The Nature of STEM

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The Next Generation Science Standards (NGSS) compiles eight specific tenets to guide educators like myself towards teaching the nature of science in a clear and precise manor. These understandings are broken into two specific parts. The first four, *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,* are aligned with engineering and scientific practices. The last four, *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,* align with cross-cutting concepts.

I feel fortunate that I have a good resource to help me present these understandings. Our district has spent a lot of time and money compiling an OER website of standards, lessons, and activities. In addition, all units are aligned to the NGSS. I use the website in my planning and pay attention to the specific understandings that I will be focusing on for a lesson. An example of this was ***4.ESS3.1*** *Obtain and combine information to describe that energy and fuels are derived from natural resources and that some energy and fuel sources are renewable (sunlight, wind, water) and some are not (fossil fuels, minerals)* (Standards Overview: Fourth Grade, p.105). This particular lesson impressed upon students that natural resources are necessary for human survival. By partitioning resources into renewable and nonrenewable resources found in nature, students could then make the crosscutting connections about energy and matter.

As fortunate as I am, all of this would be useless if I didn't educate myself better. The best enhancement to my teaching would be professional development and discovery. One step toward this was the enrollment into the Endeavor program. As a result of this, my understanding of the tenets has deepened and an overall appreciation for the depth of science itself has been discovered. No longer is science a class I teach if I have time, regardless of what grade level I am teaching. Science is a necessity to be woven into its companion disciplines. No more silos.

One specific area of enhancement for me has been the discovery using phenomena in teaching. I don't know if it is the creative side of me or what, but since learning about this, my desire to draw in students has increased immensely. One of the greatest shifts for me was the encouragement to start with a phenomenon. NGSS (September, 2016) states the following:

> The point of using phenomena to drive instruction is to help students engage in practices to develop the knowledge necessary to explain or predict the phenomena. Therefore, the focus is not just on the phenomenon itself. It is the phenomenon plus the student-generated questions about the phenomenon that guides the learning and teaching. The practice of asking questions or identifying problems becomes a critical part of trying to figure something out. (p. 2, first bullet point)

Using student generated questioning has long been considered best practice (Tofade, Elsner, & Haines, 2013), so the idea of beginning a lesson using something visual, stunning, mesmerizing, or even mind-boggling, seems to be an amazing form of question generating. Recently I tried this in my classroom during our waves unit. Students watched the video that I chose for my discussion post. The video phenomenon (Nakaya, 2014), was a wave machine that was created with two turbines and a rope. As students watched the video, it generated questions and discussions, "oooohs" and "ahhhs", and best of all, ideas. This shift in my teaching made the nature of my science teaching a dynamic process that I will now hold dear to me, letting go of static ways. The longing for better practice has been there, but the justification and reasoning has not. This is now a fundamental shift for me.

In addition to changing the nature of science in my classroom, I am also finding changes and solutions to the nature of engineering. In 2006 the National Academy of Engineering and National Research Council Center for Education met to establish the Committee on K–12 Engineering Education to have face to face discussion on the status of engineering in US schools. The members' goals were, "to provide carefully reasoned guidance to key stakeholders regarding the creation and implementation of K–12 engineering curricula and instructional practices, focusing especially on the connections among science, technology, engineering, and mathematics education. (States, Committee on Understanding and Improving K-12 Engineering Education in the United, Engineering, & Council, 1900) I found that the nature of science and the nature of engineering had substantial overlapping, but I will address three of the committee's findings.

In Principle 1 of the 3 general principles, point 2 encourages educators to teach students that problems can have many possible solutions. I chose this one because of the correlation to discussions we have had on our posts about science is always changing. If we had remained static in our ideas of the earth's core, new ideas about tectonic plates would not have arisen.

Secondly, the committee felt as though engineering and developmentally appropriate science concepts and inquiry could go hand in hand. If inquiry is about proposing explanations about what research and discovery has been done, then a 4th grade mind should be able to test this out. In a recent class project using the previously mentioned 4.ESS3.1, students were given the task of creating a windmill of their own design using tools and materials from the classroom. It was amazing that with 4th grade knowledge, students would line up to use the box fan and test out their thinking. Once a change had been made, I could see the discussions and explanations occuring about why the changes they had made were reaping results. In addition, this inquiry from peers would allow conversations to be had about changing their own design. Now only is this developmentally appropriate in a scientific manner, but I felt in a social manner as well. No one project had to be correct. Ideas were being generated. Social discussions and allowances were being made.

My third and final connection was found in Principle 3: K-12 engineering education should promote habits of mind (States, p.5). The committee stated six engineering habits of mind that should be addressed. I was particularly drawn to number 5:

> "Communication is essential to effective collaboration, to understanding the particular wants and needs of a "customer," and to explaining and justifying the final design solution."

I was drawn to this one in particular because I believe that the nature of science is the exact same way. The demographics of the area in which I live offer residents high paying jobs. There are many industries here, especially considering the size of the area. In other words, there is a great deal of competition for very high paying jobs. It would be no problem for someone to take their business elsewhere if they were not satisfied with the customer service or with the results. I think that in our teaching of students in science, they need to learn to make presentations of their findings and communicate discoveries. Similarly, students should be able to explain their designs, learn to collaborate effectively in communication with each other, and justify (not prove) their findings. This is real-world preparation. This emphasis of communication is preparing students, even from a young age, to excel at their craft and make them market ready.

References

Nakaya, R. (2014, October 9). Two turbines and a rope: Waves by Daniel Palacios. Retrieved from https://thekidshouldseethis.com/post/21443931349

Science. (n.d.). Retrieved from https://www.tn.gov/education/instruction/academic-standards/science-standards.html

https://www.nextgenscience.org/resources/ngss-appendices

States, Committee on Understanding and Improving K-12 Engineering Education in the United, Engineering, N. A. of., & Council, N. R. (1900). *Engineering in K-12 Education: Understanding the Status and Improving the Prospects*. Washington: National Academies Press.

Tofade, T., Elsner, J., & Haines, S. T. (2013, September 12). Best practice strategies for effective use of questions as a teaching tool. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3776909/