**Project Title**: All about Arsenic

**School**: Kearsarge Regional High School, N. Sutton, NH.

**Grade Level**: 10 - 12

**Your Name**: Mary M. Wright

**Project Partners**:
Nick Bears Colby College, New London,
Brenday Mitchell: Bow High School, Bow, NH

**Teacher/Scientist Partner Profile**: I have been teaching in public and private schools for over 25 years. The last 43 I've been teaching at Kearsarge Regional High School in N. Sutton, NH. I have a BS in Biology from Bates College in Lewiston, ME and a MS in Zoology from the University of ME (Orono). Outside of school, I have been involved in various social justice projects and I'm a former local president of the teacher's union.

I had the pleasure of having two of Dr. Baer's children as students when he recruited me to be part of the All About Arsenic Project. I'm so glad that he did! Projects like this increase student engagement which leads to in depth learning. Students have felt empowered when explaining the importance of the project to their families and community members. They have also started asking broader questions about drinking water quality nationally and globally.

**Summary**: This year's (2021-2022) All about Arsenic Project involved primarily 33 College Preparatory Chemistry students, 33 (approximately -- as numbers fluctuated greatly during the school year) non college preparatoryBiology students (most were not at grade level in reading and math), and to a lesser extent, a few of my 22 College Preparatory Anatomy and Physiology students.

Our school was still enforcing many covid protocols for the first part of the year negating the possibility of field trips and visitors to the school. There was also a move to an every other day block schedule to reduce contacts and implementation of remediation periods to address student setbacks. This resulted in less contact time for the year. However, students in the Non-CP Biology class spent significantly more time using Tuva for Data analysis and designing their own experiments than last year's CP biology group. The CP Chemistry students also spent more time working with Tuva and their final water quality projects, in general, were better than the previous year. In addition, now that the local data set is getting quite large, they have discovered that our region also has a significant Uranium issue.

**Non CP Biology classes**: In early September students were introduced to TUVA using a data story about various Dog Breeds. Once students were successful in manipulating data using Tuva tools, we moved on to a more complex data story: "Too much Mercury?" This data story had students look at the impact of Mercury on the weight of Loons in New England. This then helped students design their own laboratory experiments assessing toxic risk. These students performed a seed germination experiment looking at the impact of various potentially toxic substances of their choosing on the rate of germination (lab modified from Toxic Risk, NSTAPress). Students designed and carried out their own experiment, graphed results, and discussed their conclusions (using claim, evidence, reasoning). As the year progressed, we used Tuva in our genetics unit (Genes: To Express or not to Express?)

**CP Chemistry class:** In September students were asked to read the article "Global solutions to a silent

problem" and answer questions in preparation for a class discussion. Students also viewed a video created by last year's students where Dr Stanton from Dartmouth college was interviewed. These two activities were the bases for a class discussion. It was during this discussion that the water testing protocol was introduced. I ran through the goals of the project as well as the various data points that would be collected. Collection tubes were distributed to students whose parents expressed an interest in having their water tested.

In late September I gave a lesson on how metals become ions and then become soluble in water (where they become more bioavailable). In October, Students were introduced to Tuva with the activity called: Meet the Elements. This was followed by: Well should we Question the water? Students then developed Tuva graphing skills (filtering data, graph types, etc.). Around this time, our results came in and students started looking at the combined data from our area over a number of years. Students were asked to select a drinking water issue to research. Their annotated bibliography was due in early Feb. Students were introduced to peer reviewed journal databases and were asked to find three articles related to water contamination and submit an annotated bibliography. This became the first step in a research paper (or presentation) on drinking water contaminants. (Jan). They could do any of the following: a) participate in an online conference with Bow High School on a water contamination issue (slide presentation and videos were the two mediums students selected), b) create an informational pamphlet such as might be useful in a library or pediatrician's office to educate the public c) create an informational hyperdoc d) create an online pictographic.

In May, our students presented to Bow high school students, who in turn presented to our classes. Other activities related to the project include: 1. A lab simulation where students used flame tests to determine what metal ion is contaminating a "Well" and determine the source of this contamination. 2. A chemical reaction/ solubility lab. This helped students understand how metals (and non metal ions) can cycle through an ecosystem.

**Discussion**:

I was pleased to increase the use of TUVA this year by including my general biology classes in various lessons using TUVA. After the initial learning curve, they enjoyed creating graphs and using these graphs to answer questions. They also did a good job in designing their individual experiments, though many had trouble collecting accurate data.

In some ways this year's project with the cp chemistry students was a little less successful. Due to Dr. Bear's canceled class, we didn't have contact with Colby Sawyer students. Also, I didn't have ALL the CP Chem classes this year and had to coordinate with another teacher which reduced my class time on the Arsenic Project. However, two interesting things came out of this year's project. 1. Students discovered that our area has many wells with a high Uranium concentration. 2. Our own school has high levels of arsenic. The school has added filters to bring the water levels down to 5 ppb, but questions about the water bottle filtration system at the school remain. I hope to make both of these issues a focus of next year's class; I think our school situation will make an interesting "Well Story/" and I have ideas for using animal models (fruit flies and worms) to look at effects of arsenic or uranium on development. 3. The increased use of Tuva resulted in fewer graph interpretation problems in this year's projects.
For the upcoming year, I plan to continue to integrate the project and Tuva into the chemistry curriculum. I've ID'd additional data sets in the TUVA library, and identified where they would support the curriculum. I want to augment my lessons on how heavy metals move through water and food chains. I'm going to have my Anatomy and Physiology students pilot a biomodel lab (flys or worms) to look at the effects of either water or food that contain arsenic. Students will also present our school's "Well Story" to the school board.

**Conclusion**: I think that this project is a wonderful example of citizen science at its best. Now, with three years of data collection, it is clear that wells in our area have a number of potential hazardous metals in the water. Students have been startled by this and impressed that they have made a difference in their community. Students have also been introduced to large data sets and improved their ability to analyze data.

**References**:

Toxic Risk: NSTA Press

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TUVA. (n.d.). Drinking Water Data (2016-2020). Retrieved from https://arsenicdata.tuvalabs.com/dataset/244/

Link to "Global solution to a silent poison." https://science.sciencemag.org/content/368/6493/818.full
Pre-discussion questions for article:
https://docs.google.com/document/d/1FxaChv5LORfFLoe4XgI2IhBOfqp0BUScK5WdNLfKN0Q/edit

Annotated
bibliography template:
https://docs.google.com/document/d/1HwchNF9KDcOxBjeyuhqJH2CUu5ml5UYV8OLq0aHyXKc/edit

link to non-CP Biology lab report template:
https://docs.google.com/document/d/1uL7PGAAbINV9_123Zwds4O5K_2M9RdcsP1H1r_LyZ6k/edit?usp=sharing

**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.