Aztec and Mayan Math

Materials

- 1 Styrofoam meat tray for each student. You can get them from supermarkets, or students can bring them in.

- 1 dull pencil or ballpoint pen for each student to "engrave" the Styrofoam.

- One copy of each of four handouts for each student (masters on pages 2–5):

    "Base-10 and Base-20 Number Systems"

    "How to Write Aztec Numbers"

    "Who 'Invented' Zero (0)?" & "How to Read and Write Mayan Numbers"

    "Writing Mayan Numbers"

Preparation

Use scissors to trim the edges of the Styrofoam meat trays to produce flat pieces about 4" x 6".

In Class

1. Hand out the first activity page, "Base-10 and Base-20 Number Systems." Read out loud the information, explaining base-10 and base-20 number systems. You may wish to use the chalkboard or overhead projector to explain the examples. Help your students as necessary while they work out the two sample problems on the page.

2. You may want to ask your students why they think we use the base-10 number system. Why not a base-5 system or a base-20 system? Possibly it's because we have ten fingers. You may want to tell students that computers use a base-2 number system.

3. Hand out the second activity page, "How to Write Aztec Numbers." Explain how to write numbers as an Aztec would. Then distribute the pieces of Styrofoam and dull pencils or ballpoint pens to make Aztec number rubbings. Encourage your students to create number rubbings that challenge their classmates.

4. Hand out the third activity page, "Who "Invented" Zero (0)?" Discuss how the Maya made numbers with dots, bars, and a leaf symbol. Then, allow students to practice writing Mayan numbers with these symbols. Encourage students to make up numbers for their classmates to decipher.

5. Hand out the fourth activity page, "How to Read and Write Mayan Numbers." This sheet provides additional challenges in using Mayan numbers.

6. You may want to tell the students that the Maya used these symbols for many different purposes, including keeping track of goods for religious offerings and business transactions. They also used these symbols to keep track of the Sun, Moon, and the planet Venus; and to create a calendar and number the days, weeks, and years. The Mayan calendar was many thousands of years old when the Spanish explorers arrived. In the years that followed, Christian missionaries burned many Mayan books because they wanted to convert the Maya to Christianity.

The Aztecs and Maya developed a complex and sophisticated mathematics. In recent decades anthropologists have learned a great deal about Native American mathematics from archaeological excavations and from people who still use mathematical methods developed by their ancestors.

Among the many examples of Native American mathematics we might have selected, we chose to present some elementary aspects of the Aztec and Mayan numbering systems. These concepts were chosen primarily because they are interesting and accessible to middle school and high school students. They provide insight into how various cultures have addressed the need to express large numbers as well as insight into the base-10 system that is so important in our own culture.

In the set of slides for Astronomy of the Americas is a picture of a Mayan scribe writing a book. The slide includes some of the number symbols your students will learn to interpret in this activity. Anthropologists were able to use these symbols to decode the Mayan books.

Base-10 and Base-20 Number Systems

Long before Columbus and other Europeans came to the Americas, the ancient Aztecs and Maya developed advanced number systems. They used base-20 for their systems. The number system most used throughout the world today is a base-10 system.

The upper limits of counting vary considerably among Native American Peoples. The Dakota, Cherokee, Ojibway, Navajo, Winnebago, Wyandot, Micmac, and others could all count into the millions; the Choctaw and Apache to the hundred thousands; and many other Native Peoples to 1,000 or more. For example, the Ojibway word for one billion is me-das-wac me-das-was as he.

The Pomo of California have a particularly interesting system of counting. While the eastern Pomo use a system similar to base-20, the southwestern Pomo use a variation of a base-40 system. This system probably developed because the Pomo were the principal suppliers of long strings of clam shell beads used in trade throughout north central California.

Native Peoples often express numbers in mathematical sentences. For example, 400 might be expressed as "20 times 20," just as in Lincoln's address at Gettysburg he expressed the number 87 as "Four score and seven...." A "score" is 20, so "Four score and seven..." is $(4 \times 20) + (7 \times 1)$.

Base 10	Base 20
"7 5"	**"3 15"**
In base 10, the number "7 5" is figured like this:	In base 20, the number "3 15"
	(which means the same as "75" in base 10)
$(7 \times 10) + (5 \times 1) = 75$	is figured like this:
$(70) + (5) = 75$	$(3 \times 20) + (15 \times 1) = 75$
	$(60) + (15) = 75$
Show how the number 225 is figured in base 10:	Show how the equivalent number to 225 in base 10 is figured in base 20:
$(\_\_\_ \times 100) + (\_\_\_ \times 10) + (\_\_\_ \times 1) = 225$	$(\_\_\_\_ \times 20) + (\_\_\_\_ \times 1) = 225$
$(\_\_\_) + (\_\_\_) + (\_\_\_) = 225$	$(\_\_\_) + (\_\_\_) + (\_\_\_) = 225$

The Aztecs used these hieroglyphs to record numbers.

The finger ⌐ represented numbers from 1 to 18.

The flag 𝗣 represented 20.

The feather ⚹ represented 400.

So, the number 468 would look like this

⚹   𝗣𝗣𝗣   ⌐⌐⌐⌐⌐⌐⌐⌐

400   +   60   +   8

(1x400) +   (3x20) +   (8)

How to Make Aztec Number Rubbings

What to Do

Use a dull pencil or ballpoint pen to draw the three Aztec number symbols onto the smooth side of a Styrofoam meat tray. Leave plenty of space between the symbols.

Make an Aztec number by placing paper over the hieroglyph and rubbing the paper with a crayon.

Challenge

Create Aztec hieroglyphic rubbings for the following numbers:

1. Your age
2. 23
3. 121
4. 882
5. 1,225

What are these Aztec numbers?

6. 𝗣𝗣⌐⌐⌐⌐   = _____

7. ⚹⚹⚹⚹𝗣⌐   = _____

Make up five Aztec numbers on the back of this paper for a friend to decode.

Who "Invented" Zero (0)?

The Maya used the zero many years before the Europeans learned about it from Arab mathematicians in the thirteenth century. Having the zero as a place holder allowed the Maya to keep complex records of long sequences of numbers; not having a zero limited the mathematical abilities of Europeans and the ancient Greeks.

The Maya recorded numbers with a series of dots and bars:

A dot (•) equals 1.

A bar (—) equals 5.

This symbol represents zero (0).

The Maya made many other important contributions to mathematics. For example, they were among the first people to use place value. In the system we use, place values represent multiples of 10. For example, in the number 25, the 5 represents five ones. The 2 represents two tens, or twenty.

In the Mayan system, place values represent multiples of 20, not 10. Another difference is that value in the Mayan number system increases from bottom to top, instead of from right to left as in the system we use. Since the Mayan system uses base-20, a number placed above, but not touching another number represents a multiple of 20.

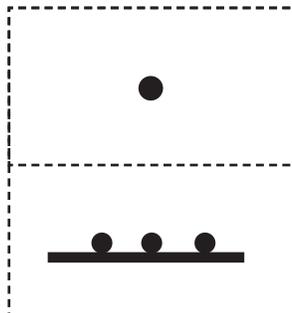# How to Read and Write Mayan Numbers

The number 8 looks like this:

Ones Row

3 dots = (3 x 1) = 3
1 bar = (1 x 5) = 5
                  ___
                   8
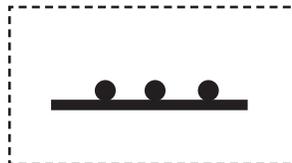
The Number 28 looks like this:

20s Row

1 dot = (1 x 20) = 20

Ones Row

3 dots = (3 x 1) = 3
1 bar   = (1 x 5) = 5
                   ___
                    28

Notice that the bars and dots in the same row are in contact with each other.

The number 100 looks like this:

20s Row
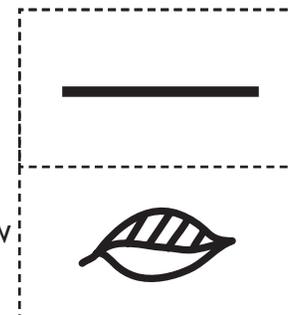
1 bar   = (5 x 20) = 100

Ones Row

1 shell = (0 x 1) = 0
                   ___
                   100

Writing Mayan Numbers

Challenge: Use the Mayan number system to write these numbers

7

20

19

92

247

Your Age _____

Make one up_____

Make one up_____

Make one up_____

Make up five more Mayan hieroglyphic numbers on the back of this paper for a friend to decode.