WALCH PUBLISHING

Teachable MOMENTS

NUMBER 1, OCTOBER 1, 2006

Pluto Is No Longer a Planet

To the Teacher

What an opportunity to teach students about the nature of science and of scientific inquiry! What a chance to bring a new level of interest to the study of the properties and characteristics of the various bodies in our solar system! Take advantage of this "teachable moment" by focusing your middle school students on the decision that changed Pluto's status and by engaging them in research and discussion around the following standards and topics. *Note:* The focus here is the Nature of Science, and this activity is designed to supplement, not supplant, your study of the solar system.

Science Standards Addressed

National Science Education Standards for Grades 5–8
EARTH AND SPACE SCIENCE—EARTH IN THE SOLAR SYSTEM

"The Earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets."

Benchmarks for Science Literacy for Grades 6–8
THE NATURE OF SCIENCE

"Scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way."

Benchmarks for Science Literacy for Grades 6–8
SCIENTIFIC INQUIRY

"What people expect to observe often affects what they actually do observe. Strong beliefs about what should happen in particular circumstances can prevent them from detecting other results. Scientists know about this danger to objectivity and take steps to try and avoid it when designing investigations and examining data. One safeguard is to have different investigators conduct independent studies of the same questions."

Options for Implementing Student Prompts

(found on page 3)

- Break students into small groups. Assign a prompt to each. Provide time for research, drafting, and rehearsal. Ask groups to present to the class.
- Assign a prompt for homework. Review in class to see the range of responses and identify the variety of research sources.
- Let students select one or more prompts to complete for a class assignment or project.
- Pair students to prepare and present a "debate" for those prompts that lend themselves to it. Have them take positions as far apart as possible in responding. Pairs can then present their positions, information, and justification to the class, possibly putting the divergent opinions/findings to a vote.

Pluto Web Sites

http://www.solarviews.com/eng/pluto.htm
http://www.nineplanets.org/pluto.html
http://www.lowell.edu/users/buie/pluto/pluto.html

Online Links to Articles and Opinions

– Pluto is demoted to 'dwarf planet'

– Planet or not, Pluto is an interesting celestial body

– Pluto vote 'hijacked' in revolt

– Who says Pluto is no longer a planet?

– Pluto kicked out of Planet Club!

Background Information on Pluto

Pluto was officially included as the ninth planet by the International Astronomical Union in 1930. It was named for the Roman god of the underworld. Pluto was the first (and only) planet to be discovered by an American, Clyde W. Tombaugh.

Pluto's discovery was made possible by Percival Lowell, who founded the Lowell Observatory in Flagstaff, Arizona. He provided financial support for three separate searches for "Planet X." Lowell made numerous unsuccessful calculations to find "Planet X," believing it could be detected from the effect it would have on Neptune's orbit. Dr. Vesto Slipher, the observatory director, hired Clyde Tombaugh for the third search. Clyde took a series of photographs of the plane of the solar system (ecliptic) one to two weeks apart and looked for anything that shifted against the backdrop of stars. His systematic approach was successful and Pluto was discovered by this young 24-year-old Kansas lab assistant on February 18, 1930. As it turned out, Pluto is too small to be the "Planet X" Percival Lowell had hoped to find. Pluto's was an incidental, but lucky, discovery.

Pluto Statistics	
Discovered by	Clyde W. Tombaugh
Date of Discovery	February 18, 1930
Mass (kg)	1.27 × 1022 kg
Mass (Earth = 1)	.0022
Equatorial Radius (km)	1,137
Equatorial Radius (Earth = 1)	0.1783
Mean Density (gm/cm^3)	2.05
Mean Distance from the Sun (km)	5,913,520,000
Mean Distance from the Sun (Earth = 1)	39.5294
Rotational Period (days)	6.3872
Orbital Period (years)	248.54
Mean Orbital Velocity (km/sec)	4.74
Orbital Eccentricity	0.2482
Tilt of Axis (degrees)	122.52
Orbital Inclination (degrees)	17.148
Equatorial Surface Gravity (m/sec^2)	0.4
Equatorial Escape Velocity (km/sec)	1.22
Visual Geometric Albedo	0.3
Magnitude (Vo)	15.12
Atmospheric Composition Methane Nitrogen	0.3

Pluto is No Longer a Planet

After years of intense debate, astronomers resolved to demote Pluto to the status of "dwarf planet" in August 2006. The vote took place at a meeting of the International Astronomical Union (IAU) in Prague. It has been referred to as "a victory of scientific reasoning over historic and cultural influences." But already the decision is being hotly debated. Campaigns to "Save Pluto" have sprung up on the Internet, and newspaper columnists are taking advantage of this unique event.

Research/Discussion Prompts

1. The final decision took place on the last day of a conference with 424 astronomers voting. This represents about 5% of the world's astronomers. About how many astronomers are there in the world? Are 424 or 5% enough to make this decision? Why or why not?

2. List as many reasons as you can that explain why some people don't want to change Pluto's status.

3. List as many reasons as you can that explain why some people support the decision.

4. Describe another situation in the history of science that had some of the same controversy as the Pluto decision.

5. The decision establishes three main categories of objects in our solar system—planets, dwarf planets, and small solar system bodies. Find at least one example of each. How are these examples similar? What are the significant differences between them?

6. Some people point out that "dwarf planet" is not a very good term for something that is not a planet. What might be another term to use for this category of objects?

7. Explain how the decision can be seen as "a victory of scientific reasoning over historical and cultural influences." What is the scientific reasoning? What are the historical and cultural forces?

8. What has really changed? Has a new discovery or observation been made? How does the Pluto decision reflect the fact that science is a "human endeavor"?

9. In your opinion, what group of people or industry will be most affected by the Pluto decision? Explain and justify your answer.

Suggested Answers

1. If 424 astronomers represent 5% of the world's astronomers, then there are 179,776 astronomers in the world. Student responses will vary but should address representation, sampling, and/or the nature of the IAU. For example, a student might deem 5% adequate if those attending/voting represented all the major countries or significant institutions. A student might also cite the IAU as the authoritative body, superseding the need for a certain level of representation. On the other hand, a student could conclude that 5% is too few, especially if those remaining at the meeting on the last day weren't a representative sample.

2. Student responses will vary but may refer to the following reasons: sentiment ("like" Pluto); it's always been that way; having to change textbooks, charts, and so forth; Pluto the Disney dog; scientific work underway (studies of Pluto, mission to Pluto); ambiguity in the planet criteria (especially "clearing the neighborhood").

3. Student responses will vary but may refer to the following reasons: "if we include Pluto, there are too many other small bodies that will have to be included;" "science is about change and innovation;" "the new criteria for planets are clear and Pluto doesn't fit them."

4. Student responses will vary but may include the following: the idea that the world was flat vs. round, the idea that the sun revolved around the earth, the theory of evolution, the biological classification system adding categories, and so forth.

5. Student responses will vary but examples of a planet could include any of the eight in our solar system—Mercury, Venus, Earth, Mars, Saturn, Jupiter, Uranus, or Neptune. Dwarf planets include Pluto, Ceres, and 2003 UB313. Small solar system bodies include asteroids (e.g. 2060 Chiron, Aten, Icarus), comets (e.g. Halley's, Shoemaker-Levy), and Kuiper Belt Objects. All three types of objects are similar in that they orbit around the sun as part of our solar system. They are different in terms of size, the volatility of their make up, and the nature of their orbits (round vs. elliptical).

6. Student responses will vary but should reflect the key ideas that the objects referred to as dwarf planets are smaller than planets, but travel a regular path in our solar system.

7. Student responses will vary. Answers should refer to observation and classification as being hallmarks of scientific reasoning. Answers may also refer to Pluto the dog, "the way I learned it in school," "what books say," etc. as examples of historical and cultural forces.

8. Student responses will vary but should refer to the fact that we have learned nothing new about Pluto; we have merely refined the classification criteria for planets. There is no new discovery. The solar system and the universe remain the same. The human system for thinking and talking about them has been refined.

9. Student responses will vary but may include one of the following: scientists/astronomers and all others who are affiliated with studies of Pluto (e.g. Alan Stern, lead scientist on NASA's robotic mission to Pluto); publishers who must now change all books referring to nine planets; teachers who must change their curricula and instructional activities.