LessonTitle: Make a Million Using Mayan	**Pre 1.1**
Utah State Core Standard and Indicators Pre-Algebra Content Standard 1.5 Process Standards 1, 3, 4	
Summary After a short introduction to the Mayan number system which includes some practice writing different numbers in Mayan, students are challenged to write a million using Mayan, base 20. By comparing our number system to others, students take a close look at the patterns in place value and the decimal system, and how positive and negative exponents are a way to record place value growth and decay.	
Enduring Understanding Studying a foreign language is often the best method for understanding how the English language works. Likewise, examining other number systems enables students to recognize just what a number system is.	**Essential Questions** How do you make a million using Mayan numbers?
Skill Focus Patterns in large and small numbers Number bases and place value as related to base 10	**Vocabulary Focus**
Assessment	
Materials: Overhead of number system samples. Calculator, A map of central America and reference books and pictures on the Mayans (optional).	
Launch	
Explore	
Summarize	
Apply	

Directions: Although there are designated homework assignments, keep in mind that portions of labs can also be used as homework assignments, depending on how class time is utilized and the end of class falls. *Also, the calculator is an important tool throughout this lab*.

Introduction and discussion: This lab could certainly be used as part of an interdisciplinary unit on Central America. However an extensive introduction is not necessary. Since students are very familiar with the existence of native Americans, the introduction may be simply stating that the Mayans were a large group of native Americans who attained a high level of civilization in central America. And archeologists have been fascinated by their culture because no one knows for sure why their civilization declined and was lost. An intriguing mystery has been the deciphering of their number system .

You could begin this lesson with a real investigation (RECOMMENDED)by having students try to figure out how the Mayan number system works and create a million using Mayan (see the 1st activity page below). Or, depending on your class and their problem solving experience, you may decide to lead them through the understanding necessary to create a million using Mayan. If this is so, skip the first activity. Continue as follows.

Write this example of a Mayan number on the board. Students enjoy guessing what number they think is represented in the sample. Share the guesses.

= **6,412**

The correct number for the sample written in base 10 is 6,412 or $6{,}412_{10}$. Inform the students that our work in this lab will be to understand how number systems work—Mayan is just one example--and be able to transfer back and forth between two different number systems. *By doing this we will be able to understand our own system better and prepare to work in algebra more effectively.*

Show the basic Mayan symbols and their use as shown below.

• = 1 = 5 = 0 (a place holder)

What are the basic symbols used in our number system? What do you think? What's different? Discuss the function of 0 as a place holder. Which system do you think will more easily record very large numbers? Why? (No value judgments—all ideas are conjectures at this point.)

Begin by demonstrating the numbers from 1-6, and having students duplicate your demonstration. Partially cover the overhead. Students should continue up to 19. Then demonstrate the change in place value by showing how to write 20 in base 20, making special note of the space for designating more than one place value, as shown. (see overhead)

Compare this to how we change to a different place value when we move from 9 to 10. Discuss how their place value moves vertically and ours moves horizontally—so their numbers get taller as they get larger and ours get wider.

Have the students try 21-26 on their own. Then check. (See below)

21 22 23 24 25 26

When students are working to predict when they will move to the third place value, keep the lower part of the overhead covered—they should realize that 399 is the last number they can count to. Point out that this is 20 x 20—compare to our multiplication by 10 when we move to a new place value.

nineteen sets of 20 = 380

= 399

nineteen ones = 19

This number in base 10 = 399. If you add one more to this number then you must move to the next place value or twenty sets of 20 (see below). This is like when you add one to 99, you must move to 100 or 10 sets of 10.

• = 1 set of twenty twenties (20^2)

= 0 sets of twenty (20^1) = 400

= 0 sets of 1 (20^0)

The third place value fills up at 7999. If you add one more to this number then you must move to the next place value or twenty sets of 400 (20^2) or 8000.

nineteen sets of 400 or 19 x 20^2 = 7600

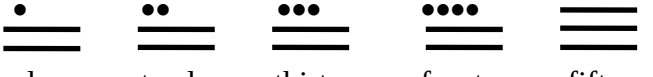
nineteen sets of 20 or 19 x 20^1 = 380

nineteen ones or 19 x 20^0 = 19

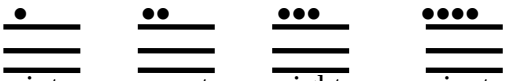
OVERHEAD (for introduction)

one two three four five

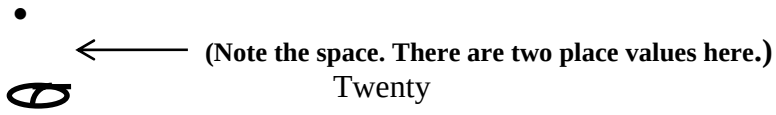
six seven eight nine ten



eleven twelve thirteen fourteen fifteen



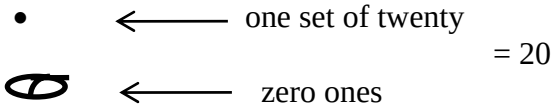
sixteen seventeen eighteen nineteen



(Note the space. There are two place values here.)

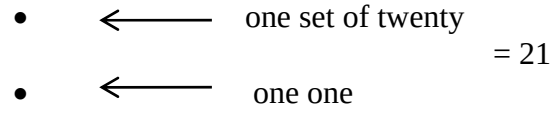
Twenty

The two place values mean:



one set of twenty = 20

zero ones



one set of twenty = 21

one one

Overhead #2

What happens when you get to 399?

nineteen sets of 20 = 380

= 399

nineteen ones = 19

• = 1 set of twenty twenties (20^2)

= 0 sets of twenty (20^1) = 400

= 0 sets of 1 (20^0)

nineteen sets of 400 or 19 x 20^2 = 7600

nineteen sets of 20 or 19 x 20^1 = 380

nineteen ones or 19 x 20^0 = 19

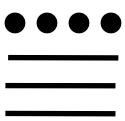
Pre 1.1

Break the Code:
Make a Million using Mayan Numbers

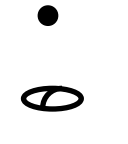
Use the examples below to figure out how the Mayan number system works. Then use your ideas to write one million using Mayan numbers.

 **= 1**

 **= 6**

 **= 19**

 **= 20**

 **= 403**

 **= 2804**

Pre 1.1 Mayan Number System (base 20)

1) Imagine you were writing the numbers from 1 to a million in base 10 using the intervals as begun below. Describe as clearly as possible why you move to each new place value to continue counting.

1	10…	100…	1000…	10000…	100000
2	20…	200…	2000…	20000…	…
3	30…	300…	3000…	…	
4	40…	400…	…		
5	50…	…			
6	60…				
7	70…				
8	80…				
9	90…				

Explanation:

2) Following your teacher's model, write the numbers 1 to 26 in Mayan.

1)	2)	3)	4)	5)
6)	7)	8)	9)	10)
11)	12)	13)	14)	15)
16)	17)	18)	19)	20)
21)	22)	23)	24)	25)
26)	27)	28)	29)	30)

3) You have written the numbers from 1 to 30 in Mayan (base 20). If you were to continue, predict when you think you would need a third place value. Explain your answer.

4) Predict how to write 400 in Mayan. Explain your answer—use problem #1 above to help you.

5) Predict the last number you could create using 3 place values in Mayan.

6) Predict how to write 8000 in Mayan. Explain your answer.

7) Explain Mayan place value. Complete the charts on the following page. Then explain.

Chart 1: Base 10

10000	=	____	=	_____
1000	=	____	=	_____
100	=	10^2	=	__100___
10	=	10^1	=	_____
1	=	____	=	_____

Chart 2: Base 20

= ____ = _____

= ____ = _____

= ____ = _____

= ____ = _____

= ____ = _____

8) Instead of writing the place value for base 20 in Mayan, it could be written as below.

10000_{20} = ____ = _____

1000_{20} = ____ = _____

100_{20} = 20^2 = _____

10_{20} = 20^1 = _____

1_{20} = ____ = _____

The Mayans probably counted using both their hands and their feet, thus coming to groups of twenty. Perhaps there was a culture which used only one hand to group with. Fill in the values for a base 5 number system.

10000_5 = ____ = _____

1000_5 = ____ = _____

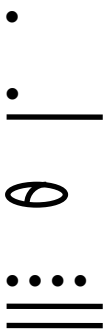
100_5 = 5^2 = _____

10_5 = 5^1 = _____

9) You choose:

- Create a base 5 number system. Use whatever symbols you want. Prepare a presentation in which you demonstrate and explain your system. If you would like, you may ask permission to create a different base number system.
- Research different ancient number systems. Prepare a presentation in which you demonstrate and explain the systems.

10) Translate these numbers from Mayan to Base 10 (Hindu Arabic). Use the place value charts from question 1 to help you.



11) Translate these Hindu Arabic numbers to the Mayan system. Use the place value charts from question 1 to help you. Be prepared to demonstrate how you thought about it.

613 = 1,600 = 6,708 =

12) Super Challenge!!! Figure out how to write a million in Mayan.
Show all your work and thinking below.