Expanded Notation and Scientific Notation

Summary

This activity will help students to learn about expanded notation and scientific notation.

Materials

Invitation to Learn

- *If You Hopped Like a Frog*

Instructional Procedures

Calculator

- *Notation and Powers Table* (pdf)

3" x 5" index cards

Marker

Place value house models

Paper

Pencils

- *0-9 Digit Cards* (pdf)

Lunch sacks

- *Power Capture Game* (pdf)

Additional Resources

Books

- *If You Hopped Like a Frog*
  , by David M. Schwartz; ISBN 0-590-09857-8 Powers of Ten, by Phillip Morrison; ISBN 0-7167-1409-4
- *Big Numbers*
  , by Edward Packard; ISBN 0-7613-1570-5
- *Zoom*
  , by Istvan Banyai; ISBN 0-670-85804-8
- *Actual Size*
  , by Steve Jenkins; ISBN 0-618-37594-5
- *G is for Googol*
  , by David M. Schwartz; ISBN 1-883672-58-9
- *When There Were Dinosaurs, Using Expanded Notation to Represent Numbers in the Millions,* by Orli Zuravicky; ISBN 0-8239-8901-1 Media
- *Powers of Ten*
  , by Charles and Ray Eames (Pyramid Film and Video, 1-800-421-2304)

Articles

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Background for Teachers

Students must be versatile in different types of notation of numbers. By 6th grade, students need to be familiar with the terms standard notation, expanded notation, and scientific notation. Understanding the latter two types of notation will aid in the composition and decomposition of numbers.

Expanded notation is a method of writing numbers using the distributive property. Expanded notation begins as early as 1st grade. As students progress through school, expanded notation may be represented in different ways. In 4th grade, the number 4,376 may first be expanded to 4,000 + 300 +

70 + 6. By 5th grade, it may then be represented as (4 x 1,000) + (3 x 100) + (7 x 10) + (6 x 1). By 6th grade, students need to be able to write 4,376 as (4 x 10^3) + (3 x 10^2) + (7 x 10^1) + (6 x 10^0). Scientific notation is a method of writing numbers that are very large or very small with only a few symbols. Numbers in scientific notation are written as a product of two factors. The first factor, also known as a coefficient, is greater than or equal to 1, but less than 10. The second factor is a power of 10. For example, 7 x 10^11 is scientific notation for 700,000,000,000.

Instructional Procedures

Invitation to Learn

Read to students the book *If You Hopped Like a Frog*. Point out to students some of the facts using very large numbers. For example, if you grew as fast in your first nine months as you did in the nine months before you were born, you would weigh more than 2,500,000 elephants. Write the number 2,500,000 on the board. Have students practice reading this number. Tell students that this number is written in standard notation. We will be learning about other ways to write very large numbers such as expanded notation and scientific notation.

Instructional Procedures

(The activities listed below are intended to be taught sequentially. They will take several lessons/days to complete with students.)

Use a calculator to discover the patterns of the powers of 10. Begin with 10^0 which is equal to 1. Continue with 10^1, 10^2, and so forth. Have students record these in their *Notation and Powers Table* for future reference. As students discover the answers, write each exponential notation on an index card and display in place value house model.

Remind students about the number 2,500,000 from the elephant comparison in the book *If You Hopped Like a Frog*. This number is written in standard notation. Another way to write this number is in expanded notation.

Show students how to write the large number 2,500,000 in expanded notation. Suggested steps include:

Find the number in the largest decimal place value column. Write down that number and multiply it by the power of ten equivalent to its place value. Students could look at a place value house model that shows periods to find the place value's power of ten, or refer to their *Notation and Powers Table*. In the number 2,500,000, the two is in the one millions place which is 10^6. The first step is (2 x 10^6).

Find the number in the next largest decimal place value column. Write down that number and multiply it by the power of ten equivalent to its place value. In the number 2,500,000, the five is in the hundred thousands place which is 10^5. The expanded notation now should read (2 x 10^6) + (5 x 10^5).

Continue this pattern with all numbers other than zero. Since the rest of the digits in 2,500,000 are zeroes, the final answer should read:

2,500,000 = (2 x 10^6) + (5 x 10^5)

Practice writing other numbers in expanded notation using powers of 10. Use the place value house model and *Notation and Powers Table* for references.

Show segment of the movie *Powers of Ten*.

To practice the powers of ten place value equivalencies, play the partner game "Power Capture."

Cut apart the *0-9 Digit Cards*. Put the digit cards 0-9 in a lunch sack.

Partner One pulls out a number and writes it in the place value chart in random order on the *Power Capture Game* handout. Partner One returns the number to the sack and continues selecting digits and placing them in random order until a secret seven-digit number is generated.

Partner Two will have three turns to guess a digit in the Partner One's number. For each correct guess, Partner Two scores the number of points for the digit's place in powers of ten. Example: Partner Two guesses there is a 4 in the number and is correct. The 4 is in the hundreds place. Partner Two scores two points because the hundreds place is 10^2. After three guesses, Partner Two's turn is completed.

Each partner will keep score for each other on the *Power Capture Game* handout.

Partner Two then generates a seven-digit number, and Partner One has three guesses to capture his power.

The first person to reach a score of 50 power points is the winner.

Remind students that we have been looking at numbers in standard notation and expanded notation using powers of ten. Tell students there is another way to write very large numbers called Scientific Notation.

Remind students of the number 2,500,000 from the elephant comparison in the book *If You Hopped Like a Frog*. Show students how to write the large number 2,500,000 in scientific notation Suggested steps include:

Find the decimal point in the large number. If there is no decimal point, it is at the end of the number.

Move the decimal point to the left so that you get a number that is greater than or equal to 1, but less than 10. Drop any zeroes that are not needed. This number will be the first factor or the coefficient. In the number 2,500,000, the coefficient is 2.5.

Count the number of places you moved the decimal point to the left. The number of places you moved is the power of 10 to use for the second factor. In the number 2,500,000, the decimal is moved six places to the left. It will be 10^6.

To complete the scientific notation, write the numbers found in steps b and c as a product. The answer for the example given is as follows:

2,500,000 = 2.5 x 10^6

Have students practice writing large numbers from the interesting facts below in scientific notation:

Dogs have about 220,000,000 olfactory receptors to help them smell--roughly 40 times the number humans have.

The population of Tokyo, Japan was approximately 34,450,000 in 2000.

The biggest iceberg ever seen, known as B-15, weighed an estimated 4,000,000,000,000 tons.

One light-year is the distance light travels in one year--about 5,900,000,000,000 miles.

Scientists discovered a black hole at the center of M87, a galaxy in the constellation Virgo, rotating at 1,200,000 miles per hour using the Hubble Space Telescope.

The planet Mercury travels at 107,000 miles per hour.

Microscopic quantities of liquid water were found trapped in salt crystals in a 4,500,000,000-year-old meteorite that fell to Earth at Monahans, Texas in 1998.

In the mid 1990's, the world had an estimated 19,200,000 camels, of which nearly half were in Somalia and Sudan.

In the early 1990's, Utah's chicken population produced approximately 456,000,000 eggs.

During his lifetime, George Eastman (1854-1932), an American inventor of films and cameras, donated $75,000,000 to charities.

Source: http://www.worldalmanacforkids.com

Show students how to change numbers in scientific notation to standard notation. Suggested steps include:

Look at the exponent in the power of ten of the second factor. In the expression 2.5 x 10^6, the exponent is six.

Move the decimal point in the first factor that many places to the right, adding zeroes as needed. If you move the decimal six places to the right in 2.5, you will have to add five zeroes to get the correct answer of 2,500,000.

Extensions

Teach students how to write very small numbers such as those encountered in the 6th grade microorganism lessons in scientific notation.
Show students the complete movie *Powers of Ten* listed in additional resources.
Teach students about "googol" and "googolplex."
Prepare 3 x 5 index cards with different numbers written in scientific notation. Give each student a card. Select 3-5 students at a time to come to the front of the room with their cards and have them stand in order from least to greatest.
Family Connections
Read completed fact books to family.
Use the suggested Internet sites in additional resources to find other interesting facts with large numbers. Practice writing these numbers in scientific notation.
Check out a book from additional resources from the local library to share with family.

Assessment Plan

Have students write a number fact book where the numbers are presented in both standard and scientific notation. Students can gather facts from almanacs, encyclopedias or Internet sites such as those listed in additional resources.
Have students visit one of the Internet sites listed in Additional Resources to learn more about scientific notation. Some of these sites have practice problems, games, and feedback for students.

Bibliography

Ma, Liping. (1999). Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States.
This research investigates the importance of a profound understanding of fundamental mathematics on the part of the teacher. Teachers with this profound understanding incorporate the following four properties in their teaching and learning: connectedness, multiple perspectives, basic ideas, and longitudinal coherence.
National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics.
Teachers need many different kinds of mathematical knowledge. They must have a deep understanding of concepts, practices, principles, representations, and applications. They need knowledge about math as an entire domain, and they also need a thorough knowledge of the curriculum on their own grade level. Teachers must know how to convey mathematical ideas effectively in a coherent and connected manner.

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