

Nature of STEM

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Reflection of Current Teaching Practices

I think it is safe to say that most of us see science as a way to understand the natural world. As soon as basic needs are met, babies immediately begin observing the world around them -- everything is new and everything is fascinating. Without any instruction from a teacher, a baby will naturally observe and investigate everything he or she can reach. Babies and children naturally want to use all their senses to explore.

This wonder and natural curiosity about the world is what I always hope to help my students recapture. Cell division, light refraction, volcanoes -- as a Science teacher, I have access to nearly unlimited content and nearly unlimited ways to explore that content. Through my science teaching, I really do try to get my students hands-on and senses-on -- touching, smelling, seeing, hearing the science that is in front of them! Of course, even tasting sometimes happens as students make observations in lab, but only with express permission!

I'd like to reflect on my teaching within the tenets of the NOS Matrix that deal with practices. The "Nature of Science" as included in the NGSS guides us to use different methods for investigating, and to gather evidence. This brings to mind my 8th grade's study of photosynthesis, in which we prove the presence of this process using 6 different methods of inquiry (pH, oxygen levels, carbon dioxide levels, chromatography, iodine as a starch detector, the presence of chloroplasts), and we gather data to show that photosynthesis is occurring. We look at history and the questions early scientists asked about plant growth, such as where does the mass of a tree come from and what is it made of?

Now, looking at the tenets which relate to the cross-cutting concepts, I want to refer once again to the baby's exploration of his or her world. When they've grown a little and can speak, children don't ask purely Biology questions or purely Physics questions. They want to know everything: what a butterfly eats, was it born, where did it come from, why is it orange, how do they fly, where do they sleep, etc.

The Science curriculum we have at my school is based on the NGSS, and it spirals -- it is not silo Science. So the development of knowledge is much more natural. We don't just look at the chemistry of photosynthesis, we relate it to energy cycles, ecosystems, and we use math and data to

relate it to climate change as well. We also always come back to the order and consistency within nature. Many teachers have to balance their approach to the NGSS with the standardized test preparation they are asked to do.

I find that helping students incorporate math, language arts, and history into their science practice undeniably helps them better understand the world around them and the interconnectedness of life and the physical world. They do better on standardized tests because they aren't memorizing facts about science. Instead, they are learning to understand and analyze information -- and to ask further questions when necessary.

Possibilities for Enhancements to Teaching

Truly, one of the best things about teaching is that you are constantly in a state of learning. I am always on the lookout for opportunities to learn: to teach better, to differentiate, to incorporate STEM more successfully, etc. I believe that we are constantly learning more about how children learn, and how and why they retain some information better than other information.

Teaching has changed dramatically since I was a child, and it continues to change even in the eight years in which I've been doing it. I think teachers have to stay open to changing and improving, and curious about what might be better ways to teach. If you shut down your own curiosity and growth, you won't be as successful reaching all the minds that you had hoped would open up to you.

I enjoyed the "Phenomena and Sensemaking" video, and the ease with which you can incorporate this in your teaching. Even though there is more scientific and engineering inquiry in my classes than there would have been even ten years ago, we do often give the answers before the investigation is underway. So, I want to see how I can actually put the enquiry before the "answers" as we go forward. I had hoped to test this out in my after school Science Club. This was designed as a space in which students could investigate a concept thoroughly without grades, without any answers other than what they discovered.

I check in with NASA, National Geographic, the Smithsonian, and the American Museum of Natural History fairly often. In the Smithsonian STEMvisions blog, I found this quote, 'One of the conclusions Achieve drew from their research was that "standards based on unifying ideas seem to confer more benefits than a discipline-based structure.'" ' This is another area in which I can improve my teaching. By looking at an all-sense approach, combined with incorporating other ideas not only makes students more interested, it also can make them learn more effectively because they see the connections in the world. They understand that they are learning Science, Math, Engineering, and even English and Spanish, not just to do well on a test, but to understand their world. All of this helps them to become well-rounded, intelligent, caring citizens of the world.

From the George Lucas Educational Foundation, Edutopia is a great source for helping me to understand Project-Based-Learning. This particular article focuses on the idea of a “driving question,” which really speaks to me. Middle school students can be very difficult to engage, but if you find the key to making learning compelling you’ve got them. On a day when I’m stressed or tired, I need to remember to pause and consider the information from a middle schooler’s perspective. What approach or question will “drive” them to want to investigate and learn?

How Content Area Overlaps With Another “Nature of....”

I opted to look at the “Nature of Engineering.” My major content area is Science, but I also teach STEM each week. It began as a separate, sort of free-standing class period and curriculum, but the STEM and Science cannot be kept separate. I’ve identified three ways in which Science and Engineering overlap, but there are many, many more!

Firstly, when we begin to explore a new Science concept or a phenomenon, we discuss the various possible ways in which we can look at it. As in Engineering, there is not just one way or one right answer to questions. It has been difficult for some students to accept that there is no one answer to memorize -- but in science and engineering there are multiple solutions. Students need to be able to look at many approaches or methods, and many results, in Science, Engineering, and in life!

Secondly, both Science and Engineering draw information from several other areas. By nature, they are cross-cutting. You can’t be a successful Engineer or Scientist unless you consider any problem or question in light of current understanding, history, culture, etc. The two are intimately connected to each other as well. You can’t develop a vaccine without “engineering” it, and you can’t build a tower in Dubai without Physics, and math, and....

Thirdly, both Science and Engineering are ever-changing. Each day we become more sophisticated in our understanding of both. We may discover that “facts” are discredited, or that the future we anticipated in 2015 has already changed to something very different. Our current experience with the Coronavirus pandemic has given us all front-row seats to the evolving nature of Science and Engineering.

References

Phenomena and Sensemaking video, retrieved June 7, 2020

<https://www.youtube.com/watch?v=3ps3Js-psgo>

Crosscutting Concepts: The Bigger Picture, Katya Vines, PhD, from the Smithsonian Science Education Center STEMvisions Blog, retrieved June 7, 2020

<https://ssec.si.edu/stemvisions-blog/crosscutting-concepts-bigger-picture>

In Search of the Driving Question, Andrew Miller, August 30, 2017, from Edutopia, retrieved

June 7, 2020 <https://www.edutopia.org/article/search-driving-questio>