Web Unit Plan

Title: How Can I Relate to a Million or a Billion?

Description: How big is a million really? How about a billion? Estimating and understanding large numbers are useful mathematical skills. Students learn about large numbers so that they can comprehend the magnitude of large numbers.

At a Glance

Grade Level: 5–7

Subject sort: Mathematics

Subject: Mathematics

Topics: Large Numbers

Higher Order Thinking Skills: Problem Solving, Analysis

Key Learnings: Conceptual and Visual Grasp of a Million and a Billion

Time Needed: 9 lessons, 45 minutes per lesson

Unit Summary

After exploring the magnitude of a million and billion in multiple contexts and visual representations, students work as teams to estimate and then rank big number facts from biggest to smallest, providing explanations for their ranking. Student teams use their learning from the unit to create and display school posters showing interesting facts about big numbers in their community or school.

Curriculum-Framing Questions

- **Essential Question:**
  How can I relate?
- **Unit Questions**

  How can I relate to a million?

  How can I relate to a billion?
- **Content Questions**

  What is the magnitude of a million?

  What is the magnitude of a billion?

  How are large numbers represented?

  How much bigger is a billion than a million?

  How can visual models help to conceptualize large numbers?

Assessment Processes

View how a variety of student-centered assessments are used in the How Can I Relate to a Million or a Billion? Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Day One: Setting the Stage

Pose the Essential Question, *How can I relate?*

Have students individually write about the question in their journals. Encourage them to write about ideas, concepts, or objects that are difficult to relate to or conceptualize. Collect the journals and save them to compare to the final reflective writing at the end of the unit. (This can serve as a pre/post snapshot of some of the learning that occurs for students individually.)

Ask several students to share their responses to the Essential Question and then tell the class that they are beginning a unit that will help them relate to and understand very large numbers, such as a million and a billion.

Making Your First Million

Explain to student that today they will examine the Unit Question, *How can I relate to a million?*

Engage students in discussing large numbers by recounting that some scientists believe dinosaurs became extinct approximately 65 million years ago. Ask students to consider a certain athlete's salary reported as $20 million, or that the sun is approximately 93 million miles from Earth. Ask students the question, *How can we relate to such large numbers?*

Gather the following materials:

- Pair of scissors for each student
- Roll of transparent tape per group of 10 students
- Making a Million handout for each student

Distribute a copy of the Making a Million handout to each student. Call the students attention to the 100 mm by 100 mm grid on the handout. Ask students to determine how many square mm are on each person's page.

Ask students to individually record answers to the questions on the handout. Organize students into groups of 10, and have students share and discuss their answers with their group. Then, ask the groups to count out their grids and tape them together to form 100 mm by 100 mm rectangles.

Have the class determine how many square mm make up each group's rectangle. (Each group should have determined that the total is 100,000 square mm.) Ask students to determine how many group rectangles would be needed to piece together a square containing 1 million square mm (10 rectangles).

Have students help cut and paste four copies of the grid found on the handout onto a reproducible page, and run off 25 copies to tape together so that students can actually see 1 million square mm.

Day Two: Big Number Scavenger Hunt

Explain to students that they are going on a big number scavenger hunt to examine the magnitude of a million and a billion and explore the various ways the numbers are represented.

Pose the questions, *What does a million look like?* and *What does a billion look like?* Then, have students explore the following Web sites to gain more understanding of big numbers and the various ways to represent them:

- The MegaPenny Project*

- Names for Big Numbers*
- 87 Billion Dollars*
- Lots of Dots*

Direct students to reflect in their journals and then share one or two interesting points they learned about a million and a billion and the difference between the two.

Ask students to share two or three ways they found the numbers represented (such as names, powers of 10, standard notation, models made from dots, and so forth).

Day Three: Making Millions and Billions of Dollars

Pose the following problems to your students, and have them write their answers in two different ways:

- *If I gave you $1,000 a day, 7 days a week, how long would it take you to collect $1 million? Assume you are not spending any, and you are not earning interest (2 years, 8 months, 26 days). A million dollars will buy how many yo-yos, shoes, sports cars, or items in magazines, newspaper ads, catalogs, or online shopping?*
- *How long would it take to accumulate $1 billion?* (2,737 years, 10 months, 7 days) *A billion dollars will buy how many yo-yos, shoes, sports cars, or items in magazines, newspaper ads, catalogs, or online shopping?*

Have students explain how they arrived at their answers (that is, *what problem-solving strategies did they use?).*

Ask students the Content Question, *How much bigger is a billion than a million?* Solicit a few ideas from students during whole class discussion and then ask small groups to explore the visual differences between a million and a billion using square mms and dots. Pose the following questions to students:

- *How can we use the square mm rectangles (the 100 taped together to show a million) to visually show how much bigger a billion is than a million?*
- *How many pages of the four grids would we need to show a billion square mms*? (25,000)
- *Using the million dots from the scavenger hunt, how many pages would you need to make a billion dots?* (1,000)
- *Are you surprised by the difference? Why or why not?*

Ask students to create their own exit passes. Give an index card or a small piece of paper to each student. Ask students to write one fact or concept that they learned during class and one question they still have. These exit passes must be turned in before they leave class. This activity encourages self-reflection and can provide useful feedback. Have students also add the information written on their exit passes to their journals.

Day Four: Rice Activity

Read the book *The Rajah's Rice*, by W. H. Freeman and Company (1994) to introduce the rice activity. This book is about Zandra, the official bather of the rajah's elephants. She saves the elephants from serious illness. In turn, she asks the rajah for a reward that is more costly than the rajah realizes. She asks for only a measure of rice for the hungry villagers—two grains on the first square of a chessboard, four on the second, and so on, doubling the amount of rice on each square of the chessboard each day until all the squares on the chessboard are covered. Although the amount seems insignificant at first, it grows at an alarming rate. Doubling has little effect on small numbers but an increasingly enormous effect

as the numbers grow larger. The rajah's storehouse is soon empty, and he must admit that he cannot fill her seemingly modest request.

Tell the class that, like Zandra, they will grow grains of rice by doubling each day to see how many days must pass before they collect a million grains of rice on a single day. Place the students in small groups and ask them to predict on which day they think they will collect a million grains of rice in one day. Then, ask them to solve the problem and create a chart to keep track of the growing rice, similar to the following example:

Day	# of grains of rice
1	1
2	2
3	4
4	8
5	16
6	32

Pose a follow-up question, *How many days are needed to reach a billion grains of rice collected in one day?*

Day Five: How Crowded Is a Country?

Explain to students that the populations of countries are usually big numbers. In this activity, students explore the notion of population density by playing a game and ranking six countries.

To get started, display the area and population of the United States and ask students to estimate the average number of people per square kilometer. Have students explain how they got their estimates.

Review the term *population density*, which is a way of describing how crowded a place is by stating the average number of people in each square kilometer or square mile.

Write the area and population data for two more countries and ask students to identify which country is more crowded. Have students explain their responses.

Next, introduce the *How Crowded Is It?* game. For this game, students use the How Crowded Is It? handout and work through the following steps:

1. Each team visits the United Nations Cyberschoolbus* Web site and chooses six countries.
2. Using the site, teams find the area and population for each country and fill in their charts on the handout.
3. After the teams have their information, the teams have five minutes to estimate and order the six countries from the most crowded to the least crowded.
4. Next, students calculate the actual population densities or request the data from the Web site and record their data.
5. Then, teams put in the actual order of the countries as their second group (such as Group 1a) and compare it to their estimated order.
6. Finally, the teams calculate their score as follows:
    - 5 points for each country listed in the correct place

- 3 points for each country off by one place
- 1 point for countries off by two places
- 0 points for countries off by three or more places

For example, a team's final table might look like the following:

Team's Estimated List	Actual Order	Points Awarded
1. Indonesia	Denmark	3
2. Denmark	Indonesia	3
3. Libya	Romania	0
4. Ghana	Ghana	5
5. Romania	Argentina	1
6. Argentina	Libya	3
	Total	15

The team with the most points wins the round. Teams play two or more rounds of the game.

While teams try to put the countries in order, use the opportunity to give help as needed with estimation and to assess the students' estimation abilities. While students determine the actual orders and calculate their scores, assess student progress by observing and asking questions. Use guiding questions such as the following to gain insights into students thinking:

- *Were you surprised by any of the data?*
- *What did you learn from the data?*
- *How did you decide which country was most crowded?*
- *How did you decide which country was least crowded?*
- *Did you estimate? How? Did you round the numbers? Did you use numbers that worked well together?*
- *Did your ability to rank countries improve as you played more rounds of the game? Why or why not?*
- *What have you learned from the data you collected?*

Once again, ask students to create their own exit passes. Hand out an index card or a small piece of paper to each student. Ask students to write one fact or concept that they learned during the activity and one question they still have. These exit passes must be turned in before they leave class. Once again, ask students to add the information to their journals.

Days Six through Nine: Final Project

Student groups complete research about their school or community that yields big number facts. Each group creates a slideshow presentation to share with the class and a poster to display in the school. Each slideshow presentation should include the following elements:

- One big number fact (displayed large enough on the poster so it is easy to read)
- Explanation of how the group calculated the number

- Graph showing the relationships used to create the big number fact (for example, number of heartbeats and number of years)
- Visual representation of the number fact (such as dots, square mms, or another representation)
- Two or three mathematical representations of the number (using exponents, standard form, names, and so forth)
- Source of the data

Have students use computers (if available) to display the information they gather. Each poster should include the following elements:

- One big number to a page displayed in two or more ways
- Explanation of what the big number stands for
- Graph
- Explanation of how the calculations were derived
- Source of the data

Review the project rubric with students to help guide the process. Give students time to gather data, and encourage them to make appointments to discuss the project with people in the school or community to help research big numbers. Give students a list of possible questions to help get them started, such as:

- *How many times does the fifth/sixth/seventh grade breathe (collectively) in a year or a decade?*
- *How many times does a grade's heart beat collectively in a year or decade?*
- *How many minutes are students in school in a year or decade?*
- *How many days, hours, minutes has everyone in the fifth/sixth/seventh grade been alive?*
- *How many napkins are used at the school during the course of a day, month, or school year?*
- *How high would a stack of 1 million DVDs be?*
- *How many days would it take for a local bagel company to sell 1 million bagels if the average sales are 250 bagels per day?*

While students work in their small groups, use the collaboration observation sheet to note how individual students work in their groups. After students complete their presentations and posters, display the posters in the school. Using string or fishing line, attach the sheets together at the top, and display them throughout the school.

Unit Summary and Final Reflections

Return to the Essential Question, *How can I relate?* Ask students to think about how they responded to the question at the beginning of the unit. Encourage them to write about what they have learned about these things over the course of the unit and to provide as much detail and examples as possible in their journals. Use this reflection as part of your assessment of their learning within the unit.

Prerequisite Skills

- Fluency with basic number combinations for multiplication and division
- Ability to use strategies to estimate computations and reasonableness of results

- Comfort with the basic place–value structure of the base-10 number system
- Familiarity with slideshow presentation software

Differentiated Instruction

Resource Student

- Make modifications as dictated in the student's IEP
- Provide visual aids and examples (visual images of big numbers from the unit plan can be helpful)
- Supply an outline of the tasks and timeline for the project (including milestones)
- Assign the student to a group best suited to work with the student
- Provide extra time as needed to complete individual assignments

Gifted Student

- Encourage the student to create a big numbers book, with illustrations and connections to real life
- Have the student present a big numbers book to the class or to lower grade classes
- Ask the student to create a game that uses data from the United Nations Cyberschoolbus* Web site
- Have the student examine a trillion and provide visual examples of the magnitude of a trillion along with how it compares to a million and a billion

English Language Learner

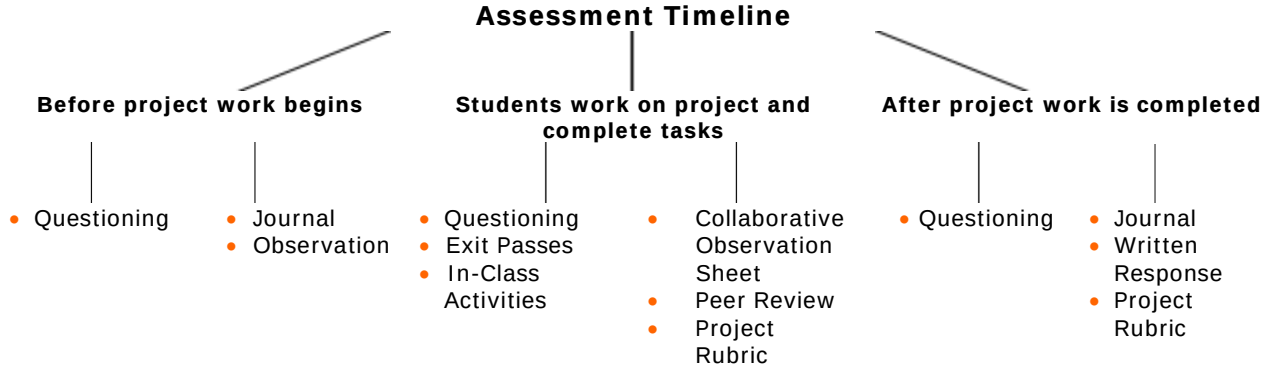
- Provide visual aids and examples (visual images of big numbers from this unit plan can be helpful)
- Address the various ways of naming big numbers in various cultures (for example, a billion in the United States is not the same in the United Kingdom)

Credits:

A teacher participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

Things You Need

Assessment Plan



Throughout the unit, use both informal and formal methods for checking student understanding. Questioning occurs throughout the unit to probe student thinking and allow student reflection. Anecdotal notes and observations assist in keeping track of individual student needs while students explore the concepts of the unit. Have students check work with their group members. Use exit passes and journals to encourage self-reflection and provide useful feedback. While students work in groups, use the collaboration observation sheet to provide feedback to individual students regarding their efforts and assess collaboration. The project rubric is used by student groups to self-asses their presentations and posters before teacher assessment. The same rubric is used by the teacher at the end of the unit to assess the presentation and poster. Students respond to the Essential Question in their writing journals in conclusion of the project and make comparisons to what they wrote at the beginning of the unit.

THINGS YOU NEED (highlight box)

Targeted Content Standards and Benchmarks

Targeted NCTM Content Standards

Number and Operations Standard for Grades 3–5 and 6–8

In grades 3–5 and 6–8, all students should—

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems
- Understand the place–value structure of the base-10 number system and be able to represent and compare whole numbers and decimals;
- Select appropriate methods and tools for computing with whole numbers from among mental computation, estimation, calculators, and paper and pencil according to the context and nature of the computation and use the selected method or tool.

In grades 6–8, all students should—

- Develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation;
- Develop a deeper understanding of very large and very small numbers and of various representations of them;
- Judge the effects of such operations as multiplication, division, and computing powers and roots on the magnitude of quantities;
- Judge the reasonableness of numerical computations and their results.

Problem Solving Standard for Grades 3–8

In grades 3–8, instructional programs should enable all students to—

- Solve problems that arise in mathematics and in other contexts
- Build new mathematical knowledge through problem solving
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving

Connections Standard for Grades 3–8

In grades 3–8, instructional programs should enable all students to—

- Recognize and use connections among mathematical ideas

- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in contexts outside of mathematics

Student Objectives:
Students will be able to:

- Develop an understanding of a million
- Develop an understanding of a billion
- Develop an understanding of the magnitude of the difference between one billion and one million
- Become familiar with a variety of ways to represent large numbers
- Develop a deeper understanding of the effect of computing powers of 10 and doubling on the magnitudes of quantities

Materials and Resources

Printed Materials

Anno, M. (1995). *Anno's magic seeds*. New York: Philomel Books.

Barry, D. (1994*). The rajah's rice.* New York: W. H. Freeman and Company.

Birch. (1993*). The king's chessboards.* Upper Saddle River, NJ: Scott Foresman.

Demi. (1997). *One grain of rice.* New York: Scholastic.

Hertzberg, H. (1993). *One million*. New York: Times Books. (This book is a nice accompaniment to the Lots of Dots* Web site exploration during the scavenger hunt of big numbers.)

McGuffee, M., & Gard, D. (1998). *One in a billion.* Cooper City, FL: SpanPress.

McKibbon, H. W. (1996). *The token gift.* Vancouver, Canada: Annick Press.

Morgan, R. (1999). *In the next three seconds.* London: Puffin.

Nolan, H. (2001). *How much, how many, how far, how heavy, how long, how tall is 1,000?* Tonawanda, NY: Kids Can Press.

Packard, E. (2000). *Big numbers.* Minneapolis, MN: Millbrook Press.

Schwartz, D. (1999). *On beyond a million.* New York: Doubleday.

Schwartz, D. M. (1998). *G is for googol.* New York: Tricycle Press.

Schwartz, D. M. (1985). *How much is a million?* New York: William Morrow.

Schwartz, D. M. (1989). *If you made a million.* Parsippany, NJ: Pearson Learning.

Supplies

- Rice and small measuring tools for rice activity
- Posters for final project
- String or fishing line to display the posters in the school
- Markers for creating posters
- Index cards or small pieces of paper for exit passes

Internet Resources

- Ask Dr. Math
  http://mathforum.org/library/drmath/sets/elem_large_numbers.html*
  Dr. Math responds to large numbers questions
- A Feel for Big Numbers with Grains of Salt
  www.vendian.org/envelope/dir0/grain_feel.html*
  Descriptions of what kinds of places large numbers of grains of salt can fill
- "What Order of Magnitude Is ...?" Game
  www.vendian.org/envelope/dir0/what_order_is.html*
  Explanation of strategies for determining order of magnitude
- Counting to 10 Billion... on Your Fingers
  www.vendian.org/envelope/dir0/counting_on_fingers.html*
  Diagrams to show how 10 billion can be represented with your hands
- The MegaPenny Project
  www.kokogiak.com/megapenny*
  A project to help students visualize large numbers using pennies
- Names for Big Numbers
  www.stormloader.com/ajy/bignum.html#ten9*
  Explanation of the background naming of big numbers
- 87 Billion Dollars
  www.crunchweb.net/87billion*
  Diagrams and pictures to help visualize 87 billion dollars
- Lots of Dots
  www.vendian.org/envelope/dir2/lots_of_dots*
  The use of dots to help show big numbers
- United Nations Cyberschoolbus
  http://cyberschoolbus.un.org/infonation3/basic.asp*
  Creates charts on selected countries using data selected by the user

Technology—Hardware

- Computer for Internet research
- Printer to print final projects
- Internet connectivity to connect to Web sites

Technology—Software

- Presentation program to present final projects
- Word processing or desktop publishing to create final project posters
- Internet browser to search Web sites