

Introduction

This research was conducted at Hightstown High School (HHS) in Hightstown, NJ. HHS is extremely diverse; approximately 30% of students are economically disadvantaged and 6% of students are English Language Learners. This research project idea was born from my attendance at the Teaching with Primary Sources Summer Teacher Institute with a focus on STEM Education at the Library of Congress in the Summer of 2015. I began using primary sources in my classroom as a method to introduce topics and unpack prior knowledge. As I have become more familiar with the Next Generation Science Standards, I wondered how I could use primary sources and analysis techniques to increase student proficiency in the eight Nature of Science understandings outlined in Appendix H (NGSS Lead States, 2013).

Literature Review

The Nature of Science (NOS) is generally referring to techniques and principles characteristic of scientific processes (Lederman, Lederman, & Antink, 2013). Appendix H of the Next Generation Science Standards outlines eight understandings of around NOS:

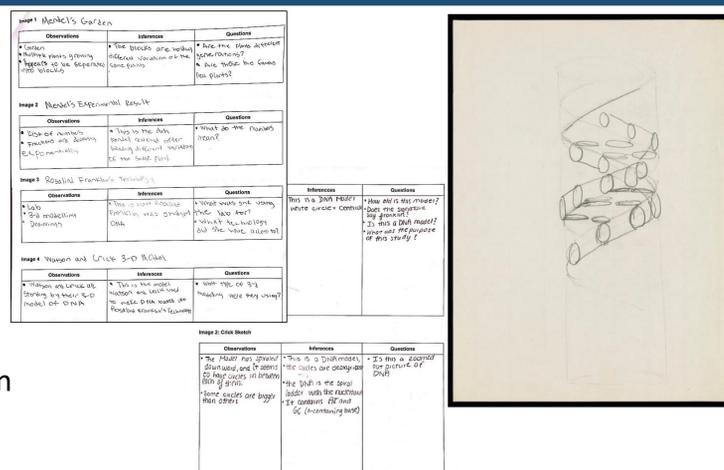
- Scientific investigations use a variety of methods
 - Scientific knowledge is based on empirical evidence
 - Scientific knowledge is open to revision in light of new evidence
 - Scientific models, laws, mechanisms, and theories explain natural phenomena
 - Science is a way of knowing
 - Scientific knowledge assumes an order and consistency in natural systems
 - Science is a human endeavor
 - Science addresses questions about the natural and material world
- Lederman et al. (2013) and *A Framework for K-12 Science Education* (2012) emphasize the importance of an explicit reflective approach on the NOS understandings at the conclusion of an activity in order to provide students with a practical understanding of the nature of science.

Research Question

How does explicit reflection on the Nature of Science (NOS) principles as a part of the analysis of primary source documents affect student understanding of the grade banded elements of NOS as outlined in NGSS?

Treatment

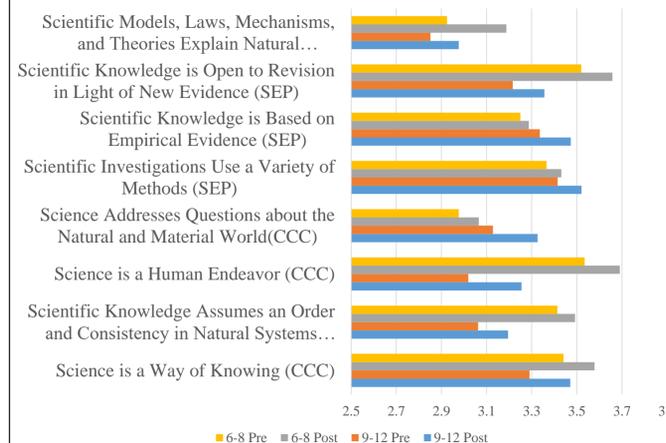
Throughout two units of instruction, genetics and evolution, students analyzed various primary sources about the topic of study. This analysis was followed by explicit reflection on the understandings of NOS.



The image shows handwritten notes on a grid background, organized into sections labeled 'Image 1', 'Image 2', 'Image 3', and 'Image 4'. Each section contains columns for 'Observations', 'Inferences', and 'Questions'. To the right of the notes is a hand-drawn sketch of a DNA double helix structure.

Data and Analysis

Bar graph showing central tendency of student proficiency of each understanding of NOS based on average score of agreement with middle school and high school elements, pre and post treatment, (N=64)



Interpretation and Conclusion

- Prior to treatment, students had a greater knowledge of MS understandings and a greater knowledge of understandings closely linked to the SEPs
- Students made the most growth in understandings closely related to the CCCs at the High School level, even though this group of understandings had the lowest overall central tendency post treatment
- Other aspects of my NGSS aligned classroom may have contributed to student growth in understandings.

Value

Understanding the Nature of Science (NOS) is an essential part of becoming productive and contributing members of our global society. One of my goals as a science educator is to ensure my students have enough understanding of NOS to make informed decisions related to science for themselves and others. As I became more familiar with the NOS understandings through this classroom research, I identified many opportunities to explicitly reflect on NOS beyond reflection on historical primary sources.

Thanks

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- Science Reader: Dan Lawver

References

Crick, Francis. (ca. 1953). *Sketch of the DNA Double Helix*. Illustration. From World Digital Library. Retrieved November 9, 2017 from <https://www.wdl.org/en/item/3252/>.

Lederman, N. G., Lederman, J. S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. *International Journal of Education in Mathematics, Science, and Technology*, 1(3), 138-147.

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NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States, Appendix H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards*. Washington, DC: The National Academies Press.