Nature of Science (NOS) and Common Core Mathematics Practice (CCMP) Analysis
By Erica MacIntosh

The article that being analyzed is titled “Direct Evidence of Water Ice at Moon’s Poles” By: Kelly Beatty written on August 24, 2018 from Sky and Telescope (1).

The tenet “Scientific Knowledge is Based on Empirical Evidence” is demonstrated in this article in multiple ways. It first discusses early evidence by distant observation, then direct observation when we first landed on the Moon. As technology advanced we were able to reanalyze Apollo samples and found “substantial amounts water trapped in tiny beads of volcanic glass”(1). Indirect evidence was later found by analyzing radio energy, infrared, and near ultra-violet data that showed bright areas. The article continues to discuss that even though this data supports water on the moon, it could be explained by other means. Finally recent evidence shows near infrared absorptions that can only be caused by the vibration of water molecules at or near the surface. This is a perfect example of the nature of science in real world circumstances. Scientists use different types of data, both direct and indirect, as evidence for hypothesis. They also do not just acquire data once for a single time experiment, as we often do in our classroom labs. Evidence continues to be gathered over time as technology advances and multiple people in different contexts analyze the data. As stated in the NGSS APPENDIX H high school matrix “Science arguments are strengthened by multiple lines of evidence supporting a single explanation”(2).

The second NGSS tenet demonstrated is “Scientific Knowledge is Open to Revision in Light of New Evidence”. This follows directly from the tenet discussed above. As new data was collected over time, scientists continued to modify and establish current scientific knowledge about the presence of water on the Moon. In this case the first data pointed to evidence of water on the moon, when ancient people viewed the moon and saw what they thought were seas. Then the evidence of the Apollo astronauts lead scientists to believe that there was no water on the moon. The pendulum began to swing back to scientists believing there was probably water on the moon when they collected new evidence from the Apollo samples and analyzed reflection data. Then currently to the theory that water is definitively on the moon when they collected evidence that current knowledge stated could only occur by water molecules. In the future, they might find data that shows this data could be created by a different substance or there may be

a mission to take samples directly from the moon. In that case they would revise the current knowledge on the subject.

The third NGSS tenet present is “Scientific Knowledge Assumes an Order and Consistency in Natural Systems”. As stated in the NGSS (2) we must assume that basic laws are consistent throughout the universe. This is specifically applicable to the ideas addressed in this article because we have not gone and visited this area of the Moon. We are assuming that these tests would behave the same on the Moon as they do here on Earth. This is a reasonable assumption in this case, as in most cases, and therefore the results should be considered valid.

The article will now be evaluated using Common Core Math Practices. The first practice we will look at is “Model with mathematics”. As described in the core standards (3) the article does identify important quantities in a practical situation. The data collected was mathematically appropriate to the matter at hand. The article also maps the relationship between the data and the situation using a variety of graphs of the wavelength spectrum as well as daytime temperatures on various areas of the Moon. The scientists in the article analyzed those relationships mathematically to draw conclusions about the presence of water ice on the Moon. This demonstrates that the article is appropriate for a high school science classroom.

The second mathematical practice present in the article is “Use appropriate tools strategically”. The tools that the scientists use continue to change as they collect more data. The first tool they used in recent years was the neutron-spectrometer. They evaluated the data they received, applied it to the situation, then determined they should use a different tool to gain another form of data. The next step was to use the Moon Mineralogy Mapper along with infrared telescopes to gather more definitive data for their analysis. Sometimes the appropriate tool changes depending on the data required.

Finally, the article exemplifies the practice of “Attend to precision”. Working with the correct tools together helped the scientists to be very precise in their data. The Moon Mineralogy Mapper allowed the data to be gathered from very specific places and compared to locations with different geology. The article even states “The work of Li and

his colleagues sidesteps all of these ambiguities by looking for three specific near infrared absorptions — near 1.3,
1.5, and 2.0 microns” (1). Students would see that the scientists are purposefully being precise in their observations and purposeful in the gathering of data. The scientists used a “degree of precision appropriate for the problem context” (3) which exemplifies the Common Core standards.

Sources:
(1) Beatty, K. (2018, September 10). Direct Evidence of Water Ice at Moon's Poles. Retrieved from https://www.skyandtelescope.com/astronomy-news/direct-evidence-of-water-ice-at-the-moons-poles/

(2) Next generation science standards: For states, by states. (2013). Washington, D.C.: The National Academies Press.

(3) Standards for Mathematical Practice. (2018). Retrieved from http://www.corestandards.org/Math/Practice/