Project Title: Water Pollution and the Impact on Human Health and Ecology

School: Westbrook High School

Grade level: 10-12

Teacher: Ragan Hedstrom

Partners: Partnered with Dr. Douglas Currie of University of Southern Maine.
MDI Biological Laboratory, TUVA Labs, Molly Schauffler, University of Maine

Teacher Profile: My name is Ragan Hedstrom and I have been teaching at Westbrook High School for eight years. I teach Earth, Space and Environmental Science to 10-12 grade, as well as a concurrent enrollment course called Fundamentals of Environmental Science that is only for seniors. I have taught at 3 different schools, and started my career teaching in Baltimore, Maryland. I earned my BA and MA in Environmental Science and Policy at Clark University, and have been involved with environmental work in a variety of capacities ever since.

After college I worked as an educator aboard traditional sailing vessels, and as a biologist aboard scallop fishing boats and research vessels. These experiences have dramatically shaped how I teach. I love to do hands-on, and real-world studies with my students.

I run the Sustainability Club here at the school, have implemented recycling and composting at the school, have been an advocate for solar power for our school buildings. I love to teach about how humans impact our environment, and help students identify solutions to environmental problems. Getting involved in the All About Arsenic program aligns with my goals of bringing real world problems and data into my classroom.

Summary:
I incorporated pieces of this project throughout my Environmental Science course. I started by introducing arsenic when we discussed biogeochemical cycles, and the inorganic components of ecosystems. They first learned about carbon, nitrogen, and phosphorus, then I was able to discuss other natural elements found in the ecosystem such as arsenic. We read articles about biomagnification of DDT and mercury, and finally started to investigate Arsenic. We watched "In Small Doses," and gathered information about the health implications of Arsenic in well water.

Once students had a solid understanding of groundwater, arsenic, and the health implications, each student identified one location they would be able to get a water sample. If students did not have a home they could test, they were assigned locations throughout the school campus. We were able to obtain approximately 55 samples throughout the year. 30 Environmental Science students were involved, and 25 faculty members submitted water samples to have their homes/camps tested.

A few weeks later, when we discussed the water cycle and watershed ecology, we discussed how water is the universal solvent causing materials flow through ecosystems, and how humans have contributed to arsenic contamination. We then did two controlled experiments that relate to this, one using planaria to study the impact of chemical exposure on the motility of the worms, and another on the impact of inorganic compounds on the growth of pea plants. Although none of the variables used was actually Arsenic, students were able to make the connection about ways in which controlled experiments could help to draw conclusions about the impacts of arsenic contamination.

My first semester class did not get to analyze the data from our data set because the results came back after the semester had ended. The second semester students were able to analyze the results, finding trends such as the average level of arsenic for our sample, and the difference in data between the types of wells. We had a couple of data points that were extreme outliers, and we spent some time discussing the potential reasons that would cause the outliers to be so dramatically different. Once our results were available, the second semester students were able to utilize TUVA to look at the data. We looked at the samples using the 10 ppb limit and the 5 ppb limit as reference lines. We did actually have 3 faculty members with arsenic reading above 5ppb, but below 10, and 3 more above 10 ppb. We also used TUVA to make connections between arsenic and any other element. Students used Tuva multiple times throughout the semester for other reasons, too. We were able to discuss the value of data in graphical representation, and the diversity of ways the same data set can be represented. Topics covered using Tuva include length of daylight, Mercury in the water, Wildfires, and the arsenic data set.

My second semester class worked with Sergio and Isi to develop an advocacy piece on topic of their choice. Four students chose to do their project on Arsenic, while others chose to focus on various topics we had discussed throughout the year. The students got really invested in their advocacy pieces. They reported that this was a very powerful experience for them that they will carry with them after graduation. It was a new experience for them to realize they actually can take action to make a difference.

Project Details:
30 Environmental Science students
60 Earth, Space and Environmental Science students
25 Faculty members

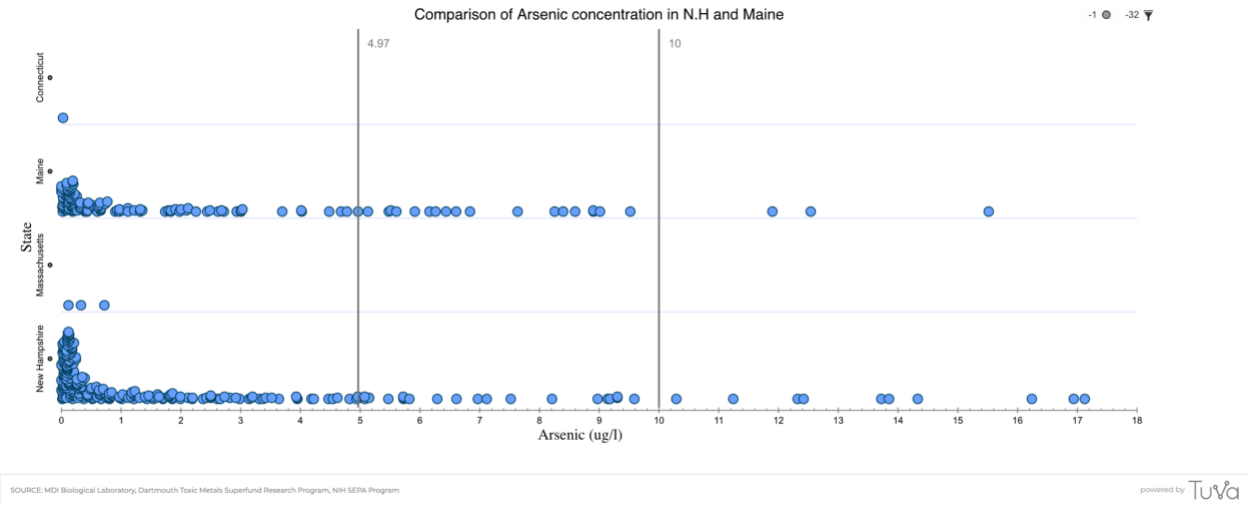
Funds were used to purchase falcon tubes, parafilm, and envelopes for the sampling process. Additionally, a digital balance, petri dishes, seeds and grow lights were purchased for the two controlled experiments we conducted.

Dr. Doug Currie helped to plan and provide materials for the bioassay on planaria. We have discussed using arsenic in the future but decided to have the students use chemicals that would elicit a known reaction.

Watershed:
Biogeochemical Cycles (group work/presentations)
[Template] Understanding the threat of mercury - Hedstrom
TUVA- mercury for lunch

Controlled experiment:
Planaria- Guidelines- how to write a lab report
[Template] Blank Lab Report- Planaria, Arsenic
Planaria basics
5 minute video- How to analyze data

Tuva:
One thing we focused on was the comparison between N.H. and Maine in the 5-10 µg/L range. We concluded that N.H. actually has a higher percentage of wells with a reading below 5 µg/L than Maine, and proportionately, Maine has more cases within the range in question. A cutoff of of 10 µg/L really does not help that many people, whereas a cutoff of 5 µg/L would make a difference to many.



Outreach:

Seeking Solutions for the Environment Final Research Project

Example pieces of work:

- One student wrote a testimony for the public hearing that took place on may 4th. The hearing ended up being delayed by 3 hours, and she was not able to present it live. It was, however submitted in writing. Click here to read the testimony.

- Another student made a pamphlet with the goal of educating Maine residents about the concerns, and encouraging them to advocate for the legislation. Her plan is to distribute them in target audience. Arsenic .pdf

- 2 students formed a partnership and wrote a template of a letter, and sent instructions to fellow students, friends and family members with the idea that more voices would be more powerful . Megan Thibodeau - Copy of Advocacy Assignment- email
- Other students were inspired to do advocacy pieces for other environmental topics:
    - A pamphlet about glyphates, their health effects, how to avoid them, and how to advocate for change
    - Tik tok videos aimed at teaching people about the perils of balloon releases, and teaching people how to contact their legislators.
    - A template letter to send to legislators focusing on the bill to increase the amount of recycled plastic to 25% used in the production of beverage bottles (LD 1467)

Discussion:
This was my first year participating in the program, and the learning curve was steep.

Students learned:

- Not all drinking water is the same, and there are possible toxins
- Biomagnification, and the impact of small doses
- How to communicate effectively using data
- How to perform a bioassay
- What advocacy is, and the variety of ways to get involved with topics they are passionate about

I learned:

- How to use TUVA to demonstrate different ways data can be represented
- About Planaria, and how to perform a bioassay.
- The importance of getting well water tested, and risks that apply specifically to Maine
- I learned how to create a lesson plan devoted to advocacy. I learned a lot about writing Op Eds, attending public hearings, submitting testimony (both live and written).

In the future, I would get the water samples collected as early as possible. It took longer than 8 weeks to get the results back. I am getting better at looking at TUVA for topics I cover in all of my classes, and I want to get better at analyzing the arsenic data using TUVA. I would like to see more of a connection between Dr. Currie's students and my students.

Conclusion: For my first year, I feel this was a success with a lot of room to grow. My students and I had a variety of meaningful learning experiences. It was great getting the students to engage in multiple controlled experiments and think deeply about the procedure as well as how to utilize the results to draw conclusions.

I am excited to participate in the training again this summer in order to get more familiar and build upon what I have already implemented. Sometimes I was just overwhelmed with the amount of resources and materials available. There is an unbelievable amount of knowledge available, but sometimes I didn't even know where to start. Having the training in June made it difficult for me to remember all the intricacies of the project when I needed them (especially in this crazy year of COVID).

I love having a college professor assigned for collaboration. It helped me to raise the bar to a higher level of science and gave me the confidence to execute the labs. It has given me the opportunity to incorporate real data into teaching and learning.

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