Nature of Stem Assignment by Yishan Lee

Since I am a science teacher, I have chosen to focus on the nature of science. I was exposed to the tenets of the nature of science early on in my career. As a product of the traditional, lecture-based education system, I did not realize the dynamic nature of scientific knowledge until I became a teacher. Having witnessed the downgrading of Pluto from a planet to a dwarf planet in my lifetime, it was not difficult for me to grasp the idea that scientific knowledge is subject to change as new evidence becomes available. Hence, I made sure to address this tentative nature of science in the first week of school through a puzzle activity called "The Extra Piece," which was originally designed by Jason Choi from Sleepy Hollow High School in Westchester, New York.

In this activity, students are given a set of 4 tangram-like pieces without any further directions. I would ask my students to brainstorm ideas on what they should do with the material. Most students would infer that they need to build a shape with the pieces with the majority believing that they should build a square, which prompts me to ask what makes them think that. After providing evidence and reasoning to support their inferences, students are encouraged to test out their inferences by manipulating the pieces. In my experience, all students are able to validate their inference within a short amount of time. We would discuss what this result means about their original inference before I derail their scientific progress entirely by introducing an extra piece to simulate the discovery of new evidence. By this time, the confidence and excitement from before gradually become replaced by groans and calls for help. Students would come up with clever methods to make the extra piece fit in with the rest by folding or overlapping the pieces, only to be informed that they must use all parts of the new evidence.

It was always fascinating to observe how students tackled this challenge. Some students were reluctant to take apart the original square entirely. Others were eager to start from scratch again. Usually, I could always count on at least one group to solve this puzzle successfully. When that happens, I would inform the class that scientists work as a community by sharing their findings with others. Students would swarm around the "solution" before replicating the results back at their own tables. We usually close out the activity by discussing how this activity simulates the work of scientists. If time permits, we can also discuss what would happen if the new evidence does not fit in with existing evidence. The hands-on component and interesting

conversations that we can initiate based on the activity are the reasons why this lesson has always been in my curriculum ever since my first year of teaching.

Over the years, I continued to curate activities and lessons that emphasize other nature of science principles. For example, last year I used the 9-dot puzzle to introduce the creative nature of science. Students had to connect all 9 dots (arranged in a 3 by 3 grid) with 4 straight lines. Additionally, students may not lift their pencil off the paper once they begin drawing a line. Although I knew of only one solution, I encouraged my students to try as many creative methods as possible within the constraints provided. This activity pushed my students to think outside of the box, quite literally. When we revealed the solution at the end, I made sure to remind my students that there could be other solutions waiting to be discovered.

In another lesson, I introduced the concepts of the "known," "known unknown," and "unknown unknown." I ask my students to think of examples that would fit into the "known" and "known unknown" categories. Eventually they began to see the pattern and recognize that if it was something they could ask and be curious about, it would not go into the "unknown unknown" category. We also wondered how much "unknown unknown" is there. This lesson helped my students understand the empirical nature of science, that our knowledge is based on what we can observe directly or indirectly. Even then, our observations are subject to personal biases and interpretation, which may be far from the absolute truth. To further illustrate this idea, I used the blind men and elephant comic and a powerful image to initiate a discussion among my students and derive the conclusion that science is subjective and theory-laden. This particular tenet was especially crucial in our astronomy unit, as the origin of the universe tended to be a controversial topic resisted by students with contradicting religious beliefs.

There remains one tenet that I still need to seamlessly integrate into my curriculum, that science is socially and culturally embedded. To promote the social aspect of science, I intentionally assign tasks that require students to work together and pool their knowledge and skills. I frequently ask students to communicate their strategies or findings with their classmates. Emphasizing the cultural aspect of science is something I still struggle with, I hope to learn more from other teachers in this area. Additionally, I recognize that the dynamic nature of science applies to my own understanding as well, which is continuously evolving as I seek to improve my content knowledge and pedagogy. My next step would be to create opportunities

to tie in these tenets of science throughout the curriculum as opposed to just the introduction unit. I also want to utilize more consequential, real-world phenomena to deliver these principles of science.

After reading about the nature of engineering, math, and technology, I recognize the overlap between the nature of all these disciplines, especially between science and technology. As stated in the reading, “new products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.” This nature of technology closely relates to the tentative knowledge of science, because our understanding of the natural world changes over time as new technology becomes available, allowing us to make observations that we were unable to before. The nature of technology also overlaps with the principle that science is imaginative and creative, as human beings develop innovative technology to help make the world suitable for ourselves or to achieve goals that we would not have been able to meet without technology. Lastly, the development of technology tends to involve collaboration between individuals, which closely aligns with the nature of science which states that science is socially and culturally embedded.

Acknowledging the nature of science, math, engineering, and technology will help our students bridge the connection between these disciplines, allowing them to thrive in the 21st century. After all, we are not preparing our students for test-taking. Rather, we are gearing them up for the real world at a time during which STEM matters more than ever as our survival depends on it.