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Methods of STEM-Secondary

February 12, 2019

Assignment #1

Nature of Science/Nature of Math

Article: Third Gravitational Wave Detection, From Black Hole Merger 3 Billion Years Away

by Dennis Overbye

Part A. Select 3 of the tenets of Nature of Science discussed in NGSS and write a brief analysis of how the article meets each tenet.

I chose this article because I attended a presentation from a scientist who worked on this project. I also chose this article because it coincides well with the Nature of Science philosophy. The three tenets I will focus on are as follows: Science is a Human Endeavor, Science Models, Laws, Mechanisms and Theories Explain Natural Phenomena, and Scientific Knowledge is Open to Revision in Light of New Evidence.

Science is a Human Endeavor:

The Appendices for NGSS (2013) clearly states, “Humans have a need to explain the world around them...sometimes it is curiosity or safety.” In the New York Times, Overbye (2017), addresses the need for humanity to explain their discoveries. For example, after the article explains gravitational waves (vibrations in the fabric of space-time), Columbia University astronomer Marka (2017) asks “The burning question now is: Where did such massive black holes come from? “How were such large black-hole binaries created? How did they form? “This is indeed one of the big questions of our field today.” Students can use this same curiosity to ask their own “burning questions” during class discussions or experiments. They may not create new explanations but they can practice asking questions and explanations to prepare themselves f for the future (NGSS, 2013).

Science Models, Laws, Mechanisms and Theories Explain Natural Phenomena:

NGSS standards use models, patterns, cause and effect to explain phenomena. Students are learning how to apply these strategies to explain their natural world. Similarly, scientist’s studying gravitational waves are using models, theories and laws to explain how black holes “shake” space-time. Overbye (2017) shows how LIGO scientist used Einstein’s theory

to explain the nature of black holes: “It validated Einstein’s longstanding prediction that space-time can shake like a bowlful of jelly when massive objects swing their weight around, and it has put astronomers on intimate terms with the most extreme objects in his cosmic zoo and the ones doing the shaking: massive black holes.” NGSS (2013) suggests science teachers not only teach crosscutting concepts but also to probe students into a deeper understanding of how the crosscutting concepts explain the phenomena.

Scientific Knowledge is Open to Revision in Light of New Evidence:

After verifying Einstein’s equations that gravity waves travel “presumably the speed of light (Overbye 2017), MIT professor, Dr. Reitze says, “Once again Einstein triumphs. That’s not surprising,” Dr. Reitze went on, adding, “at some point he’s going to be wrong, and we’ll be looking.” This is a perfect example of science in a school classroom. Experiments and claims are constantly changing for students as they gather more evidence to support their claims. In fact, NGSS (2013) suggests students should clearly define and apply observations, inferences, and other strategies within the phenomena they are learning. This is accomplished through revisions and proving something or someone is wrong.

Part B. Select 3 of the practices in Common Core Mathematics Practices and write a brief analysis of how the article meets the math practice.

Make sense of problems and persevere in solving them:

NGSS (2013) states, “Science is a quantitative discipline, so it is important…that students’ science learning coheres well with…math.” Science and math should be a taught together because they coincide in real-world application. For example, Overbye (2017) mentions how the scientists studying black holes 3 billion years away used math! After a journey lasting 3 billion years, that is to say, a quarter of the age of the universe, those waves started jiggling LIGO’s mirrors back and forth by a fraction of an atomic diameter 20 times a second. The pitch rose to 180 cycles per second in about a tenth of a second before cutting off” (Overbye, 2017).

Construct viable arguments and critique the reasoning of others:

It is important to peer review findings. It can prevent embarrassing misconceptions during a group presentation or correct miscalculations in math. The LIGO project includes a prolific amount of scientists. A paper published included 1,300 authors around the world! (Overbye, 2017)

Use appropriate tools strategically:

In addition to peer reviews and construction team work, the equipment we use in class should coincide with the nature of science. Not only should the students understand how to use tools to calculate and interpret data they should also know how to identify limitations and potential the of their tools. The scientists at LIGO knew telescopes could not "see" colliding black holes. This meant they needed to build a new tool to measure ripples in space-time. The LIGO was able to "hear" a chirp to confirm gravitational waves. The scientists also needed to know how to use this data collected by their tools. Overbye (2017) describes the tool:

"LIGO was designed to look for these changes by using lasers to monitor the distances between mirrors in a pair of L-shaped antennas in Hanford, Wash., and in Livingston, La. There is another antenna in Italy known as Virgo now undergoing its final testing. When it is online, possibly later this summer, having three detectors will greatly improve astronomers' ability to tell where the gravitational waves are coming from."

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References

Next Generation of Science Standards. (2013, May). APPENDIX L – Connections to the Common Core State Standards for Mathematics.

Next Generation of Science Standards. (2013, January). The Nature of Science in The Next Generation Science Standards.

Overbye, Dennis. (2017, June). New York Times. Third Gravitational Wave Detection, From Black Hole Merger 3 Billion Years Away. Retrieved from www.nytimes.com/2017/06/01/science/black-holes-collision-ligo-gravitational-waves