

Urban legends

by Bob Riddle

In August of 2003, many people looked skyward because they had heard that Mars was supposed to be as large as a full Moon. Urban legends such as this become widespread from people simply not asking “Are you sure?” or looking into the topic and learning more before making a decision. But urban legends are also a great way to teach students to become good questioners—skeptics if you will—whenever they hear or read about these kinds of claims.

A more recent urban legend is generating interest due in large part to statements made by doomsday predictors, news media, and—coming soon to a theater near you—a movie celebrating our demise. Having students investigate claims such as this provide them with the information they need to critically examine the data and separate the fact from the fiction.

The Long Count

Three years from now, some folks would have us believe that the world as we know it will come to an end, or, depending on the source, some sort of “cosmic event” will happen. Whatever the suggested event is, it is supposed to happen when the Mayan calendar, based on a numbering system called the Long Count, or Long Cycle, reaches the last day of the current counting cycle. One belief is that this last day is on December 21, 2012, the date of the December solstice. The date for this event was determined by adjusting for leap years and the modern Gregorian calendar and then literally counting the days since the current cycle began.

The Long Count system is a base 20 numbering system that is very accurate in terms of tracking historical events or for counting days to future events by counting forward from the first day. The count involves a series of numbers representing various lengths or periods of time measured in days. As with any calendar, when the last day is reached, the calendar in a sense is reset back to day 0, or the calendar counting starts all over.



The Mayans used a variety of calendar counting methods, with the Long Count used specifically for very long periods of time (e.g., 5,000 years). When written horizontally, there are a series of five numbers separated by periods that make up the day number. Starting at the beginning of a counting cycle, 0.0.0.0.0, each unit increases by one day (kin) using base 20, except for the uinal, which changes at 18 rather than 20. The numbers are usually written vertically (see Figure 1) from the baktun down to kin, and represent the number of days, as shown in Figure 1. Twenty kin

FIGURE 1 Number of days used in the Long Count

0.	Baktun = 144,000 days (20 katun)
0.	Katun = 7,200 days (20 tun)
0.	Tun = 360 days (18 uinal)
0.	Uinal = 20 days (20 kin)
0	Kin = 1 day

equals 1 uinal, 18 uinals equals 1 tun, 20 tun equals 1 katun, and 20 katun equals 1 baktun. When each value reaches its maximum number, it resets to 0 while the value to the left increases by one. For example, the first day of the count would be 0.0.0.0.1, the second day 0.0.0.0.2, and so on. When the rightmost space reaches 19, the day after 0.0.0.0.19, or the 20th day since starting the count, would be: 0.0.0.1.0. The 21st day = 0.0.0.1.1, the 22nd day = 0.0.0.1.2, and so on. A way to help students picture how the numbers change could be to have them use a clicker-type counter. Have students observe how the numbers change as the ones column reaches 9, then resets back to 0, while the tens column changes to one. Each time the ones column reaches the count of 10, it resets to 0 and the next column, tens, increases by one. This continues until the tens column reaches 10, and then it resets to 0 and the hundreds column increases from 0 to 1, and so on. In the Mayan Long Count system, they used

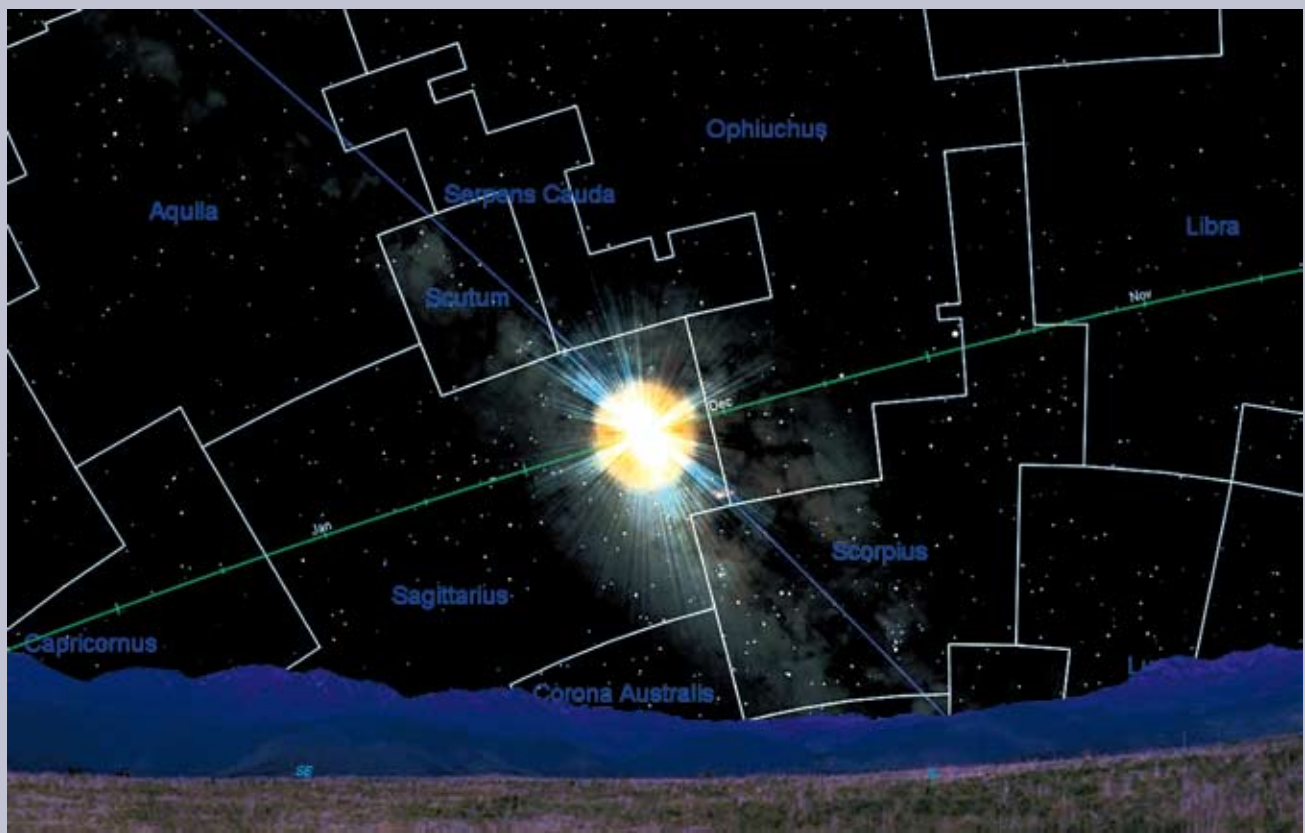
base 20 instead of base 10, so numbers changed when the count reached 20, rather than 10.

An interesting side note to the counting system is that the ancient Mayans knew that it took approximately 365 days for the Sun to return to its same location. This is shown by having the uinal column stop at 18. Each time uinal reached 18, one year had passed. When the kin count reached 20 for the 20th time, there would be 18 uinal, and $18 \times 20 = 360$ days.

In Mayan mythology, there were three attempts at creation of the Earth and life on it before the fourth, and current, successful Long Count started. Using the modern Gregorian calendar, it has been determined that the current Long Count started 5,135.35 years ago on August 13, 3134 BC, or by using the Mayan system, 12.0.0.0.0. Each creation (one Long Count cycle) represented a span of 14 baktuns, and we are now nearing the end of the 13th baktun, which has been calculated to end on December 21, 2012. In terms

FIGURE 2

The Sun's position on the December solstice of 2012. The galactic equator is the blue line within the Milky Way, the slightly brighter area on either side. The ecliptic is shown by the green line.



of Mayan mythology, there is no mention of any event, cataclysmic, cosmic, or otherwise, at the end of any baktun. Nevertheless, end-of-the-world promoters and others have created an urban legend about this with the suggestion that on this particular date something will happen.

This predicted event has been attributed to an alignment involving the Sun's position along the ecliptic path on the December (winter) solstice intersecting the plane of the galaxy, the galactic equator. On any December (winter) solstice, the Sun is at a specific celestial coordinate position of 23.5° south and 18 hours of right ascension, or simply 18 hours. This is the Sun's southernmost distance south of the celestial equator. Currently, the Sun is located within the constellation of Sagittarius the Archer on the December (winter) solstice (see Figure 2). However, due to a slow Earth motion called *precession*, the stars relative to the view from Earth have shifted enough so that at the start of this current Mayan Long Count cycle, the Sun was in the constellation of Capricornus the Sea Goat on the winter solstice. Additionally, the intersection of the galactic equator with the ecliptic has also shifted such that it now intersects the ecliptic at the winter solstice point. However, at the beginning of this Long Count, that intersection was to the west of the current winter-solstice position.

Precession is often described as a wobble-like motion of the Earth around its axis. Like a spinning top that is slowing down, the poles of the Earth spin in a circle around the axis of rotation. Earth completes one precession in approximately 26,000 years. But unlike a top, it will not stop spinning and fall over. As the Earth spins through a precession cycle, the North Pole and South Pole of the Earth trace out a circle among the stars. This means that any star on or near the apparent circle becomes a pole star. Currently, the star marking the end of the Little Bear's tail, Polaris, is the North Pole star, while the Southern Hemisphere has no South Pole star. With regard to the constellations marking seasons, their celestial coordinates will change over time during a precession cycle. The location for the winter solstice, for example, has moved from Capricornus west to Sagittarius. What this means is that approximately every 26,000 years, or once every precession cycle, the Sun returns to the same location. In other words, nothing has happened during the past precession cycles. Unless there is something extra special about this particular cycle, there will be no cosmic calamity on December 21, 2012.

Your students are probably not as cynical as we adults may be, but at the least they can become skeptics, and

ask questions whenever they encounter something such as what has been predicted for December 21, 2012. Students should gather as much information as possible and learn about the topic before coming to a conclusion or making a decision.

December

- 2 Full Moon
Uranus ends retrograde motion
- 4 Moon at perigee: 363,479 km
- 7 Soyuz TMA-17 launch to International Space Station
WISE launch
- 9 Last quarter Moon
- 12 Cassini flyby of Titan
- 14 Geminids meteor-shower peak
- 16 New Moon
- 18 Moon near Mercury
Mercury at greatest east elongation
- 20 Moon at apogee: 405,731 km
- 21 Moon near Jupiter
Mars begins retrograde motion
December solstice (12:47 EST)
- 24 First quarter Moon
Pluto in solar conjunction
- 25 Saturn at western quadrature
- 26 Mercury begins retrograde motion
- 28 Cassini flyby of Titan
- 31 Full Moon ("Blue Moon")
Partial lunar eclipse

Questions for students

1. This urban legend and others are very well suited for students to research and debate whether or not they are examples of science or pseudoscience. What is meant by pseudoscience? (*Pseudoscience is an idea or practice that appears to be scientific but does not actually adhere to science methodologies.*)
2. What is meant by Earth precession? (*Earth precession is a wobbling motion [like a spinning top slowing down] around the axis of rotation caused by the gravitational pull from the Sun and our Moon.*)
- 3a. Using the Long Count numbering system, how would you express December 21, 2012, the last day of the twelfth Baktun? (*12.19.19.17.19*)
- 3b. Have students determine their birthday and current age using the Long Count numbering system. (See *Resources for the Calendar Count activity.*)

Visible planets

Mercury will be visible for most of the month over the western horizon after sunset as an evening planet.

Venus will be too close to the Sun to be easily seen.

Mars will rise several hours after sunset and will be visible over the southwestern horizon at sunrise.

Jupiter will rise in the afternoon and will be visible over the southern horizon at sunset.

Saturn will rise after midnight local time and will be over the southern horizon at sunrise.

Resources

Calendar count—www.pbs.org/wgbh/nova/teachers/activities/2804_maya.html

Cassini mission—<http://saturn.jpl.nasa.gov>

Geminids meteor shower—<http://meteorshowersonline.com/geminids.html>

International Year of Astronomy—<http://iyo09.org>

Maya civilization—www.civilization.ca/cmcc/exhibitions/civil/maya/mmc07eng.shtml

Mayan calendar—<http://history.howstuffworks.com/central-american-history/mayan-calendar3.htm>

Mayan Long Count Calculator—<http://www.pauahtun.org/cgi-bin/gregmaya.py>

Nibiru and doomsday 2012: Questions and answers—<http://astrobiology.nasa.gov/ask-an-astrobiologist/intro/nibiru-and-doomsday-2012-questions-and-answers>

Precession—www.istp.gsfc.nasa.gov/stargaze/Spprocess.htm

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Riddle, B. 2006. The equinox. *Science Scope* 29 (6): 78–79.

Riddle, B. 2008. Tracking planets around the Sun. *Science Scope* 31 (7): 84–86.

The Skeptic's Dictionary—www.skeptdic.com/maya.html

Wide-field Infrared Survey Explorer—<http://wise.ssl.berkeley.edu>

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