About  $\frac{1}{2}$  hour.

Note: Need a book like "How Much is a Million" by David M. Schwartz that describes big numbers. I read this books to the mathletes. Also, print a copy of last page of this handout which show a googol for mathletes to see (and count).

### 1. Introduction

This lesson is all about big numbers. Let's start with the poem **Smart** by Shel Silverstein

My dad gave me one dollar bill 'Cause I'm his smartest son, And I swapped it for two shiny quarters 'Cause two is more than one!

And then I took the quarters And traded them to Lou For three dimes -- I guess he don't know That three is more than two!

Just then, along came old blind Bates And just 'cause he can't see He gave me four nickels for my three dimes, And four is more than three!

And I took the nickels to Hiram Coombs Down at the seed-feed store, And the fool gave me five pennies for them, And five is more than four!

And then I went and showed my dad, And he got red in the cheeks And closed his eyes and shook his head--Too proud of me to speak!

### 2. Explore the poem and defining a unit

Why is this poem funny? Did the boy get a good deal? Isn't five bigger than one? What was wrong with his logic?

The problems is the boy has confused number value without a "unit" and number value with a unit. But what is a unit.

Put on board: 2 \_\_\_\_\_ and ask for examples of units; for example, 2 inches 2 pennies 2 feet 2 nickles 2 yards 2 quarters 2 miles 2 dollars So, is 2 big or small? Depends on the unit.

Clarify that "big" is a relative term -- it changes with the context ; what other ones do we use all the time? small; tall, etc; the meaning changes with the unit and comparison being made.

#### **3.** Proof no largest number

Can someone name a big number?

[Notes: Accept any answer except "googol" or "infinity". If someone says "googol", say "we'll come back to that number later, let's have some others." If someone says "infinity" say that infinity is a destination, like a place that we just keep going TOWARDS, but not an actual number we can get to.]

Acceptable answers are numbers like hundred, thousand, million, billion, zillion....

Is there a biggest number? No.

We can prove this by taking any number you think is biggest, and just add one. For example, if a zillion was the biggest number, what would be larger? A zillion one.

#### 4. Exploring multiplying by ten

Because we do need some large number, we give them special names. Let's explore some of these big numbers.

I'd like to start by counting fingers in this room.

How many do you think there are? Let me have some guess?

Write them on the board.

As appropriate, have students stand up and we'll count number of fingers (by tens of course). As we count have people sit down.

NOTE: Be sure to put th this table on board as we start to count:

1 10 1 x 10 = 10 and we say 1 times 10 is 10 2 2 2 x 10 = 20 and we say 2 times 10 is 20

2 20 2 x 10 = 20 and we say 2 times 10 is 20

jump down to last few number of people in room

Can you give me a rule for multiplying by 10. [Add a 0 to the number.]

How many toes are in the room? 230 How many fingers and toes? 460 Are these big numbers So if we have 450 children at our school, how many fingers? 4500 Is this a big number? If we had 1000 children in out school, we'd have 10,000 fingers. Is that a big number?

The highest mountain on earth is Mt Everest at about 29,000 feet. Airplanes fly over 30,000 feet, which is even higher.

The international space station is about 250 miles in outer space. Is that high? Which is higher, 30,000 feet or 250 miles? [250 miles is about 1,250,000 feet!] Refer back to Shel Silverstein poem to be sure the units are right.

#### 5. How big is a million?

So let's explore how big 1 million is.

Read first 20 pages "How Much is a Million" by David M. Schwartz.

Note: the pages in the book are NOT numbered. I stop after showing the seven pages of tiny stars.

Note: On page just before all the tiny stars, it says "Presto! One hundred stars." I say "I actually counted these and there are 100 which are spread out here." I go round and show the page to the students. I have them guess the number of pages needed for 1 million stars as I slowly turn the next couple of pages.

So, 1 million is a really big number. Let's look at how we name our numbers. Write these on board and just say the name. Have students say names as write them.

To help us name the numbers, we group the zeros into threes and put in commas to separate them. So next we have

10,000	ten thousand
100,000	hundred thousand
1,000,000	one million
10,000,000	ten million
100,000,000	one hundred million
1,000,000	Billion
1,000,000,000	Trillion
1,000,000,000,000	Quadrillion
1,000,000,000,000,000	Quintillion

# 6. Optional: finish reading book

Finish reading "How Big Is A Million"

# 7. What is a googol?

Mathematicians who work with probability wanted a name for a really big number. In 1920, the mathematician Edward Kasner asked his 9-year old nephew what he thought the number 1 followed by 100 zeros should be called and he supposedly replied something as silly as that is a "googol." So, now we have a googol.

Here's a picture of what a googol looks like!

And there is an even larger number: a googolplex or a googol of googols!!!

 $Googolplex = 10^{googol}$ 

#### 8. For you to think about on your own

You may like to look the biggest number you see/hear/read about in the next few weeks. Remember to include the unit, so we compare the value.

000,10,000,000,000,000,000,000,1 googol = 1 with 100 zeros000,000,000