Project Title: All About Arsenic

School: Bow High School

Grade Level: 10-12

Your Name: Brenda Mitchell

Project Partners: Priyanka Roy; Keene State College   and the Bow Committee on Drinking Water Quality

Teacher/Scientist Profile: I have been teaching middle and high school science since 1985. I studied Microbiology and Immunology (at the time it was becoming Biochemistry) at the Univ of CA at Berkeley. I then attended San Franscisco State Univ to get a teaching credential and later received a MA in administration and supervision in education.
I am passionate about the environment and sustainability. I bring that to the Chemistry classroom by linking chemistry to the environment. My entire course is centered around looking at water and water contaminants. This made the All About Arsenic project a natural fit!

Summary: Provide a 500-word summary of your project. Describe the curriculum or how you were involved. How were arsenic monitoring and data literacy integrated into that curriculum? Provide specifics (# samples collected, what the samples were analyzed for, etc).

Project Details:
During the 2021-22 school year there were 80 students involved in the water collection project. Water collection was done beginning in December and besides the students, other samples were solicited from district employees and community members through email and newsletter. In addition a poster with information and testing kits was set up at a district teacher meeting.
The project is set up to integrate with topics throughout the school year. This year it was less continuous due to the lasting effects of the pandemic: students came in to Chemistry with a wider range of background information that usual.

–**September/October**: Introduction to data literacy: looking at TUVA files and having students construct graphs and questions. Review of central tendency, variability and types of graphs. Data Lit Activity 1, 2
Students are introduced to particle diagrams using premade laminated 8 by 11 sheets with water molecules and paper cut outs of ions.
–**November/December**: Students conduct a lab that generates many (conflicting) data points. They design their own questions and procedures and then graph the data (using Sheets). Generates discussion of noise vs what can be controlled. Labs: Chem Is Try and Rocket Lab
Students are introduced to the properties of water: polarity, electromagnetic forces, ionic bonds, solubility
Labs: solubility races, paper chromatography, micro column chromotography, water filtration lab, . The particle diagrams are refined to be drawn by students with water and particles provided.
Water collection is done. Arsenic (and other contaminants) are introduced as soluble. Dangers of Arsenic and other contaminants that are common in Bow are taught. Data from past years is briefly examined as a class and in groups.
–**January/February/March**: Students do a career exploration project. As part of the project, some Priyanka Roy's students presented to the Honor students and any other interested students via the internet. Students were able to ask questions and interact with the college students about their research. Video from past interviews.

Students look at results from the water collection (anecdata) and generate questions to ask as well as graphs to support their answers to the questions. Data
Solubility is looked at through the reactions lab. Particle diagrams are further refined; students must now predict the solubility of the particles and divide the soluble ones into ions and show their interactions with water.
–**April/May/June**: Honors students conduct a bioassay using contaminants chosen from results of the water collection or that model Arsenic as a contaminant.(Honors students are self selected and the number ranges from 4 to 20. Honors students meet as a group in our FLEX period once a month.) Students are encouraged to quantify the results using quantitative analysis. Students presented their projects twice: once at the Keane State Excellent conference as part of Priyanka Roy's lab.(photos below) This was done live so students were able to watch other presentations on campus. It would be great to expand this next year so students can attend the poster sessions. The other presentation was between Kearsarge HS and Bow HS. Mary Wright of Kearsarge had some her students present to us in an online conference and then in a separate session we present to them. Students are able to interact with one another and discussions are held in both schools both pre and post conference. Parents and other students are encouraged to attend, on line or in person.
Projects from this year. One Two Three Four Five
Resources used: Toxic Risk

This year I was the only Chemistry teacher. There was some collaboration with the Environmental Science teacher (Laurel Swope-Brush) who does citizen science with NH DES collecting an analyzing water samples from local bodies of water.

The stipend during 2021-22 was used for the purchase of a wireless, portable spectrophotometer for water analysis. This was used for determination of particulate matter and concentration of known compounds that follow Beer's Law. In the past I have purchased other wireless probes that are also used for analysis of water samples. Last year I purchased enough supplies (tubes etc) for several years.

Throughout the year, I write brief articles for the school newsletter regarding the project. Here is one. Two and three and the ad I sent to parents/staff

I created a web site that parents/community members can access. link to web page.

The Bow Clean Drinking Water Committee has expressed interest in the work we do. In December I met with Cynthia Klevens and Tim O'Donovan (the outgoing and ingoing chairs respectively) via internet. I shared all the data with them. They have invited students to become defacto members of the committee and/or to present at meetings. This year I did not have any students who were interested but I am hoping for next year. Laurel Swope-Brush is also looking for student participants from her class. Link to the committee

In May the school district found that the water at the middle school has several contaminants that showed up in a routine test. Students have complained that the water tastes and smells bad. One of the students who was part of the project last year, Michael Sardella, has volunteered to work with the superintendant, Dean Cascadden, on examining this data and propose/model solution. This will be done over the summer and next year as part of his Senior Project.

Discussion:
        This year the water collection part of the project was "famous". The students were aware that this was going to happen and were eager to get their water tested! The testing kits were received with eagerness. Students who presented at Keene State or Kearsarge HS expressed gratitude for the "opportunities given to them". The quote is from Jessica Birnbaum who sent me a thank you note.

More conventional learning was centered around what was in their own home water, what things that were in their water were of concern, where these things came from and what the trends were at the Bow, state and regional levels. Students learned how to look at large data sets and some methods of data analysis. Realizing that data is variable was a huge learning as was using box and whisker plots to represent data.

I learned more about how to present data to elicit student ideas. I also learned that often follow up questions are essential to allow students to understand what to do to present their data analysis.

Next year I want to have more formal data literacy assignments that do more with the questioning. I also want to continue to present this information to the science department and to see if we can develop a ladder of data literacy activities across our courses similar to what we do with writing lab reports. I am thrilled that we can return to having students register the samples in class as I think that will really streamline the collection process.
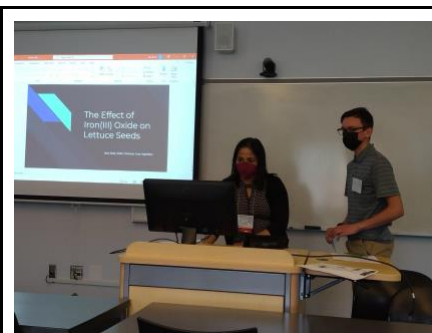
Students collecting precipitates using a Buchner funnel	Students testing water samples	Student measuring reactants to create precipitates

Bow HS students Nicholaus Thissell, Jessica Birnbaum and Aiden Ciminesi present at Keene State. Priyanka Roy is shown introducing them and helping to set up their slides.

Conclusion:
This year the project was challenging due to the pandemic but it has also reached maturity. The relationships established in previous years (Dr Roy at Keene State, the water committee) are flowing smoothly. The curriculum changes are also well established.

References: Links to the labs done and student work are in the text above.