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Nature of STEM Assignment
Week 4

Four years ago, there was a change starting at the Shepherd Middle School in Ottawa, Illinois. There had been talk for a few years of opening a STEM lab at the school and this year was the year they started looking for a teacher to run the lab. The district was sending the Technology teacher to training and other schools to visit their STEM labs and everyone thought that he would naturally move over to that position. In late October of that year, I decided to go in and ask my principal what requirements they wanted in their STEM teacher. I was in my seventeenth year teaching seventh grade math and had my middle school science endorsement. Little did I know that what I was really asking was what was their philosophy on the nature of STEM. We have separate science, math, and technology programs, so were they looking for a program that integrated design, inquiry, analysis, and 21st century skills or were they looking for a program that focused on the engineering aspect of STEM? Of course, until about two weeks ago, I did not have the vocabulary of NOS, NOM, NOT, or NOE, so I did not know that was the answer I was searching for. Looking back at the last three years in the STEM lab, I would say that we focus on the Nature of Engineering more than anything else.

According to the "Nature of Engineering Summary", the first principle of engineering education is to emphasize engineering design. Each of the expeditions my students work through involves the engineering design process. During this process the students learn that engineering is extremely iterative; it is a cycle that only ends when they run out of time or money and have to present their best product to the public. They learn that in STEM we focus more on the process we go through to create or innovate a design rather than the final product. In each expedition students are asked to reflect on their prototype and find ways to improve their design.

The second principle of engineering as stated by "The Nature of Engineering Summary" says, "Engineering education should incorporate important and developmentally appropriate mathematics, science, and technology knowledge and skills" (Katehi, Pearson, & Feder, 2009). Several of the expeditions focus on scientific skills and concepts, such as kinetic and potential energy, cells, space travel, plate tectonics, flight, weather and light waves. During these expeditions there is a central theme that threads through the entire expedition, culminating in some sort of final project. As they work towards the final project mini lessons on content are woven in as needed. Students use testing and measurement equipment to find temperature, speed, velocity, wind speed, air pressure, volts, amps, ohms, force, etc. Students use their data from these instruments, along with their mathematics skills, to average, graph, and make predictions based on data. We also use technology skills to design various prototypes in Tinkercad and then printing them with the 3D printers.

Several engineering habits of mind are occurring in the STEM lab, also. This is the third principle found in the “Nature of Engineering Summary”. We start the first year with the marshmallow challenge found on TED Talk. After building their marshmallow tower, we watch the TED Talk about how kindergarten students are the ones who usually do the best in this challenge, after architects, of course. We spend some time discovering how school has trained them to look for the right answer and “what the teacher wants” instead of letting their creativity lead the way. Students almost always work in groups or partners, learning to collaborate and build off of others’ ideas. Again, by middle school, students have learned who usually has the right answer and who always participates in groups, so we are constantly teaching the students to use collaboration skills and strategies.

When I first learned I was moving to the STEM lab I met with the science teachers and reviewed what their curriculum covered. I tried to choose expeditions that did not overlap with what they already taught. Looking back, I wish I had chosen expeditions that enhanced the content they already taught, so students would be able to apply what they are learning in science to real world problems. This would allow students to better develop an understanding of the nature of science. Students need a chance to stand back and see how their knowledge, experiments, models, and conclusions reflect that of a professional scientist.

After reviewing the eight tenets of science included in the NGSS appendix H, I see several areas for improvement. First, I would like to emphasize and help the students see that science is open to revision in the light of new evidence. Too often, we focus on laws and theories as truth and if new data comes along that changes the way we look at something, for example Pluto, then students feel that the previous scientists were wrong. This response contradicts the nature of science that theories are always changing as we continue to collect evidence and make more and more observations.

I also see a chance for improvement by looking at the scientists who have made the discoveries we study and use regularly in the classroom. We might mention the scientist and talk briefly about an experiment or discovery, but we do not typically spend time on who that scientist is. By doing that, we can show that science is a highly creative human endeavor. If science were strictly procedural, then two scientists would review the same data and come up with identical conclusions. Also, scientists bring unique skills and experiences into a situation allowing different perspectives and ways of communicating what they find. Showing students the creative, collaborative side of science, instead of dry and procedural, may appeal to some students and allow them to look at information differently.

The ultimate goal of STEM is to fully integrate science, technology, engineering, and math. The years of teaching math at the same level has made it easy for me to stress the areas where math overlaps what they are working on in STEM. My answer to my math students when they ask, “When are we ever going to use this?” was always to never limit themselves now on what they might need in the future. By the time they

graduate and start looking for jobs, there will be changes and problems we cannot even imagine now. I always stressed that their ability to make sense of problems and persevere in solving them is more important than memorizing facts and getting the right answer. I carried this practice over to STEM and I have been able to emphasize this mathematical practice found in the CCSS so much better. By setting up a classroom atmosphere that is about the process and not the “right answer” allows students to take risks and dive into problems they may not know exactly how to solve. The cyclical nature of the Engineering Design Process encourages students to continue improving and learning from previous attempts. We are creating students who know how to persevere.

My STEM students are also encouraged to model with mathematics. They are given the chance to apply what they are learning in the math classroom to solve everyday, real world problems. One of the standards the seventh graders focus on in math is ratio and proportions. There are several expeditions that require the students to use proportional reasoning to make predictions and analyze data. When students are working on these areas I try to connect those problems to what I know their math teachers have been teaching. Eighth grade students spend a lot of time graphing equations and looking at relationships. We have several expeditions that use graphs to organize and communicate data. I find that students are able to graph data points, but struggle to connect their graph to the equation and formulas used. For example, students make graphs using the potential energy and kinetic energy formulas. They can usually see that as height increases potential energy also increases and as velocity increases, so does kinetic energy. However, they rarely make the connection between a linear equation and an exponential one. Having a chance to model these types of equations they are learning in math deepens their understanding on “Why they need to learn this”.

When I used to teach math, I always found some students struggled to use a ruler, and a protractor while others picked up on it extremely quickly. This discrepancy in skill makes it hard to work on this skill in the math classroom since it often requires individualized attention to each student. When students are studying angles of incidence and reflection, they draw and measure the angles. When they are drawing their bridge blueprints, they have to precisely measure each piece. I am able to work with students who might struggle with this and help them learn how to use these tools appropriately.

In “Is There a ‘Nature of STEM’?” article, it states, “the NOE and NOT tend to be about shaping the world, and NOS and NOM tend to be about discovering secrets of an already established natural world” (Peters-Burton, 2014). This idea needs to become the focus of my STEM lab that I was searching for four years ago in my principal’s office. By using what they are already learning in math and science and showing them the technology that is available and how engineers work to continually try to solve society’s problems and meet its needs, we will better equip students to be active participants in an ever changing world.

References

- Appendix H – Understanding the scientific enterprise: the nature of science in the Next Generation Science Standards. (2013). Retrieved from <https://www.nextgenscience.org/sites/default/files/Appendix%20H%20-%20The%20Nature%20of%20Science%20in%20the%20Next%20Generation%20Science%20Standards%204.15.13.pdf>
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