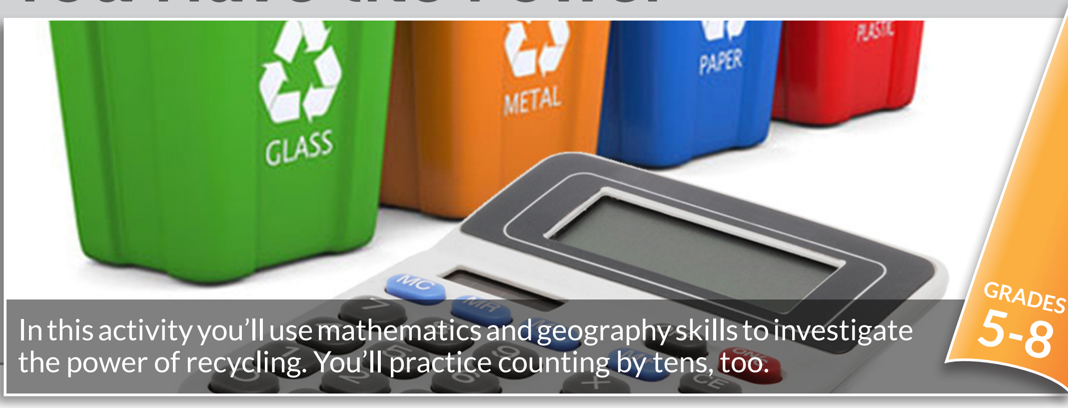
You Have the Power



In this activity you'll use mathematics and geography skills to investigate the power of recycling. You'll practice counting by tens, too.

GRADES 5-8

ISRI Voice of the Recycling Industry

JASON Learning

PREPARE:

Time Required: 2 class periods (90 minutes) without extensions

- Gather materials (see activity pages).
- Each group has a different challenge. The nature of the materials they may need to do their research and prepare their communication tools will vary. You might gather additional material.

MOTIVATE:

Share some amazing and interesting recycling facts from ISRI's Kid's Recycling Fact Sheet such as:

- The United States annually recycles enough copper to provide the copper content of more than 25,000 Statues of Liberty.
- Each year, recycling aluminum cans in the U.S. saves enough energy to fuel more than one million vehicles on the road for 12 months.
- The United States recycled enough gold in 2012 to, if beaten into a thin sheet, cover an area of 44 square miles — more than half the size of Washington, DC.

Have students think about how did people came up with these numbers. Did someone actually go out, for example, and take exact measurements on every vehicle on the road to see how much fuel each one consumes in one year? Discuss the idea of using estimations to make powerful statements! Have students consider the two following statements and discuss the differences. Is one more powerful than the other and why?

"Each year, recycling aluminum cans in the U.S. saves enough energy to fuel more than one million vehicles on the road for 12 months "   Vs. "Each year, recycling aluminum cans in the U.S. saves a lot of energy!"

Explain that the man behind the idea of making these kinds of estimations was a famous Italian physicist named Enrico Fermi, born in 1901. He used to like to challenge people to estimate big numbers! Through estimation, he was able to get pretty close to actual numbers on a few "big" and sometimes unusual questions. His most famous "Fermi" question was:

How many piano tuners are there in New York City? (Anyone?)

Explain to students that they are going to undertake a recycling question that will require them to do some research, and then some calculations and estimations based on powers of 10. Their work will be important, because their estimations will be used to create powerful messages to illustrate the power of recycling in their community!

TEACH:

- Conduct activity with students (see activity pages).
- For the Warm-up question in part 1, an example of a question to propose to students might be: "How many giant steps of [pick a student or yourself] would it take to reach the [choose a location like the cafeteria/athletic field/ or principal's office].
- The groups have been provided with some information on the approximate equivalence of the (energy or raw material) savings of recycling one of the four materials. In each of the challenges, some basic facts have been rounded to the nearest ten.
- Depending on the level of students, the estimations can be done visually (with manipulatives), with sticky notes prelabeled with 10s on them (create visual displays of the information as histograms on the classroom's board or wall) or on paper with calculators.
- Discuss the importance of starting with a known, or reasonably close to known, number on which all your other calculations will be based when conducting large scale estimations. Students should be discussing ways to determine the # of cans, bottles, or newspapers their families use, on average in one week, whether through discussion, class collaboration, or actually collecting data from home or discussing with family members. Allow the students to determine how they should do this so they aren't beginning with a completely random number. The power of a Fermi estimation is that when checked against reality, it comes close to actual values! You might have students collect actual baseline data to establish how many soda cans, glass bottles, plastic bottles, and newspapers each family uses in one week, to share with the class and use the class figures to carry out the further estimations.

REFLECT/ASSESS

Using your estimation, develop a poster, flyer, power point presentation, podcast or video that incorporates a powerful statement to encourage the community to recycle. Your message might begin with: "Imagine if each of us recycled just [X cans, bottles, newspapers] every week, then we could . . . [build x, save as much energy as, or travel to . . . etc]".

EXTEND

- Have students create their own Fermi questions or challenge and try to answer them based on the power of estimations!
- Have students learn more about Enrico Fermi using the internet and other library resources.

JOURNAL QUESTION

Have students reflect back on the estimations presented by their classmates. Have them discuss at least 2 new things they learned and the impact this might have on their recycling plans.

WEBLINKS

Fermi Questions
http://www.fermiquestions.com/
Science, Optics and You (fun, visual representation of powers of 10)
http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/
ISRI's Kid's Recycling Fact Sheet
http://www.isri.org/docs/default-source/recycling-industry/fact-sheet---kids-recycling-facts.pdf?sfvrsn=6

You Have the Power

Sample estimated answers: (actual estimations will vary)

*** These are not actual, correct figures but rather a way to illustrate how the math is carried out. Actual answers will vary depending on how many cans, bottles, or newspapers a family is estimated to use / week in the classroom.**

Soda Cans

A soda can is about 6 inches high (15 cm). If we lined up all the cans our class and their families use in a year, how many miles would that line go?

Example based on each person in the family using one can/day. For a family of 4, this would be: 28 soda cans per week (1 can x 4 people x 7 days). If all numbers are rounded to the nearest ten, we get:

- 30 soda cans/week/family (28 cans, rounded up)
- 20 families/classroom
- 50 weeks in a year (52 weeks, rounded down)

30 soda cans/per week/per family x 20 families x 50 weeks in a year = 240,000 soda cans

240,000 soda cans x 6 in = 1440000 in / 12 = 120,000 feet   120,000 feet/ 5280 feet/mile = 22.72 miles

Plastic Bottles

The energy used to make 10 plastic bottles is about what you'd need to drive a small car a mile. Start at your school. Use a map to estimate how far you could go in a car, using the energy of all the class's bottles that could be recycled in a year.

Example based on each person in the family using approximately 5 bottles/week. For a family of 4, this would be: 20 bottles per week (5 bottles x 4 people).

- 20 bottles/week/family
- 20 families/classroom
- 50 weeks/year (52 weeks, round down)

20 bottles/week/family x 20 families/classroom x 50 weeks/classroom = 20,000 bottles

20,000 bottles/10 bottles/mile = 2,000 miles

You can spin fiber to make a t-shirt from two bottles. How many t-shirts could be made from the energy saved by recycling all the bottles all the families in your school use in a year?

- 20,000 bottles/classroom
- 10 classrooms/school
- 2 bottles/t-shirt

20,000 bottles/classroom x 10 classrooms = 200,000 bottles/2 bottles/t-shirt = 100,000 t-shirts

Newspapers

Question: About 100 newspapers can save two trees. How many trees could your class save if all of their family's papers were recycled?

Example based on each family in the class reading approximately one newspaper per day = app. 375 newspapers per year, rounded to 400.

- 7 newspapers/week/family or
- 400 newspapers/year/family (375, rounded up to 400)
- 20 families per classroom

400 newspapers/year/family x 20 families = 8,000 newspapers

8,000 newspapers/100 newspapers/2 trees = 800 x 2 trees = 1600 trees

If there are approximately 500 trees to each acre of land in a forest, how many acres of forest could all the families in your entire school save?

- 1600 trees/class
- 10 classes/school

1600 trees/class x 10 classes = 16,000 trees/500 = 32 acres of land

How many schoolyards would this be equivalent to? (Need to know the size of your schoolyard)

- 2 acres/schoolyard

32 acres/2 acres/schoolyard = 16 schoolyards The school could save a forest the size of 16 schoolyards!

Glass Bottles

By recycling two big glass bottles, you can save enough energy to run a 50 watt bulb for 10 hours. How many hours of light would there be with the energy saved from the bottles all the families in your class use in a week if you recycled all of them?

Example based on each person in the family using 3 glass bottles/week (an average American uses about 164 glass bottle per year). For a family of four, this would be (3 bottles x 4 people) approximately 12 glass bottles/week.

- 10 glass bottles/family/week (12 bottles, rounded down)
- 20 families/classroom
- 2 bottles/lightbulb/10hours of light

10 bottles/family/week x 20 families = 200 bottles/week

200 bottles/2 bottles/lightbulb = 100 light bulbs x 10 hours of light = 1000 hours of light (about 42 days' worth!)

The energy saved from recycling 5 glass bottles can power 1 school computer for an hour. How many hours could a school computer be powered for if it could run on the energy saved by the class and their families if they recycled all the glass bottles used in a week?

200 bottles/week /5 bottles/computer/hour = 40 hours

The average American generates 82 pounds of glass per year (equivalent to about 164 average bottles). The example on the student card uses a traditional light bulb. A new energy efficient bulb uses 1/10 as much. Another fact: The energy saved from recycling a glass bottle can run a laptop for half an hour so if each student recycled a bottle a day they could power their typical school computer time.

You Have the Power

Meet Enrico Fermi. He was an Italian physicist who was born in 1901. He loved to challenge people to estimate big numbers. He'd ask questions like:

- How many drops of water are in Lake Erie?
- How many school busses parked end-to-end would it take to go from your town to the state capital?

To answer these questions, you would need to know a little mathematics, a little geography, and be able to put these skills together. Estimations are guesses but they are backed up by a lot of knowledge and skills. These are the basic skills that a scientist might use to solve important questions about the environment, too. One of the challenges of recycling is that most people don't believe that something small they do can make a difference. In this activity, you will collect some baseline data from your classmates and their families about their use and recycling of different products to make larger Fermi-like estimations. Your work will be important, because you will use your estimations to convey the message that little steps can make big differences.

Materials

- Student data sheets
- Map(s) of the community or the world
- String or yarn (for measuring distances on the map to scale)
- Sticky notes
- Scale (for weighing a newspaper)
- Calculators
- Materials for preparing a presentation to the community: markers, glue, paper, poster board, rulers, computers
- Other: materials as needed for conducting estimations or creating presentations: i.e. rolls of adding machine tape saved from your school's accounting department could be used for showing the distance or length or something – be creative!

Part 1: Warm-Up Question

1. With a partner, consider the challenge your teacher has prepared for you. Brainstorm how you might go about estimating this based on some basic measurements and knowledge.
2. Estimate the answer using the methods you and your partner have discussed.
3. Test your estimation. How far off or close were you? Why do you think that is?

Part 2:

1. Your group will be assigned to collect data on one of the following commodities: soda cans; plastic bottles; newspapers; or glass bottles. Some teams might be assigned the same challenge.
2. Estimate how many soda cans, glass bottles, plastic bottles, or newspapers the average family in your class uses in one week. How can you estimate this? There may be different ways to do this. Share ideas!
3. With your team, complete your estimations for the challenge you have been assigned in Table I on the student data sheet. Explain how you came up with the figures by showing your math in the correct quadrant on the student data sheet.
4. Using the baseline estimations you created in Part 2, complete the estimations for Table II. Show the math.
5. Present your findings to the class. Describe how you came up with your estimate and what your message would be to your community to impart the power of recycling!

Reflect and Apply

Using your estimation, develop a poster, flyer, power point presentation, podcast or video that incorporates a powerful statement to encourage the community to recycle. Your message might begin with: "Imagine if each of us recycled just [X cans, bottles, newspapers] every week, then we could . . . [build x, save as much energy as, or travel to . . . etc]

Extensions

- Create your own Fermi question or challenge and try to answer it based on the power of estimations!
- Learn more about Enrico Fermi using the internet and other library resources.

JOURNAL QUESTION

Reflect back on the estimations presented by your other classmates. Discuss at least 2 new things you learned and the impact they might have on your recycling plans!

Student Name: Period:

Table I. Show Your Math!

Soda Cans	Plastic Bottles
How many soda cans does your family use in a week?	How many plastic bottles does your family use in a week?
How many soda cans do all of our class families use in a week?	How many plastic bottles do all of our class families use in a week?
How many soda cans could our class families recycle in a year?	How many plastic bottles could our class families recycle in a year?
Newspapers	**Glass Bottles**
How many newspapers does your family use in a week?	How many glass bottles does your family use in a week?
How many newspapers do all of our class families use in a week?	How many glass bottles do all of our class families use in a week?
How much does a pile of 10 newspapers weigh?	How many glass bottles could our class families recycle in a year?

Table II

Soda Cans	Plastic Bottles
A soda can is about 6 inches high. If we lined up all the cans our class and their families use in a year, how many feet would that line go? Start on a map; Where could that line go? The energy used to make one can is about the same as what is needed to make an average car go a mile. How many miles could you go on the energy of the cans recycled by the class? Where could you go? (Use a map.)	The energy used to make 10 plastic bottles is about what you'd need to drive a small car a mile. Start at your school. Use a map, to estimate how far you could go in a car, using the energy from all the bottles that could be recycled by your whole class in a year. How many plastic bottles do all of our class families use in a week? How many plastic bottles could our class families recycle in a year?
Newspapers	**Glass Bottles**
About 100 newspapers can save two trees. How many trees could your class save if all of their family's papers were recycled? If there are approximately 500 trees to each acre of land in a forest, how many acres of forest could all the families in your entire school save? How many schoolyards would this be equivalent to? (Need to know the size of your schoolyard)	By recycling two big glass bottles, you can save enough energy to run a 50 watt bulb for 10 hours. How many hours of light would there be from the energy saved from the bottles all the families in your class use in a week if you recycled all of them? The energy saved from recycling 5 glass bottles can power 1 school computer for an hour. How many hours could a school computer be powered for if it could run on the energy saved by the class and their families if they recycled all the glass bottles used in a week?