The Diminishing Apple

Students use an apple to explore the distribution of the Earth's natural resources.

By Catherine Kelly

Looking for a way to bring fractions and proportion to life? How about an activity that integrates these mathematics concepts with science-process skills and geography?

For the past several years I've successfully used The Apple Ocean, an activity initially designed by Lindy Millman (1988) of the San Fransisco Bay Chapter of the Oceanic Society to teach third- and fourth-grade children about diminishing natural resources. I revised the activity for students in grades four to six.

Why *apple* ocean? The semi-round apple can easily be cut into slices to represent the Earth. The main goal of the activity is to teach children about the relatively small proportions of actual drinkable water, habitable land, and productive areas on the Earth.

Introducing the Apple

I introduced the activity to the students using constructivist-based inquiry: The day prior to the lesson, I had the students work with globes, flat maps, and atlases to look at the world from several different perspectives.

I then held up an apple and asked, "How do you think this apple and the world around you might or might not be connected?" One child noticed the obvious size difference between the globe and the apple when I suggested the apple as a "model" of the world. Another student wanted to know how we were going to make the apple "become" the Earth.

"Well," I responded, "let's find out by using parts-to-whole mathematics and science (I purposefully did not use the word *fractions*—I let them discover this as they progressed through the lesson).

Students had worked with *fractions*, *ratios*, and *proportion* throughout the semester, so they already had a good working knowledge of how mathematics fits into the real world.

The activity (done in small groups of twos or threes) required the following materials:

- One apple for every two students (the softer yellow or green apples are easier for children to cut and manipulate);
- Dull plastic knives;
- Paper plates (one plate per group);
- Paper towels (two or three sheets per group); and
- Pencils or markers.

I established a strong behavior standard at the beginning of the lesson concerning safety issues with knives, explaining that knives are scientific tools for experimental purposes and that the children should consider themselves "scientists" doing actual investigations.

Before starting the activity, I checked allergy lists with the school nurse to make sure none of the children were allergic to apples. One child was indeed allergic, so we had him work with fraction manipulatives instead of apple slices.

Envisioning the Apple

After I distributed the materials, many students asked about the paper towels and knives—they assumed we were going to eat apples for the activity! "We *are* going to cut the apples, but we aren't going to eat them," I said. "Your apples represent the Earth, and we are going to examine its parts."

Students then cut their apple into four equal pieces. (I suggested that they cut top-to-bottom for accuracy. Later in the activity, when they cut 1/4 pieces into 1/8 pieces, I suggested cutting the slices in the middle horizontally rather than vertically to make the cutting easier.) "Take away three of the pieces and set them aside," I said. "Those pieces represent the ocean—three quarters of the Earth is covered with ocean. How can we represent this with numbers?" A student volunteer walked up to the overhead projector (I used a transparency of a circle divided into four equal parts), shaded in three parts, and wrote 3/4. I also had the children draw fractional representations on a paper plate as they cut the apple. (See Figure 1 on the next page to see what a completed pie chart should look like.)

"There certainly *is* more water than land on the globe, and probably people can only live on certain parts of land," observed a student.

One child commented how the divided circle on the transparency looked like a pumpkin pie. I asked the children if they had ever pictured a piece of pumpkin pie as a triangle with three points. I could practically see the light bulbs go off in their heads with this analogy! Throughout the activity, I continued to prompt them to think of the "pie" chart on their paper plates as a pumpkin pie with a point in the middle from which they could draw fractions.

The Land

I asked students to look again at their apple slices. "The remaining piece of apple (one-fourth of the apple) represents the *land*, or area not covered by ocean." Students wrote the corresponding fraction (1/4) on their paper plates while a student volunteer designated one-fourth of the circle on the overhead transparency as land.

At this point, students had many questions, such as, "Why are there three pieces of apple for the ocean and only one piece for the land?" and "Where do all the people live?" I suggested that they look at the class globes again to see how much land it looks like there is for people to use. After examining the globe, one student commented, "There certainly *is* more water than land, and probably people can only live on certain parts of land."

Next, students took the quarter piece of apple representing land and cut it into two equal pieces. "One piece represents all the land that is too dry, too wet, too cold, or too hot for people. This is *uninhabitable land*, such as mountains, river basins, deserts, and icebergs," I explained. (Students were already familiar with these terms from a geography unit.) One student reacted: "Whoa! You mean that now the land is cut even more and some of it can't even be used to grow food or to live on?" Students drew this slice of uninhabitable land on the paper plate and labeled it, "Uninhabitable Land." They wrote the corresponding fraction (1/8) under the label while a student completed the same task on the overhead.

I continued: "The other one-eighth piece of the Earth's surface represents the *land that is habitable by people*." Students drew this section on the paper plate, labeling it, "Habitable Land" and writing the fraction (1/8).

Getting Smaller and Smaller

Students cut the one-eighth piece representing habitable land into four equal pieces, setting aside three of those pieces. The remaining piece represented the portion of habitable land in which people can grow food. Students represented this fraction (1/32) on the paper

Figure 1.

Divisions of the Earth.

The pie chart below shows the actual distribution of the Earth's resources. Teachers can use this as a guide when students make their own pie chart.

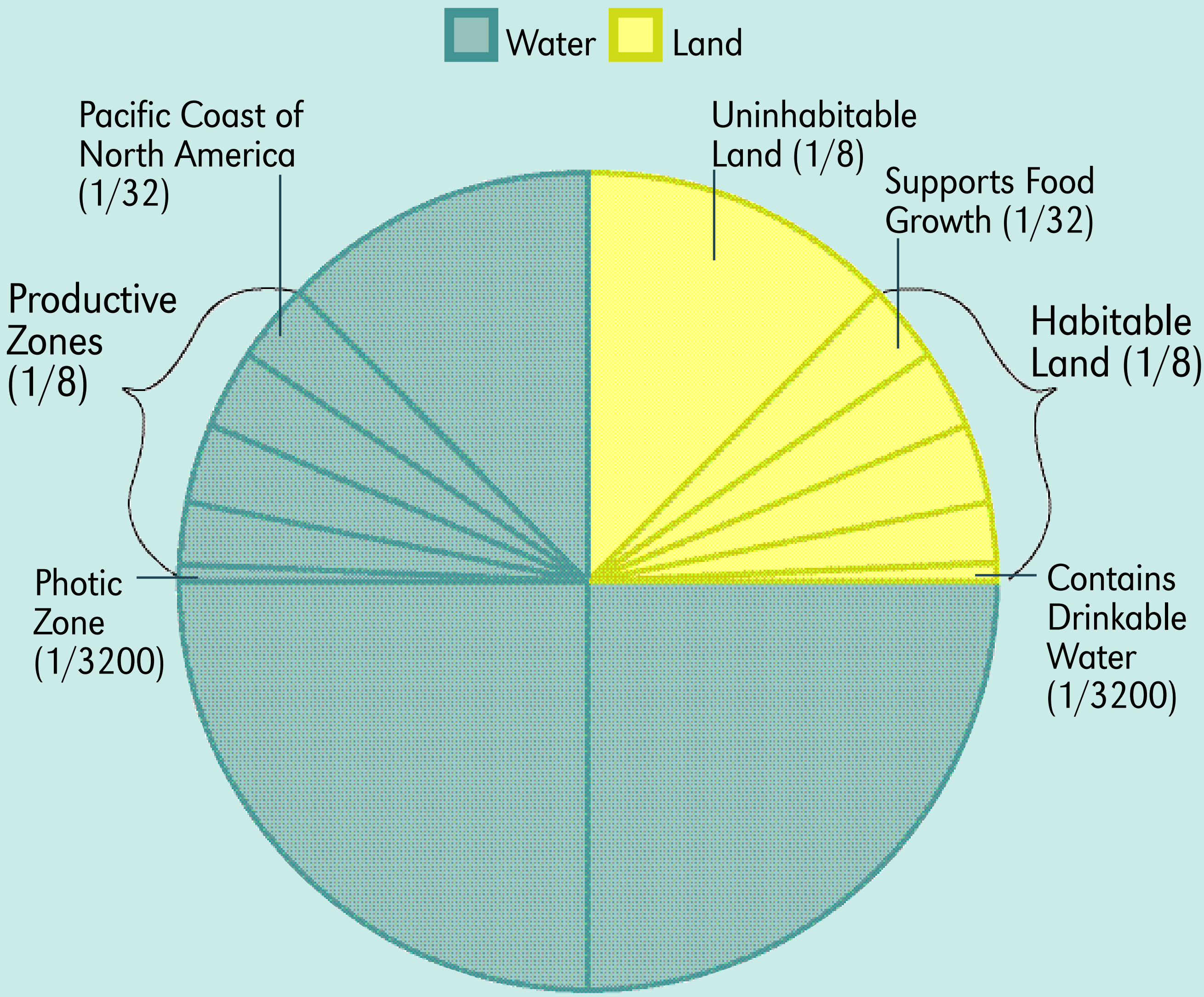

plate with the label, "Supports Food Growth."

This fraction definitely presented a challenge to the students (they were accustomed to working with halves, thirds, and fourths), but it offered them the opportunity to "see" a double-digit fraction and realize that although the number 32 was a larger number, it represented a smaller *proportion* of the Earth. Students understood the term *proportion* as "a part considered in relation to the whole." In this way the children could build useful number sense and global perspectives. One girl pondered, "We would not have clothes to wear if all of the useable land were gone, because then we wouldn't be able to grow cotton." Other students chimed in about the need to conserve useable land.

Next, students took the one thirty-second (1/32) section and shaved off a very thin slice. "This tiny section represents 3/100ths of one percent of the Earth's surface, or 1/3200, a very tiny portion of the apple as a whole. *All* of our drinkable water comes from this area," I explained. Again, students represented this slice on the paper plates, labeled it, "Drinkable Water," and wrote the appropriate fraction (1/3200).

"Won't we run out of water someday?" asked many students, noting such a small fraction. "How can this little slice of the Earth be our only drinking water?"

One student reasoned, "We won't run out of water because we can buy it in bottles at the store. Also, I remember seeing on television how they make ocean water okay to drink on the islands."

These comments spurred a lively discussion of where water comes from (aquifers and other underground sources), how it arrives to the supermarket in bottles, and how it comes out of the faucet.

The Ocean

Setting aside the land slices, the students now focused on the three large quarter-apple slices that represented the ocean. They conducted tasks similar to those they did when cutting land slices.

They first took one apple quarter and cut it in half. This piece, an eighth of the world's surface, represented the productive zones of the oceans—most of the Earth's oceans are not very productive and support very little life. Students were once again shocked by the idea of so little productivity based on the amount of the Earth's surface area that is covered by water. They drew this representation on the paper plate, labeled it, "Productive Zones," and wrote the appropriate fraction (1/8).

Next, students cut this one-eighth section (the productive zone) into four equal pieces. One of these pieces represented the productive area along the Pacific coast of North America, one of the richest regions of the oceans. (Students and I then examined the Pacific Coast on a

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Cutting the apple . . .

examining its parts . . .

. . . and drawing the fractional representation.

class wall map.) They added this piece to the paper plate, labeled it, "Pacific Coast," and wrote the appropriate fraction (1/32).

Next, students took one of the leftover 1/32 pieces and shaved off a very thin slice. This tiny piece represented the *photic zone,* the top 100 meters of the ocean through which light can penetrate and support photosynthesis. (Students understood *photosynthesis* as the process by which plants use sunlight and water to survive.) They were amazed to learn that almost all of the ocean's life is concentrated in this narrow surface region. Under the label "Photic Zone" on their paper plates, students wrote the representative numeric fraction of 1/3200.

Tying It All Together

I asked students to consider how their apple model reflected their initial observations about the Earth when they worked with the globes and atlases. After closely examining the actual pieces derived from cutting the apple, students noted the proportional differences among the pieces and saw that the fractional pieces "made sense." Some students ordered their pieces by size: 1/3200 slice, 1/32, 1/8, 1/4, 1 whole; others looked only at the proportion of land to water: 1/4 land to 3/4 water.

"With this information, how does the proportion of land to water on Earth become more significant to us?" I asked. One girl responded: "Did you know there is 1/4 of land we have today and 3/4 of the ocean? Not much of that land can grow crops, cotton, trees, and plants. In the future, there will be less of those things, even less clothes. We must conserve our resources."

The Apple of My Eye

The integrated apple-cutting activity took one full day. The experience enabled students to actually see and manipulate fractional parts (quarters and eighths) while learning the significance of symbolic representation and proportion.

This activity led interdisciplinary, standards-based learning by helping children begin to use and see maps in mathematics and science as well as other disciplines as real tools and not just as classroom wall hangings. My students said it best in their written conclusions about the activity:

- "I learned about the Earth and that some things in the sea can't live without light";
- "I learned how much land we use and don't use"; and
- "First I thought that putting together science and mathematics would be hard, but then it was really fun. I learned that we don't have that much water. The smallest slice of an apple is how much clean water we have. When you waste water, half of it goes into the ground, and the other half evaporates into the air. What will happen when we run out of water? What new ways will be invented to find water? Will we someday need ration cards for food?"

And to think that all it took was an apple!

Connecting to the Standards

This activity relates to the *National Science Education Standards* Program Standard C, which states that science programs should be coordinated with mathematics programs to enhance student understanding of mathematics in the study of science and to improve student understanding of mathematics (National Research Council 1996).

Catherine Kelly is an assistant professor of mathematics education at the University of Colorado in Colorado Springs. ***The author would like to thank Carolyn De La Garza and Sheila Kelly for their help with the apple ocean activity.***

Resources

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