Gabriella Blazich
Methods of STEM Education
June 7, 2020

Nature of Science

According to Appendix H of the Next Generation Science Standards, “science is a way of explaining the natural world (NGSS Release, 2013, p. 1).” Science education must incorporate the foundational knowledge of science, an understanding of science as a discipline and the practices that are included in science. The Next Generation Science Standards tie these factors together. As a middle/high school teacher on Long Island, I follow the New York State Science Learning Standards. These standards are very similar to NGSS with a few additions

There are eight main tenets that are included in the nature of science. In my teaching, I try to address all eight of these tenets. I know that I am more successful in addressing some of these tenets than others.

In November, my 9th Grade Living Environment class learned about enzymes. They completed a lab activity in which hydrogen peroxide was added to liver. The catalase in the liver causes the peroxide to bubble to release hydrogen gas. Student groups were given raw room temperature liver, cooked liver, frozen liver, liver soaked in an acid, and liver soaked in a base. They had to find the optimal conditions for catalase to work by comparing the rate of reaction for each test. This lesson addressed several of the tenets of science. One tenet of science that was addressed was science addresses questions about the natural and material world. Before the activity started, students predicted what would happen when the liver was placed in the peroxide and wrote down questions that they had about this reaction. They tried to answer some of their questions using the data they collected. This enzyme lab addressed the tenet of the empirical nature of science because students used their own observations to determine the optimal conditions for this enzyme to work. They collected observations from several different tests and had to draw a conclusion from the data they collected. This lesson addressed the use of a variety of methods in science because the students used qualitative descriptions of the amount of bubbles produced and used a timer to see how long the reaction between catalase and peroxide took. This lesson also addressed the human nature of science because students had to think of creative ways to compare the data collected from each test and propose an explanation of why the rate of reaction was different in each test. Students recognized that catalase worked better in the tests where more bubbles were produced, such when the room-temperature liver was placed in peroxide. They inferred that the catalase was somehow changed in the pieces of liver that produced no bubbles, such as the cooked liver. This lesson also addressed the subjective and theory-laden nature of science that science knowledge assumes an order and consistency in natural systems, and that science laws and theories explain natural phenomena ((Science Learning Hub). Students bring their background knowledge and experiences to everything that they do. Prior to this lesson, students had already learned about proteins and knew that proteins could be changed at different conditions. They also knew that the food they eat changes when it is cooked or soaked in something and that liver is just another type of food. They used this background knowledge to address the differences in the reaction rates for raw liver and cooked liver. They realized that the different methods of preparation of liver caused the enzymes to change shapes because like other proteins, enzymes are very specific and sensitive. A few students also told me that they thought liver was disgusting and did not even want to look at it, which impacted their observations.

I believe that this lesson addressed most of main tenets of science listed in Appendix H of the NGSS. This lesson did not really address the tentative nature of science and did not focus much on the idea that science is a human endeavor and is socially and culturally embedded. As I have been reflecting on my first year of teaching, I realized that I often leave these two tenets out of my lessons. I also realized how important it is to specifically address each of these tenets. As a student, I was always taught in very traditional classrooms where notetaking was the main activity. I am actively trying to move away from this viewpoint and create a classroom environment that is very different from the one that I grew up in. Science is not constant, and our view of it and the way we approach it should not be either.

Next year, I want to start off my classes by doing the pattern cube activity that is mentioned in “What’s in a Word?” (Schwartz, 2007). In this activity, students are given a cube with different words on it and have to work together to find a pattern that connects the words and propose a possible word for the hidden side of the cube. The goal of this activity is to show students that they cannot be 100% certain of the hidden word or prove the pattern that they proposed was correct, two lessons which can be applied to science in general. Students need to realize that there is no absolute truth in science and that hypotheses/theories can only be supported, not proved. Next year, I also want to plan more lessons that address how scientific knowledge is influenced by the society and culture it is produced in. I know that I often just present my students with facts without really giving the context that this information was produced in. One way to do this would be to discuss the differing viewpoints on "controversial" topics, such as GMOs and global warming, and examine where these views come from and why certain groups might push specific viewpoints. I also want to teach my students more about research funding and how research is used to influence new policies.

Since all of the STEM disciplines can be considered to be at least somewhat interconnected, it makes sense that the nature of engineering overlaps with the nature of science. The natures of both disciplines include connections between the discipline and the outside world. Science knowledge needs to be recognized as a human endeavor that is culturally and socially situated. The same is true of engineering. Engineering students should understand the cultural, economic, and environmental effects of engineering and the impact that engineering has had on the world (National Academy of Engineering and National Research Council, 2009, p. 6). The natures of both science and technology place importance on the skill of creativity. This skill is crucial to those that are successful in both disciplines. In science, creativity is used to answer questions about the natural world. In engineering, creativity is used to solve problems in the natural world. Creativity is inherent in the processes of both of these disciplines. One of the principles of engineering is engineering education should emphasize engineering design, which can create a meaningful context for science knowledge (National Academy of Engineering and National Research Council, 2009, p. 5). By providing students with engineering skills and an understanding of the discipline of engineering, we can create jumping off points for science concepts and education. Students can use their engineering skills to address questions that stem from scientific phenomena. This year, my 8th Grade Physical/Earth Science students completed a project which combined these two disciplines. They learned about bridge collapses and then competed in a bridge building competition using only glue and popsicle sticks. This project combined engineering skills with physical science concepts and I found it to be one of the most rewarding assignments that my students completed all year.

Works Cited

National Academy of Engineering and National Research Council. (2009). In L. P. Katehi, G. Pearson, & M. Feder (Eds.), *Engineering in K-12 education: Understanding the status and improving the prospects* (p. 5-6). Washington, DC: National Academies Press.

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press.

Schwartz, R. (2007). What's in a Word? How Word Choice Can Develop (Mis)conceptions about the Nature of Science. Science Scope, 31(2), 42-47.

Science Learning Hub. (n.d.). Tenets of the nature of science. Retrieved June 08, 2020, from https://www.sciencelearn.org.nz/resources/413-tenets-of-the-nature-of-science