaics. To do this, students will recreate an image of a landscape photograph by coloring and then arranging small tiles or “pixels” that correspond to the original photograph. As students piece together their own mosaics, they will be encouraged to think about how satellite images are constructed, and the limitations and advantages of using such a process to capture images of the Earth from space. Through the activity, students will recognize how pixels’ size and color affect image resolution and clarity. In so doing, students will explore mathematical concepts of surface area, perimeter, and tessellations as they construct their pixel mosaics, and make connections about how these concepts emerge in the creation and use of real satellite imagery.

Suggested Lesson Sequence	Please see the <a href="#">Global Visions</a> module description.
Lesson Level	<u>Extended</u>
Science Connections	<ul style="list-style-type: none"> <li>· Students learn to use imagery as a scientific tool.</li> <li>· Students explore the connection between <b>pixel size</b> and <b>image resolution</b>.</li> </ul>
Math Connections	<ul style="list-style-type: none"> <li>· Students construct a <b>mosaic</b> using a <b>coordinate system</b> to represent a satellite image.</li> <li>· Students identify the <b>area</b> or space inside a particular image captured by a satellite.</li> <li>· Students identify the <b>perimeter</b> or border region of an image.</li> <li>· Students describe how the <b>area</b> and <b>perimeter</b> are determined by the <b>pixel configuration</b> of any satellite image.</li> <li>· Students describe how pixels act as a <b>tessellation</b> of a given region.</li> <li>· Students describe how the <b>size</b> or <b>dimension of a pixel</b> is related to the <b>resolution</b> and <b>clarity of the image</b>.</li> <li>· Students explain how a <b>coordinate system</b> of labeling is the most accurate and efficient way to <b>arrange</b> the pixels.</li> </ul>

Technology Connections	<ul style="list-style-type: none"> <li>· Students will explore the relationship between <b>pixel size</b> and <b>color resolution</b>.</li> <li>· Students explore how satellite imagery is created.</li> <li>· Students describe how satellite technology allows us a much wider perspective and broader lens with which to view the Earth from space.</li> </ul>
Lesson Assessment Tools	<ul style="list-style-type: none"> <li>· <a href="#">Assessment and Standards Table (Word)</a></li> <li>· <a href="#">Assessment Activity Description (below)</a></li> <li>· <a href="#">Authentic Assessment (below)</a></li> </ul>

## Materials

Powerpoint Reader ([Windows](#) / [Mac](#)), and [Quicktime Player](#)

What is a Pixel? background information sheet ([Word](#))

Grids and Images Gallery ([Powerpoint](#))

Pixel Mosaic movie ([Quicktime](#)), starring Pixel the Satellite

Slide Show Assessment ([Powerpoint](#))

Computer with projection device and speakers (desired)

Tape or glue

Crayons (or colored pencils or markers - a minimum of 24 colors is best)

Scissors

Optional: Satellite images, magnifying glasses, newspaper photos, graph paper transparencies, graph paper of various sized grids

*About the slideshow:* this slideshow is not meant for students to read through on their own. It is 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

**Pixel:** one small, individual element of a picture. In fact, the word "pixel" is short for "picture element." Pixels are usually square or rectangular in shape.

## Procedure

### I. Assessing Prior Knowledge

Begin a discussion with your class to have them think about what pictures are made of. That is, if you were to look at a picture very very closely, what would you see? Some students will likely mention that they would see colors, and mixtures of colors. Ask them to think about how they have mixed colors in the past to create other colors—perhaps when painting or

coloring with crayons. Now, how do these colors take a shape to create a picture? When we draw or paint by hand, we create these shapes ourselves, and they can take any form. However, ask if students realize that when we look at any TV or computer screen, the picture we see actually comes from millions of tiny individually colored squares, or "picture elements", called *pixels*? The size of these pixels is actually very important to our understanding of any picture taken of the Earth. Ask students to think about the following questions: with many small sized pixels, would students expect to see more or less detail than with larger sized pixels? This question lies at the core of the math and science that students will learn about in this lesson.

## II. Contextual Preparation

In this lesson, students will create colored mosaics that will illustrate not only how an image taken from a satellite or digital camera is created (by joining smaller pixels), but also how differences in pixel size affect the resolution, clarity, and extent of the image. To learn more about pixels, students can read [What is a Pixel?](#) on the computer screen or printed out on a piece of paper.

Follow up this reading by playing the [Pixel Mosaic Animated Movie](#) on a computer. A projection device and speakers are desirable for viewing the movie, but not essential. For hearing-impaired students, or for your own use in the classroom if you have no speakers, the movie transcript is as follows:

"You know, when you orbit a few hundred miles above the Earth like I do, it's sometimes hard to see all the little details way down on the ground. 9. For example, just the other day I was in the mood to look for some flowers. But, darn it all, from so far away, I couldn't pick out a rose bush from a pine tree. 10. It's like this: stretch your arm out as far away from your body as you can, and look at the back of your hand. Even though you can't see them, I'd bet you my satellite dish that you have little hairs on the back of your hand. (Try it and see!) 11. But, even though I may not be able to see such details from where I hang out, I can still see patterns made by larger groups of flowers or trees as their colors blur together! 12. That's what you and your teacher are going to think about during the next lesson. In the mean time, I'm off to fly over Africa! 13. See you soo-oon!"

## III. Student Activities

1. There are two phases of this lesson, and each phase requires images and grids. Prior to the class period, teachers should download and print the following files from the [Pixel Mosaic Image and Grid Gallery](#). Choose one of the three available images to use throughout the entire lesson, and print *only one of each*. Color printing is necessary.

Phase One	Phase Two
You will need: Raw Image (choose one of the three available images)  Image with Large Tiles  Blank Grid with Large Tiles	You will need:  Image with Small Tiles  Blank Grid with Small Tiles

- Once the photos have been printed, prepare for phase one of the activity. The "Image with Large Tiles" and the "Blank Grid with Large Tiles" each contain a matching grid that is separated into 12 large tiles (within which exist smaller tiles). As illustrated in Figure 1 below, each of the larger tiles is labeled as a coordinate system (A1, B1, C1, D1, etc.). For both the photo and the blank grid template, teachers need to cut out these 12 tiles along the dark grid lines. (Do not cut on the inner dashed lines.)

Figure 1

A1	A2	A3	A4
B1	B2	B3	B4
C1	C2	C3	C4
D1	D2	D3	D4

- After the tiles have been cut, they need to be distributed. Each child (or pair or small group) should receive one tile from the photo-grid image, and one tile from the blank grid template. **IMPORTANT:** It is essential that each group be given matching tiles. That is, if children working in one group are given tile "C4" from the photo-grid image, then they also need to be given tile "C4" from the blank grid template.
- With these two matching tiles - one from the photograph and one blank grid- the children will begin to create pieces of the pixel mosaic. Specifically, they should begin by looking at the tile from the color photograph. They will notice that within their tile are a number of smaller squares separated by dashed lines (as is the case with the blank grid paper). Their task is to look at each of those individual squares or tiles (which are representative of "pixels") and select one colored crayon that they feel best captures the colors contained within the dashed lines. The children then use this crayon to fully color the corresponding pixel on the blank tile. This process is repeated for every pixel within their larger tile.

5. Students will have completed this step when they have colored in each of the smaller rectangular pixels on their blank tile. Depending on what they see in their original color photograph tile, many of the pixels may be colored with the same crayon. In other cases, however, several colored crayons may be necessary to accurately replicate the original color tile. In any event, upon completion of this step, the class is now ready to construct the mosaic.
6. Students should now reconstruct (with tape) both the original cut image with gridlines, as well as the newly created pixel mosaic, by arranging the tiles in the appropriate configuration (A1, B1, C1, etc.). Students should be able to view the original (still intact) raw image for comparison. Inevitably, the "satellite" mosaic will vary somewhat from the original "Raw Image" because the original contains many more colored tiles or pixels.
7. As this process unfolds, the teacher may then ask a series of questions to help the children understand how their mosaics mirror the way in which satellite images are created. (See the "Questions for Class Discussion" listed below for some initial ideas.) As the children look at the picture, they will see that, although the newly created mosaic is not as clear as the original picture, it should (particularly from a distance) bear some resemblance to the original photograph.
8. Phase two of this activity is nearly identical to the previous steps. The only difference is that the second set of images ("Image with Small Tiles" and "Blank Grid with Small Tiles") utilizes smaller pixel sizes. Therefore, for phase two, each individual pixel is now smaller, there are more pixels used to cover the photograph than in phase one. Hence, the mosaics that will be created in phase two should reflect a more accurate representation of the original photograph than the result of phase one. As the pixel sizes get smaller, the children should have an easier time selecting the individual crayon that best represents the average color of the small region under examination. Consequently, fewer of the raw data (colors in the photo) are lost, and therefore the picture becomes more accurate. (As an alternative to save time, teachers may elect to complete phase one and phase two simultaneously, with half the class completing the "Blank Grid with Large Tiles" and the other half "Blank Grid with Small Tiles.")
9. Teachers should lead the class in a discussion about the impact that pixel size has on resolution, accuracy, and clarity using the questions below as a starting point.

### **Questions for Class Discussion:**

1. Describe your mosaic. How did you determine the color for you square? For which types of squares was it most difficult to choose a color?

*Students should have selected colors that matched the original landscape grid. Students*

*should have more difficulty selecting colors when multiple colors are seen in the original tile.*

2. Compare your completed mosaic to the original photograph. What do you notice?

*Students should be able to discern similar color patterns but fine details will difficult to observe.*

3. Each square that you colored in our mosaic can be called a "pixel." What, then, is a pixel in a satellite image?

*A pixel is small square within a picture that is made up of one color. Satellite images are created by millions of other pixels joined together.*

4. What things can we change about how we made our mosaic? How would these changes make our mosaic look more or less like the original photo?

*Coloring a grid with smaller tiles will make our mosaic look more like the original photo.*

5. Give real life examples of when more resolution would be helpful in an image.

*By increasing the resolution of an image with smaller pixel sizes, we can see smaller objects in greater detail. Also, we can see more detail in images from space.*

6. If satellites have a limited number of pixels available for any photograph what happens to the image if the pixel size (resolution) increases? Decreases?

*If the pixel size increases, the image is less clear. If the pixel size decreases, the image is more clear.*

7. How is the way we made our mosaic the same (and also different) as the way a satellite creates its images?

*The mosaics were created by coloring individual tiles or pixels. Satellite images are created through digital photography.*

#### **IV. Assessment**

By completing this activity, students should be able to construct a mosaic using a coordinate system. Using this mosaic, they should be able to explain their understanding of the relationship between pixel size and image resolution. Students should also be able to explain how their mosaic is similar to a satellite image. Display the [Pixel Mosaic Slide Show Assessment](#) to your class. This slide show reveals a series of images that have been changed

to alter their pixel sizes, and is a fun way for students to confirm the concepts that they have learned through this lesson. You might have a different student read the questions on each slide. Students may answer the questions posed on the assessment activity orally, or in writing.

### **Lesson Extensions for Authentic Assessment**

1. This activity could be duplicated with a different picture, perhaps even poster sized, and with varying pixel sizes as demonstrated in phase two. As noted, varying the size of the "pixels" will help children see the difference that pixel size has on image clarity. As the region captured by a pixel increases, the detail of the original picture is lost.
2. Students may be encouraged to explore the similarities between the mosaic activity done in class, and the ways in which color newsprint photos are created. Specifically, students are given a color newspaper photo (or comic strip), and a magnifying glass. As students place the magnifying glass over the comic strip, they will see a combination of dots that, when viewed from a distance, blur to form a single color. Questions may be developed to extend the children's thinking through the exercise. Specifically, children should think about how this exercise is similar (and dissimilar) to the way a satellite image is created.
3. Similarly, students may explore how computer and television screens also use pixels in displaying images. Students should hypothesize about how pixels are used in these screens. Then, they may take the magnifying glass and place it close to a television screen. They will see a distribution of color bands that can be found within each pixel on the screen. Like the newsprint, they will be able to see that the use of only a few different colors, when arranged strategically in the form of pixels, can produce a wide range of colors as perceived by the human eye. Students could collect data through their observations, revise their original hypotheses, and share their findings and interpretations with the class.
4. This activity has some significant mathematics connections that might be emphasized by the teacher. Specifically, teachers could emphasize notions of area, perimeter, tessellations, measurement, and the coordinate plane. If the activity was repeated, teachers might allow students to think about how they might alternatively design the blank grid that is used to capture segments (pixels) of the original photograph. That is, they could decide on a particular shape of the pixels, compute the area of each pixel, measure for the pixels accordingly, and cut out the shapes themselves. This addition to the lesson would highlight the significant math components of the activity.