Project Title:

School: Machias Memorial HS

Grade Level: 11-12

Your Name: Jim Lenke

Project Partners:
Dr. Tora Johnson, U Maine - Machias - GIS

Teacher/Scientist Partner Profile:
A degreed chemist practicing research and development in analytical instrumentation for 3 decades combined with several start up company lead product development engineers. I have been teaching high school math/ science for a total of 7 years. Given the problem of arsenic in well water, I felt this project needs a grass roots development to be successful. Which given my product development background, seems like a perfect fit.

Summary:
Because of the atypical schedule, this years project was broken into three separate parts over two groups of students and the myself. School classroom size COVID policy reduced number of students to below 9, which although nice for teaching is difficult for having a large population of student collected samples. Nonetheless, the usual protocol of arming students with two sample kits; one for their personal house and the other for a second house or neighbor resulted in a total student collection of 10 samples. To improve collection of the SEPA school area, an article was placed in the local newspaper opening sample collection to anyone, and not just associated with the school. This resulted in an additional 14 samples.

At the beginning of the school year, during realization of low collection numbers, it was realized by the teacher that the preferred target audience is those with young children. This stems from a marketing comparison of lead in drinking water. Nearly every person from 4th or 5th grade is aware of the dangers of lead in drinking water, even though the effects might not be known. This is the result of decades long campaign such that bad juju from lead in drink water is known kitchen table item. In order for arsenic to achieve similar popularity, awareness has to begin early in life and continue on. Thus was born the idea of working with local pediatricians office to get test kits to either new or younger parents. A manual was prepared for the pediatricians office along with brochures developed by MDI's Anna Farrell to hand out. A total of 28 sample kits were prepared of which 6 were returned for analysis and as of writing 5 sample kits are still available.

Arsenic and data literacy were incorporated into a Chemistry and a Honors Freshman Science courses. The Freshman course looked at the basics of arsenic poisoning and effectiveness of the SEPA program. Open discussions followed around the effectiveness concept: When is the program over? What constitutes great vs. good? How many people were saved? What socio-economic range was better served? How well was our community served? TUVA data set was used to look into some of these questions. Given the younger age group and lack of mathematical statistics, this became a difficult direction to get concrete data. On the other hand, the older students were given both planaria and tardigrades and provided with learned information from prior year planaria exposure to AsW. A couple levels of As concentration were provided (50, 16, 0 ppb) and 4 well petri dishes. They were charged with determining what will happen to the planaria. Other half of students were given tardigrades and charged with observing effects of each concentration. The 0 ppb was made from Zerowater filtered from 16 ppb, while the 50 ppb was provided by CoA. The outcomes were statistically inconclusive but conducted without error and in triplicate. Essentially, a large proportion (~40%) of

tardigrades moved location to lower concentration or with tardigrades died from high exposure. The contraindicative was the remaining percent did not move, or returned to high concentration, or did not die. Some other biological reason unbeknownst to this teacher must be responsible for the observed actions; perhaps age or specimen or mishandling.

All experiments, discussion and data analysis were completed over a one week period, which was approximately 18 hours. Data literacy took a more backseat position this year given the alternate class schedule. However, basics of graphical literacy were covered with such topics as type, slope, units, and interpretation. Using TUVA, assignments were given from the library to answer specific questions of the topic. As always, students grasp TUVA immediately and after a few coached trials organize data effectively to meet goals.

Project Details:

- Chemistry (7) and Freshman science (4)
- All-out arsenic story map, TUVA, Wikipedia for specimens, personal collection of newspaper and science publications. Lab was Chemotaxis of planaria using As and Survival rate of tardigrade in AsW.
- Myself
    - Being the only physical sciences teacher I did not collaborate with colleagues
    - Field trips were not allowed this year, however trips into our school forest were done to collect tardigrades from moss.
    - Experiments are identified above. Students wanted to know
        - What kills tardigrades?
        - What do planaria eat?
        - How does As enter both planaria and tardigrade bodies?
        - Are either specimen similar to humans in interaction?
    - Prior years data was looked in TUVA to identify geographical areas of concern as well as effectiveness of this program for the state and county. Other datasets were used to explore data literacy and making effective graphs.
    - Students helped write the article inviting the community to participate by submitting samples for analysis. The teacher coordinated a program with the local pediatrician for sampling of young families.
        - 14 samples were collected from the newspaper article
        - 6 samples were collected from the pediatrician
        - 10 samples were collected from students
        - By far the largest impact would be finding the one household with a new born with high As levels (35 ppb). The community had many participants who were quite concerned with As but relieved from no discernible level present.

- Include any data analyses your students did.

Discussion:

- Students definitely learned that it is difficult to plan ones own experiment and choose the correct control.
- I learned that this poison is not as easy to develop a convincing bioassay in the lab. Given the ubiquitous amount of instantaneous video evidence presented to students through TikTok and Youtube, to be convinced that As is truly a problem they need to experience first hand possible death to an organism.

- Next year I believe I will focus less on bioassay and more on advocacy. But yet, the body of scientific evidentiary proof of degradation is not complete and needs development.
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Conclusion: This is a great and worthwhile project. However, the path to an effective public campaign is riddled with shortcomings. But is a great opportunity for young scientists to feel they have an impact in the world and their community. Whether they carry that badge of honor with them through life remains to be determined.

References:

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