Project Title: All About Arsenic

School: Presque Isle High School

Grade Level: 11-12

Teacher: Erika Bernard

Project Partners: Who did you work with for this project? Name your mentor and their institution and any other partners.

The scientist partner on this project was Judith Roe at the University of Maine at Presque Isle.

Teacher Profile: I am currently in my 8th year of teaching science. Throughout these years I have taught everything from Earth Science to anatomy and am currently teaching various levels of chemistry. I began my college career as a physical therapy student which allowed me to take various science classes but I always loved education as well. I decided the meld the two and switched majors for get my B.S. in Secondary Education – Biology. The extra credits from my years in physical therapy also allow me to teach the physical sciences. I am currently getting my Master's in Stem Education to be a more well-rounded teacher in the classroom. While I have always been drawn to the life sciences, teaching chemistry has really gotten me interested in the environmental side of science. Last summer I had the opportunity to take an environmental chemistry course for my master's which has lent itself well to this project.

Inside the classroom, I try to make things as fun as possible for the students (this year has been HARD). I find that my background in a variety of sciences allows me to draw on other courses for background and grow the curriculum from there. Outside of the classroom I try to be outside with my 3 year old daughter and husband as much as possible. We are currently getting into gardening so we will see where that takes us.

My draw to this project is that it based of our own backyard so to speak. We have a lot of farmland around us in Maine and to study that is exciting. The real-life data experience that my students would gain in the process can't be beat. Coming off of a year of being partially remote, this is what we needed to bring excitement and curiosity back to the classroom. Plus, I never do enough data analysis in my classroom. I tend to fall into the rut of lecture/assignments/exams. My students were really engaged in this throughout the year and were constantly asking when we would be able to work on it. While I didn't do a great job at blending it into my curriculum, next year I will know what works and what doesn't.

Summary:

We started the All About Arsenic project in my College Prep Chemistry in the Fall of 2020. We first talked about the elements on the periodic table and ran through the Arsenic PowerPoint that was shared in Google Drive. From there, I had created an Arsenic Webquest for the students to gain more background information on the topic. The Webquest contained news articles and video from the Arsenic poisoning that occurred years ago at a church in New Sweden. The students were very excited to get started after this.

A lot of my students are on city water but I was able to collect 18 samples including students and teachers in the building. From there we sent them out to be analyzed. (It should also be noted that PIHS ran semesters this year so I only had half of the students in the fall that I would normally have. I hope to get more samples next year when we go back to full year classes). While we waited for the results, I continued to use Arsenic as an example for various activities in the classroom. We also practiced using TUVA Labs. There are

some great chemistry related activities such as Periodic Trends and other Elemental assignments that correlated with my lessons. This allowed the students to learn how to use the website and be ready for when the results arrived.

The results arrived just before the end of our fall semester so my spring students were really the ones that used them. When the spring semester started, I had students create brochures of the elements that had been tested. They also completed the Webquest and PowerPoint that I had used in the fall. Our results showed a couple of samples that were high in lead and one sample was high in manganese and arsenic.

With these results, we ran a bioassay using Wisconsin Fast Plant Seeds. The biology department had a lot leftover and this was a quick way to test out a bioassay. (We actually had to run this twice. The first time a couple snow days in a row dried out our seeds and they died.) I had students collect more well water than was needed for the testing so I had extra of everyone's samples. We used the well water samples that were high in arsenic and lead as well as a sample that was great in everything to compare. The seeds in the lead barely grew over the course of 2 weeks. The seeds in the Arsenic water grew great, but the leaves had white spots all over them instead of the normal green like the seeds growing in the "safe" well water.

After the results of the bioassay the students did a lot of research to see what was the case for this. They also created PowerPoints utilizing our bioassay information and graphs from TUVA using the arsenic data. The premade questions from the TUVA folder in google drive also helped steer the students in certain directions. It definitely helped them start their graphs and from there they were able to ask their own questions and find answers.

While we were not able to present at a community meeting this year, the word of our project spread quickly and the students were excited to tell family and friends. We were also able to push out some information on our school's social media pages.

Project Details:

- How many students were in the class that was involved in this project?
    - There were roughly 20 students involved with this project. Since my school ran semesters this year, ~10 students I had this spring were involved the most.

- Detail specific curricular items such as questions, articles, books, YouTube videos, and labs. It's helpful if you provide links.
    - I first relied on the shared resources in Google Drive such as the All About Arsenic PowerPoint and the TUVA resources.
    - I created a Webquest for the students to learn more about arsenic. https://www.bookwidgets.com/play/D9QPD9?teacher_id=5653584380166144
    - We utilized TUVA Labs throughout the year whenever I could find a lesson to match what we were currently doing in class. The students took to this website pretty quickly and were able to complete quite a bit on their own. Next year, I hope to have more time to input data from our bioassay.
    - For our bioassay, I used the book "Assessing Toxic Risk" by the NSTA Press. We talked about toxicology and utilized the worksheets provided by the book. https://www.amazon.com/Assessing-Students-Cornell-Scientific-Inquiry/dp/0873552229
    - Our bioassay led us to water quality and conservation. I used a simple water quality kit to help explain this along with some YouTube videos. I had modified a lab from TeachEngineering.org to help with this as well.
        - Teach Engineering: https://www.teachengineering.org/activities/view/uok-2216-wastewater-treatment-plant-model-water-quality

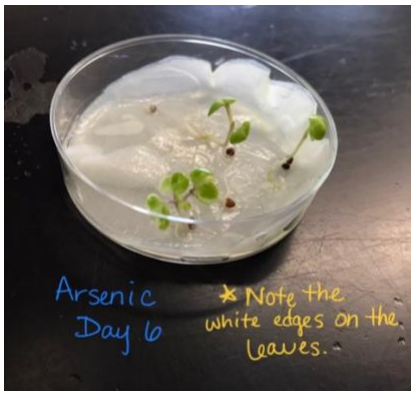
- Our water quality kit is a little old and used by our other classes. I couldn't find it on amazon anymore, but linked a similar one. https://www.amazon.com/Earth-Force-Low-Cost-Quality-Monitoring/dp/B0080GR71G/ref=sr_1_1?dchild=1&keywords=low+cost+water+monitoring+kit+lamotte&qid=1623682222&sr=8-1
- We also watched the "In Small Doses" Youtube video and a TED Talk on water conservation: https://www.youtube.com/watch?v=6HVNpoFvRdk&t=145s https://www.youtube.com/watch?v=nLB8A--QdHc

- Did you:
  - Collaborate with any other teachers in your school?
    - The only collaboration was through the collection of well water. A few teachers were excited to have their wells tested!
  - Go on any field trips? Why and where?
    - Not this year. We are hoping to go to the water treatment facility next year. We are also hoping to head up to UMPI and complete some bioassays there.
  - Conduct any experiments? What kinds of questions did students ask?
    - We conducted a bioassay utilizing the book "Assessing Toxic Risk". This helped students understand toxicology and what questions to ask before starting the project. We also completed a water quality lab.
  - Use your stipend to purchase anything for your classroom? If so, what, and how did you use it?
    - I did not use the stipend this year. Luckily, I work with a lot of teaches who collect everything and never throw it away (we're a bunch of hoarders). I was able to find everything I needed this year in our storage closets. Next year, I will need to order new items such as falcon tubes for collection.
  - Invite any guests to visit your classroom?
    - Not this year. We tried to get a zoom meeting with the head of our water conservation program in Aroostook County. Sadly, times never worked out.

- How did you use Tuva, both for the arsenic data and for other datasets?
  - This year, we used TUVA throughout the year. A good number of lessons in TUVA matched up with my chemistry curriculum and they were great additions to the classwork. We also used to during our bioassay and final activity for the arsenic project. Next year, I hope to put our bioassay data into TUVA so we can use the website to create graphs.

- How did you plan your community meeting?
  - Sadly, we did not get to this. Instead, we pushed out information on our School's social media pages. Next year, we hope to meet with the city council.

- Include any data analyses your students did.
  - Bioassays:

- 

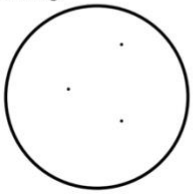
- Below is an example of the data that the students thought would be beneficial to collect during our bioassay. They worked as a class on this and I let them lead the way. They completed these for a couple of weeks.

Bioassay

Petri-dish # 4
# of seeds 3
Water sample-Well

Daily Observations

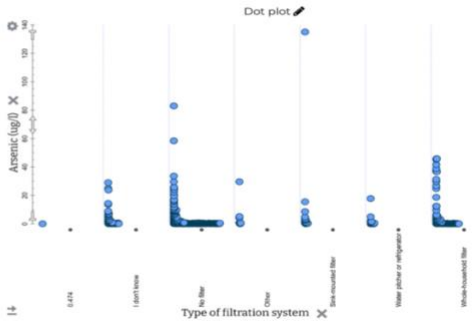
Day 1: Start
1. Amount of water given: 1 Pipet
2. # of seeds germinated: 0
3. # of leaves: 0
4. Color of stem and leaves: N/A
5. Height of the stem: N/A
6. Drawing:

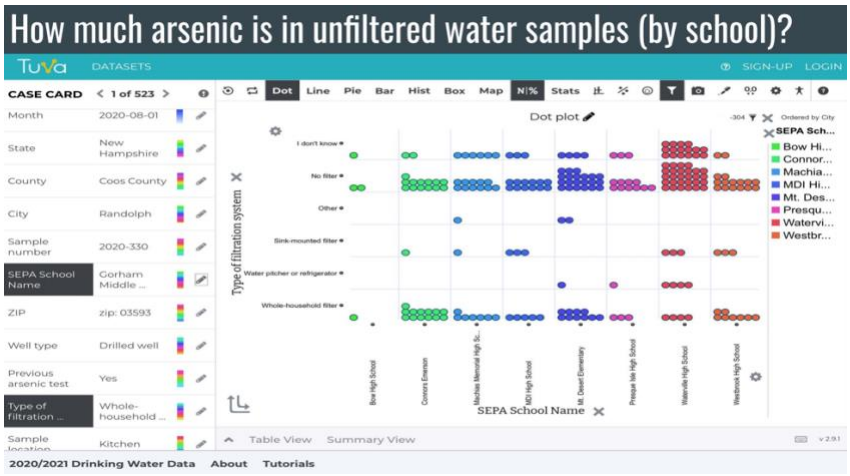


- Examples of graphs made with TUVA to complete our Arsenic PowerPoints.

Are some filters more effective than others at filtering out arsenic?

Sink mounted filters and water pitcher filters are a lot more effective at filtering out arsenic than no filter which can have high levels of arsenic.





Discussion:

- What did students learn? It's great to include quotes if you have them.
    - The main takeaway from the project, in my opinion, was how little students even knew about arsenic and other contaminants in our water supply. After learning the foundation of the element, it was also amazing to see students ask questions about our area specifically. They wanted to learn about the agriculture, the use of pesticides and our water supply in general. They asked questions and tried to solve problems on conservation. More specifically near the end of the project, the students were interested in toxicology as a whole. We were able to branch out using the "Assessing Toxic Risk" text into other toxins that are naturally occurring. Asking all of these questions and finding answers will hopefully stay with the students throughout life. The students really liked being able to use TUVA to answer questions with actual data. The fact that this project wasn't just a made-up scenario was huge for them.

- What did you learn?
    - Teaching data literacy was the biggest thing I learned this year. What I thought I had been doing right in years past, I realized wasn't transferring over enough as a whole. For example, completing labs and creating graphs in class was great, but students weren't ever seeing the big picture. Through this project, I realized that it isn't just about teaching students the measurements and units, it's really about how they can apply it and ask more questions. As a science teacher, this project changed how I viewed data literacy. It was hard at first, but letting the students take over for the bioassay was amazing to watch. They were able to create the whole task on their own using questions and ideas that I hadn't even thought of. I also learned a lot more about arsenic and water quality.

- What would you do differently?
    - I believe that getting to complete this project again next year will be so beneficial for myself and my students. I was not as organized as I wanted to be this year. Part of that was the fact that we went to semesters at the last minute, part was the fear of going remote. My plan that I had created over the summer wasn't as useful as I thought it would be for the new schedule that we had.
    - While I was able to collect samples extremely quickly and the results were back by December, I didn't get the ball rolling soon enough in the spring semester. I had a hard time fitting in the project with my everyday curriculum. Now that I have seen what the students can do and what they are interested in, I think I will have a much better idea for next year. I understand the flow

of the project better and what I can fit in with each unit. Making this part of our "normal" curriculum is obviously the main goal.

- I also feel more prepared to hold a community meeting next year with our local city council. I know what the well water looks like in my area and the students and I have even preplanned areas we really want to test in the fall. Even though I won't see my current students again next year, they are invested in the process and ready to still bring me samples.

Conclusion: I feel really lucky to be able to participate in projects such as this for my students. They learned so much this year and I feel like we barely touched the surface. Through sampling water, analyzing results and trying to teach others, or job is not nearly finished. I also feel like I dropped the ball a lot this year in regards to this project. Now that I have run through it once, I know what I should do and what I can do better next time. We are all very excited to continue with it.

References:

*The All About Arsenic website and the shared google drive folder were my main starting points.
Webquest:
https://www.bookwidgets.com/play/D9QPD9?teacher_id=5653584380166144
TUVA:
https://arsenicdata.tuvalabs.com/
"Assessing Toxic Risk" by the NSTA Press:
https://www.amazon.com/Assessing-Students-Cornell-Scientific-Inquiry/dp/0873552229
Teach Engineering Activity:
https://www.teachengineering.org/activities/view/uok-2216-wastewater-treatment-plant-model-water-quality
Simple Water Quality Kit:
https://www.amazon.com/Earth-Force-Low-Cost-Quality-Monitoring/dp/B0080GR71G/ref=sr_1_1?dchild=1&keywords=low+cost+water+monitoring+kit+lamotte&qid=1623682222&sr=8-1
"In Small Doses" Youtube video:
https://www.youtube.com/watch?v=6HVNpoFvRdk&t=145s
TED Talk on water conservation:
https://www.youtube.com/watch?v=nLB8A--QdHc

Acknowledgement: The work reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number R25GM129796. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.