Two Ways About It
Lesson Plan

Overview

In this lesson, students will go on an "E-quest", that is, a quest for energy. During their quest, they hike along a large lake, searching for a source of energy along its shore. Along the way, students learn about important mathematical concepts such as negative numbers, ratio tables, multiplication, and number sense to the hundreds of thousands and millions place. In addition, students will hone their skills of viewing and interpreting satellite imagery. Finally, students will be introduced to the pros and cons of hydroelectric dams, including discussion on the environmental effects of dams. This lesson provides the mathematical background necessary for Quad Squad, as well as scientific background of hydroelectric power that will enrich students' understanding of Salmon Run.

Suggested Lesson Sequence	Please see the Earth Systems and Humans and Maps and More module descriptions.
Lesson Level	Extended
Mathematics Connections (Keywords in **BOLD**)	· Students will develop an understanding of how **negative numbers** are used by counting on a **number line**. · Students will use **ratio tables** to **multiply** to the **hundreds** or **thousands** and **millions place**. · Students will measure ground **distances** using a **scale**. · Students will use a number line to determine the difference between **positive (negative) scale units** and **direction**. · Students will solve **story problems** using **multiplication**.
Science Connections (Keywords in **BOLD**)	· Students will identify various forms of **energy**, including **electricity**. · Students will describe some benefits and **environmental issues** relating to **hydroelectric energy**.
Technology Connections (Keywords in **BOLD**)	· Students will identify linkages between **satellite images** and **ground photos**. · Students will examine and interpret **satellite imagery** of the earth. · Students will use a **computer** to compare a **satellite image** with a **map**.
Lesson Assessment Tools	· Assessment and National Standards table (Word) · Assessment task description (below) · Authentic assessment (below)

Materials

- This lesson requires Powerpoint Reader (Windows / Mac) and Adobe Reader.
- E-Quest Activity Sheet (PDF)
- E-Quest Image Slides (Powerpoint)
- Assessment Activity Sheet (PDF)
- The ability to show color images to the class, using several computers or one large display

Vocabulary Words

- Anxious: excited.
- Electricity: a form of energy that is mainly transported through power lines and other wire cables. Electricity can be created from other energy sources by turning turbines that produce an electrical current.
- Energy: the capacity for doing some sort of work. If a person has energy, they can exercise or work. If a machine uses energy, it can create heat, light, sound, or maybe move. *Electricity* is one form of *energy*.
- Exhausted: extremely tired.
- Hydroelectric dam: a large human-made structure that backs up the flow of a river to create a lake. When the river water flows through the dam, it has the energy to turn large water wheels, or *turbines*, within the dam to produce electricity for humans to use.
- Kilometer: a metric unit of distance that is shorter than a mile. In fact, 5 kilometers equals approximately 3 miles. A kilometer is one thousand meters long. Kilometer can be abbreviated using the letters "km".
- Kilowatt: a unit of power. One kilowatt is equal to one thousand watts. For comparison, a nightlight bulb uses about 3 watts of power.
- Negative number: Numbers with a value less than zero. That is, on a number line, negative numbers occur *to the left* of zero.
- Terrain: the surface of the earth, including hills, valleys, and other features.

Procedure

1. This lesson is designed in part to familiarize students with negative numbers. To do so, the lesson asks students to search for an energy source going on an "imaginary hike" in two opposite directions along a lake. These two directions are modeled with a number line that includes negative numbers.

2. *Assessing prior knowledge.* To begin the lesson, ask students to make a list of different types of "energy." Write the various suggested forms of energy on the board. Then, ask the students to suggest ways in which energy is used. At the end of this discussion, the class should have recorded a list of energy types and uses.

3. *Setting the context.* Hand out a copy of the E-Quest Activity Sheet to each student. Read the first paragraph of the activity sheet aloud with the class to help students to focus upon the context of the lesson.

4. As indicated on the activity sheet, students are to study the region of land around Lake Francis Case as depicted on the image. Lake Francis Case is an actual lake created by damming the Missouri River in central South Dakota. Task #1 asks students to create a key on the Lakeside Image #1. Because the images on this activity sheet will most likely be printed in black & white, it will be helpful to load the ESC CD-ROM to project the E-Quest Images so that students can see them in color.

   For Task #1, students should:
   1) Label any natural features they can see on the image. Features might include waterways, trees, agricultural fields, roads, etc.
   2) Locate and label the Lakeside Lodge.
   3) Locate the lake, and any small inlet streams that flow into the lake.
   4) Estimate the dimensions (size) of the image in both the north-south direction as well as the east-west direction.
   5) Develop a key that contains their best guess as to what surface features are denoted by the colors: green, blue, brown, and orange.

5. For Task #2, students are to discuss the mystery note. Teachers may wish to read the poem out loud. ("If you want to find some power, and turn your field trip sweet not sour… You'll find a source as plain as day, if you walk the line just 6 kilometers away.") What is the best way to locate the energy source along the lakeside? What clue did the rhyme provide? It did provide a distance, but no direction was given. Ask the students for suggestions as to how to begin the "E-quest". When students have gotten the more subtle clue that they should "walk the line" to find the source, they may move on to Task #3.

6. Answers will vary for Task #3. The important thing to look for is whether or not students are "reading" the image appropriately. West of the lodge, the image indicates that the students will be "traveling" through grassy or forested areas (dark green) covering several ridges and valleys, as seen in the image. The second question for Task #3 requires the students to recognize that, at 3 kilometers per hour, they would have traveled a total of 6 kilometers in two hours. At the bottom of the page, students are asked to describe what they see in Lakeside Photo #1. You may find it useful to carry a color print-out of each of these photos with you to show students when they ask to see them, or project the image on an overhead screen.

7. Task #4 asks the students to think generally about relative magnitude (distance from zero) of numbers. According to the story, the students are now six kilometers west of the lodge. Realizing they should have gone the other direction from the lodge, they now are asked to think about finding their way to a location that is six kilometers to the *east* of the lodge. This net distance is 12 kilometers. To enhance students' understanding of this important mathematical concept, teachers may wish to pause and give students similar problems like, for example: A deer is three kilometers west of the lodge. His mother is four kilometers east of the lodge. How far apart are they?

8. Task #5 introduces ratio tables as a powerful alternative to traditional multiplication algorithms. Students calculate the amount of electricity required to light 23 bulbs (45 watts

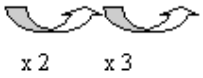
each). The ratio table is an excellent tool for helping students develop rich number sense, proportional reasoning, and conceptual understanding of multiplication as illustrated in the example below.

Example: It requires 2 teaspoons of oil to make 4 pancakes. If the cook at the lodge needs to make 24 pancakes to serve everybody, how many tablespoons of oil are necessary?

Possible solution strategies with ratio tables:

Strategy #1

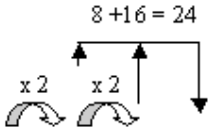
Number of Pancakes	4	8	24
Teaspoons of oil	2	4	12



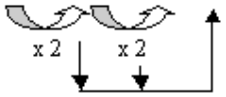
Strategy #2

Number of Pancakes	4	24
Teaspoons of oil	2	12

Strategy #3

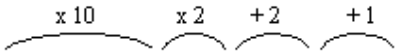


Number of Pancakes	4	8	16	24
Teaspoons of oil	2	4	8	12



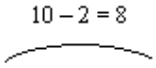
Possible Solution Strategies for Task #5

Problem: 23 bulbs, 45 watts each

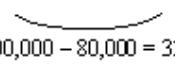


Number of Lightbulbs	1	2	10	20	22	23		
Number of Watts	45	90	450	900	990	1035		

Problem: 40,000 watts, 8 turbines



Number of Turbines	1	2	10	8		
Number of Kilowatts	40,000	80,000	400,000	320,000		



9. Integer Discussion: Discuss with the students how they might have found the "missing power source" (the hydroelectric dam) sooner than they did. What additional information would have been helpful on the mysterious note? One bit of information would have been the direction of the treasure away from the Lakeside Lodge in terms of East or West. Another way that direction is often indicated is through the use of *negative numbers*. To introduce this concept, display the Lakeside Image #2 on a large computer screen, showing that the numbers to the left of the Lakeside Lodge are negative in sign. Direct the students to place negative signs in front of the appropriate numbers on their own image. (It may be difficult for them to see their signs on the image.) Which compass direction corresponds to the negative numbers? Which compass direction corresponds to the positive numbers? To enhance students' understanding, additional examples may be illustrated with the use of a number line. For example: "If a rabbit takes 4 hops from its den in the negative direction, how far is it from the den? If a second rabbit hops twice from the lodge in the positive direction, how far is *it* from the den? How far are the two rabbits from *each other*?" It is not necessary at this point to introduce algorithms for adding and subtracting integers. Helping develop general conceptual understanding of the number line is the goal of this activity.

8. Hydroelectric Dams, Energy, and Ecology Discussion: The activity sheet helps students learn about the energy that it can produce. This is an excellent time to engage students in a discussion about the hydroelectric dam and its other effects on people, as well as on the surrounding environment. Questions for discussion might include:

- What would the image have looked like before the dam was built? *(the lake would not have been there and instead a smaller river would have been visible)*
- Where is the dam built? (*across a river—in this case it is the Missouri River in South Dakota)*
- People build dams. What might this river have looked like before the dam was built? *(Have the students draw a trace on their images where they think the river would have been prior to the existence of the dam. Discuss the environmental changes associated with the dam including, for example, loss of natural land habitat, increase of water habitat, etc.)*
- Big rivers usually overflow their banks (flood) in the spring time, when snow melts and big rains fall. How might a dam affect flooding? *(a dam regulates (evens out) the flow of water throughout the year so that flooding becomes less frequent)*
- How might this affect people living in cities along the river? *(As stated in the above question, floods become less frequent. However, as a result of wetland draining along riverways, when floods do occur they can be very severe and affect many people)*
- Some species of trees, such as the cottonwood, rely upon floods for seed germination. How might the dam affect cottonwood trees downstream? *(fewer floods would result in fewer species such as the cottonwood that rely upon flooding for seed distribution)*
- When it was built, how might the dam have affected cottonwood trees (and other vegetation) living along the river upstream? *(it would have flooded the upstream ecosystem and drowned the vegetation)*
- How might the dam affect fish swimming along the river? *(it would cause an impediment to fish migration and travel, and it could change the temperature of the water)*

In order to help answer these questions, here are some additional statistics about this dam (the Fort Randall Dam) from the US Army Corps of Engineers:

Fort Randall Dam is located near Lake Andes in southeastern South Dakota. Construction of Fort Randall was started in 1946 and was completed in 1953. The dam measures approximately 10,700 feet in length with a maximum height of 165 feet from the streambed to the top of the dam. Each of the eight turbines generate a capacity of 40,000 kilowatts of power.

The dam created Lake Francis Case, which is 107 miles long, has 540 miles of shoreline, and has a maximum depth of 140 feet. Water is stored at Lake Francis Case for the production of hydroelectric power. The total storage capacity of the reservoir is 5,494,000 acre-feet. The lake drains an area of approximately 263,480 square miles.

There are 19 recreation areas located around the reservoir. They include highly developed campgrounds and day use areas, moderately developed areas, and primitive areas. Recreation opportunities at the lake include camping, picnicking, fishing, hunting, boating, waterskiing, swimming, bird-watching, hiking, biking, and photography.

9. Assessment activity: Now, hand out the Assessment Activity Sheet. The questions on this sheet will serve as good assessment items as they will reveal the depth to which students understand the topics explored in this lesson. Some example responses are included below:

- How are number lines used for determining distances on maps?
  The numbers on number lines represent regular distances from one another, and can be used to determine the distance between two map positions.

- What is the difference between distance and direction on a map?
  Distance denotes the amount of space between two things, and direction refers to the actual route of travel, for example, north, south, east, or west.
- How do negative and positive numbers correspond to direction on a map?
  Negative and positive numbers correspond to opposite directions on a map. For example, in this lesson negative numbers ran westward and positive numbers ran eastward.

- What are some of the benefits of building a dam? What are some of the drawbacks?
  Answers will vary, but will include those discussion points discussed in item #8 above.

Lesson Extensions for Authentic Assessment

- Bring in an electric bill from home, or ask student to do the same. On the bill, you should be able to determine the charge for electricity use in your community. (Normally this rate is calculated as a price per kilowatt hour.) Ask students to think about how often lights are left "on" around their homes, and where this energy might come from, and what effects producing this energy may have on the environment. Then, based on the electrical charge found on the bill, together the class might investigate exactly how much it costs to keep a 60 watt bulb lit for an hour. Conserving energy (and money) by turning off lights and appliances when not in use can add up! Additionally, saving energy also saves our natural resources.

- This portion of the Missouri River was traveled by Meriwether Lewis and William Clark during

their western United States expedition in the early 1800's, right after the Louisiana Purchase. Discuss the differences between today and the early 1800's. How might the area of Lake Francis Case be different now from during the time of Lewis & Clark? What people lived in this area during the time of Lewis & Clark? What animals lived in this area during the time of Lewis & Clark? Could these animals cross the river as easily today as 200 years ago? Why or why not? Students could write a short story detailing their ideas.

Acknowledgments

The satellite image used in this lesson was acquired by the Landsat 5 satellite, launched and operated by NASA. The two surface images used in this lesson are courtesy of the United States Geological Survey.