The Nature of STEM Assignment

Tara Wright

Endeavor STEM Teaching Certificate Project

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There are currently major shifts happening in the way that students are expected and encouraged to learn STEM content and practices. Traditionally, science, technology, engineering, and mathematics were each taught as independent disciplines in a direct instruction environment with knowledge-based level of understanding. As the demands of society and our world have changed over time, we are moving into an age of synthesis where students need to be able to synthesize, make connections, and apply their knowledge in new ways (Nadelson & Seifert, 2017). As a high school mathematics teacher, if I choose to only focus on teaching rote skills that only teach mathematics content standards, I am doing my students a disservice and they are missing valuable learning opportunities to make connections in the real world. How I address the tenets of mathematics in my classroom, as well as how I tie in the tenets of the other STEM disciplines can largely impact my students' engagement in the content that I am teaching and their ability to apply it to real world problem solving.

There are eight mathematical practices that I am expected to develop in my students that really represent the nature of mathematics. These eight mathematical practices include: 1. Make sense of problems and persevere in solving them, 2. Reason abstractly and quantitatively, 3. Construct viable arguments and critique the reasoning of others, 4. Model with mathematics, 5. Use appropriate tools strategically, 6. Attend to precision, 7. Look for and make use of structure, and 8. Look for and express regularity in repeated reasoning (National Governors Association Center for Best Practices, & Council of Chief State School Officers, 2010). Although I know that my incorporation of these practices into my instruction can greatly improve, I do try to bring these practices into my lessons in small ways. For example, when teaching the properties of exponents, instead of giving my students the shortcut rules to memorize and then practice, I gave student groups a set of expressions that needed to be simplified as well as their simplified solutions with the task of looking for patterns in the way that the coefficients and exponents changed from problem to solution then developing their own "short cut" for how to simplify exponent expressions with different operations. Groups shared their observations and conclusions and the other students were able to question and share their own findings. Although it was a small activity, it addressed mathematical practices 3 and 7 and students were more engaged because they were developing their own ideas rather than copying teacher given notes.

Another small way that I try to incorporate some of the mathematical practices into my classroom is through real-world type word problems. Throughout my class, students are exposed to word problems that can be solved with basic two-step equations, systems of equations, mixture word problems, etc. There are several different types of these real-world scenario type problems that my students could easily find the solution to, however they struggled when I required them to also model the situation in the form of an equation. This was a skill that students often complained about because they could find the answer (which was most important to them) without it, yet I took the time to teach a text coding strategy to help students interpret key words into mathematical symbols and students practiced the mathematical practice 4: model with mathematics. By practicing this modeling skill, students are more prepared to interpret more complex mathematical problems that they may not be able to solve as easily.

To better enhance the STEM learning in my classroom, I know that I need to do a better job of incorporating the tenets of science, technology, and engineering. One way that I could better address the tenet of science is by using phenomena to spark student curiosity and connections to how the math content that they are learning can relate to and be used to solve problems in the real world. Once students reach algebra, they rarely see any relevance to them and their daily lives because the way that it has been traditionally taught is through repetitive practice of skills in order to find generic solutions for “x” that are not built around a real-world context or phenomena. By engaging the students with phenomena, students can engage in scientific inquiry by asking their own questions, developing interest, and begin their own search for the mathematical skills they need to know in order to be able to find answers to their questions. In essence, “students are able to identify an answer to ‘why do I need to learn this?’ before they even know what ‘this’ is.” (NGSS Lead States, 2016, p.1)

Another way that I can better enhance students’ engagement with STEM learning is to incorporate more creativity and design opportunities in problem solving. Since learning more about the tenets of science, engineering, and technology, I have really been thinking of revising a class project that I have used previously which uses rocket launch to teach students about quadratic functions and interpreting key characteristics of the function. The first year I used the project in my instruction, it was very rigid with exact instructions for how students should build a rocket out of certain materials and all were the same. In order to bring more scientific and engineering practices into this lesson opportunity, I think it would be more beneficial to my students to give them greater freedom in how they construct their rockets- which would promote the engineering design process- to determine which design would result in the greatest height reached. We could discuss scientific methods for testing launch height and students could make observations and draw conclusions based on the calculations that they do using the mathematics content. Tying in these elements were never things that I had considered before because I was narrowly focusing on my own mathematics content rather than looking for ways to make connections.

The nature of mathematics revolves primarily around logic and reasoning to observe and identify patterns and provide mathematical proof of solutions by following set mathematical rules. Mathematics can lead to one correct answer with definitive proof. Alternatively, the nature of sciences is “reliable and durable… but neither set in concrete or perfect” (Science Learning Hub – Pokapū Akoranga Pūtaiao, 2011, p. 1) The nature of science is tentative and relies on observations, evidence, and human interpretation of the data which can lead to frequent revisions and changes as more evidence or better interpretation is made available.

There are, however, several ways that math and science practices overlap. One is through modeling. Mathematics is a language that scientists use to communicate their observations, data, and evidence to support their conclusions. Scientists employ different mathematical models to highlight areas of interest in their data. This is also a skill that mathematicians use to highlight key characteristics in data sets. Another shared practice is constructing viable arguments and critiquing the reasoning of others. Mathematicians must show/explain their reasoning to justify their solutions just as scientists must give accurate analyses of their own data to justify their conclusions. Being able to critique the reasoning of others is how both mathematicians and scientists are challenged to improve upon their conclusions and search for ways to fill in any gaps that are found. Lastly, both disciplines of science and mathematics require you to use mathematics and computational thinking. Mathematical practice 2 requires students to reason abstractly and quantitatively, and it is through such reasoning and quantitative computation that scientists are able to support their own conclusions. (NGSS Lead States, 2013)

Although I have still much to learn about integrating STEM instruction in my classroom, I am learning and beginning to make better connections among the different disciplines. Teaching STEM from a more integrated approach will strengthen my students’ understanding of my own content as well as give them greater purpose and engagement into what they are learning. I look forward to implementing what I am learning into my instruction and seeing positive effects in my students and their learning.

References

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