Project Title: Arsenic in western Maine

School: Mt. Blue High School

Grade Level: 10th

Teacher: Doug Hodum

Project Partners: My scientist-partner was Terry Morocco at UMF. Additionally, Maria Howatt, a chemistry teacher at MBHS, also involved some of her students in some of the possible well water testing.

Teacher Profile: I have been a science teacher for the past 20 years, with one year of middle school special education experience prior to that. My two decades of science teaching experience has all been at Mt. Blue High School in Farmington, where I started as an earth science teacher and have since moved to biology. My undergraduate degree from Grinnell College is a BA in Environmental Technology, which was an independent major combining environmental studies, anthropology, math and physics. My MS from the University of Maine is in ecology and environmental science.

As a teacher, I love to see students making connections between what we discuss in class and the real world around them. Seeing them understand how things work and how they relate to their lives and even other classes, the aha moment, is the reason I teach. I want students to appreciate the natural world and to be curious, because those are things I care about in and out of school. I love the educational field and am busy in different facets of it.

Outside of education, though, I have a wonderful wife, a grown daughter and two rescue dogs. I love spending time with them as well as reading, cooking, staying active with running and gardening.

Given my master's degree and my passion about the environment, the All About Arsenic project is a way to make the content in my classroom and my passion and background relevant to my students and their community. I have wanted to engage my students in more public service and work. I hope to get more active in the project and have results to share with the community at large, showing students how work we do in school can influence the communities in which we live.

Summary: This year was my first with this project, and I struggled to seamlessly blend it into my curriculum. I started off fairly early in the year having my students set up bioassays with copper sulfate, iron sulfate and sodium arsenite. The students used lettuce seeds on a petri dish with paper towels. Each group had one of three concentrations of an unknown pollutant solution and one dish with a control that was just DI water. After 2-4 days, germination and growth rates were recorded for the three pollutants in the three different concentration and also the control. The students did not know anything about the different solutions, the pollutants or the control. This work allowed me to emphasize the need for controls in experiments and also the independent and dependent variables that students often struggle with when faced with doing their own lab work.

For the data interpretation piece, the students discussed the patterns they identified and tried to determine which pollutant and concentration was the most detrimental. In addition to this component, my students also use M&M data collected over the past 16 years to work with graphing and data interpretation. We discuss the type of chart to use and also how to interpret that information based on a simple question about red and blue M&Ms in a bag.

Unfortunately, only a handful of well water samples were actually collected, and none were submitted for analysis.

Immediately before the closure, I was about to order both the Daphnia and the duckweed for experiments to be designed and run by the students. The students were going to revisit the information from the earlier bioassays and be allowed to develop their own protocols to test on the Daphnia or duckweed.

Project Details:

- All 64 students in my classes were involved as well as another 15 in Ms. Howatt's chemistry class.
- I used my stipend to purchase lettuce seeds, 50 ml vials and the parafilm.
- We conducted an initial experiment with lettuce seeds. Students did that with no background just as an introduction to lab work and arsenic. The students wanted to know what the different liquids were and why we used lettuce seeds.
- We used the protocol provided by Jane Disney for the bioassay with the lettuce seed experiment. This involved 2 sets of 10 seeds in separate petri dishes with 2 mL of a control or a pollutant applied to paper towels. The germination and growth were recorded after 2 to 4 days. We used three different concentrations of each pollutant (10 ppm, 100 ppm, 1000 ppm) of ferrous sulfate, copper sulfate and sodium arsenite. Additionally, I used the video In Small Doses with all my classes to introduce them to arsenic.
- Students reviewed data from the bioassay work with the lettuce. From the data they collected, they discerned that the data from the vials numbered 3 in the data set were the most polluted (had the highest concentration of pollutant) and that the other liquid, the control, was probably just water, given the highest growth rate.
- I collaborated marginally with a chemistry teacher, Maria Howatt, and I offered to work with other teachers in the science department.
- I did not use Tuva with my students this year, especially as we did not collect any arsenic data. I had my students use Google Sheets to collect their data and also to work with the M&M data set previously referenced.
- Terry and I discussed how to roll our community meeting out, and the initial plan was to try to pull something together in March in conjunction with a science night. However, as the year unfolded, that was obviously not going to occur. At the time of the closure, we did not have plans for the community meeting. Ideally, the students would have had posters or at least visuals to show the effects of various concentrations of arsenic from the lettuce seed bioassays as well as their work with the Daphnia and duckweed. Having this information available during a district-wide musical performance is one possible strategy to use to include more of the public than a stand-alone event. Presenting to the local school board is another option as well as reaching out to doing something at an event at UMF.

Discussion:

- The students learned what a control in an experiment was and the purpose of it. They learned the difference between an independent and dependent variable and their importance when doing experiments. They saw the effects that polluted water can have on seed growth and germination. They also learned about data interpretation and about following simple lab directions, which was no simple task for some of them.
- I was reminded that my students thrive when they DO science. Using this bioassay was a wonderful way to start the year and should have been leveraged to do the other work with arsenic nearly

immediately. Real data does interest students, even when they are not entirely certain as to what they are collecting and looking at initially.

- Furthermore, I learned that I need to strike when the iron is hot. I have to be more deliberate and intentional when trying to collect well water samples. I did not do well to arrange that in the early part of the year, which is exactly when it needs to be done. This needs to be planned earlier and better if I am going to actually contribute to the data set from western Maine.
- I learned that I need a more concrete plan when heading into next year and see how this aligns with our learning targets and when and how to include it in my instruction.
- If I had to do things differently, I would collect well water samples by the end of October, allowing my community to get information and give my students more local data to use and study, bringing relevance to the class.
    - I would order the Daphnia and duckweed in the first part of the year to allow the students to work with them and collect real data for the community forum. This will also give students more lab experience and opportunities to develop their own protocols for experiments.
    - Early in the school year, I need to pick a tentative date for the community outreach. I need to coordinate with my university contact, Terry, and any colleagues to try to make this a larger scale event, maybe where student research and class work is showcased. We have done family science nights before. If the pandemic allows this type of event to happen, it might be a perfect venue for students to share their own findings.

Conclusion: This project is one that I feel could help my students feel more connected to biology and their community. Being my first year in the project, I would say I did not fully utilize the opportunity to expose my students to more citizen science or contribute to the data set about arsenic in Maine. With a partial year's experience, I feel as though next year, if I can work with my students in my classroom for data collection, they will get more experience and exposure to lab work, developing questions, collecting data and drawing conclusions than they did during this first year. The highlight of the project was the fact that the students did enjoy the bioassay work, and I have more tools in my repertoire to teach through doing science.

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