Nature of Science & Math:

Analyzing the Presence in Everyday Communication

Yes, Pluto is a Planet

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Methods of STEM Education

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The status of the planet Pluto has been debated for many years now. In 2003, a new celestial body, named Eris was discovered and was found to be slightly larger than Pluto, causing more scientists to question the status of Pluto as the ninth planet in our solar system (Tate, 2012).

Nonetheless, in the article, "Yes Pluto is a Planet," (Grinspoon & Stern, 2018) coauthors David Grinspoon, an astrobiologist, and Alan Stern, the principal investigator of the New Horizons mission, state their case for Pluto as a planet. The article explains how they define a planet, and why Pluto is, and should remain a planet, in spite of the International Astronomical Union's decision, in 2006, to demote Pluto to a dwarf planet. In response to the IAU's decision to change Pluto's status, scientists at the annual Lunar and Planetary Science Conference in Houston collaborated to formulate a new "Geophysical Planet Definition" (Grinspoon & Stern, 2018). This new category defines a planet based on its geophysical properties rather than looking at its mass or whether or not it orbits a star. The new definition does require the celestial object to have a round shape, and it cannot be lumpy or oval. A more simplistic version of this new definition designed for elementary school age children was also constructed stating that planets are, "round objects in space that are smaller than stars" (Grinspoon & Stern, 2018).

The debate presented by Grinspoon and Stern, reflects and models many of the standards for mathematical practice. For example, the first of the standards for mathematical practice describes the students ability to, "Make sense of problems and persevere in solving them"

(CCSSM). Stating that, “Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals…. They monitor and evaluate their progress and change course if necessary” (CCSSM). Grinspoon and Stern begin their article by explaining the problem of determining how a planet should be defined. Within their case, they analyze various constraints and relationships, such as planet mass and geophysical characteristics. As new celestial bodies are discovered they monitor and evaluate their understanding, and they allow for new scientific discoveries to enhance their understanding of how a planet should be defined (Grinspoon & Stern 2018). One can also apply the CCSS math practice describing how students should be able to “Construct viable arguments and critique the reasoning of others….They are able to analyze situations by breaking them into cases, and can recognize and use counter examples.” (CCSSM) In this article, Grinspoon and Stern take on the International Astronomical Union, and refute their decision to demote Pluto. They use evidence based arguments, stating that the IAU’s definition would exclude important new celestial discoveries, such as exoplanets. The arguments presented in the article also reflect the CCSSM standard that students should and must, “Attend to precision. Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning….” (CCSSM) Grinspoon and Stern emphasize the importance of accurately defining the word planet, as we make new discoveries of celestial bodies in space. In their arguments, they note that the statement put out by the IAU defines a planet as, “an object orbiting around our sun — thereby disqualifying the planets around other stars.” (Grinspoon & Stern 2018) They explain that by using the word “sun” the IAU excludes other stars. This concept of precision of word choice is

emphasized by Schwartz who uses Pluto as an example of the nature of science, "Pluto itself has not changed, but scientists' interpretation of Pluto's characteristics has changed. Like the classification of Pluto, all science is subject to revision. Understanding how and why change can occur is a cornerstone to understanding the nature of science" (Schwartz, 2007).

Many of the tenets of the nature of science that are applied to NGSS, can also be found in planetary debate that is addressed in the article, "Yes Pluto is a Planet." (Grinspoon & Stern, 2018). One of the basic understandings about the nature of science states, "Scientific knowledge is based on *empirical* knowledge" (NGSS). The word empirical, refers to something that is, capable of being verified or disproved by observation or experiment, rather than pure logic (Empirical, Merriam-Webster 2018). Greenberg and Stern use empirical knowledge, by applying new observations. For example, they reference the recent photos of Pluto captured by the New Horizons fly by, revealing what they describe to be a planet that has, "... many familiar features — mountains of ice, glaciers of nitrogen, a blue sky with layers of smog" (Grinspoon & Stern). They argue that these descriptions should compel scientists to include Pluto in the Geophysical definition of a planet. Greenberg and Stern also address the tenet from the nature of science that, "Scientific knowledge is open to revision in light of new knowledge" (NGSS). They argue that the definition of a planet should be revisited and redefined as new discoveries are made. Another case they bring is when they refer to Saturn's largest natural satellite, Titan, as a planet, given its diverse geophysical characteristics. They also make a point to mention that Titon is actually larger than the planet Mercury. Lastly, Greenberg and Stern model the tenet that, "Science is a human endeavor" (NGSS). This theme extends to the crosscutting concepts of the NGSS which

elaborates by stating that,“Technology advances have influenced the progress of science, and science has influenced advances in technology” (NGSS). Grinspoon and Stern take into account these new technological advances that allow for new discoveries, that ultimately enhance our understanding of how we define what a planet is.

The ongoing debate on how to define what is, and is not a planet, is a great example of the nature of science. Delving into the evidence stated by both sides of the Pluto debate allows us to truly appreciate the process scientists undertake in their quest for precision and empirical knowledge. We see how science is truly a discipline that is constantly evolving and growing as technology allows us to reach further into space and gain a more intimate look at the universe in which we live. This article was especially appealing to me, because I have presented the “other side” of the Pluto debate to my students for many years, based on the curriculum materials I currently use as part of my science unit on space. However, I never fully researched the argument defending Pluto’s right to remain a planet, until now. These kinds of experiences, where students are included in evolving scientific discoveries, provide students with a window into the true nature of science.

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