Final Report Project: "Beyond UTBiome: Preparing Our Future Scientists and Engineers"
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Our project was aimed at introducing research to elementary school children from underserved communities to generate interest in becoming future environmental scientists and engineers. For that purpose, we collaborated with teachers from The University of Texas Elementary School (UTES) to design engaging and instructive activities. UTES serves a diverse and underprivileged population (68% Hispanic, 18% African American, 1% Asian) in the eastern part of Austin. Our team has collaborated with UT Elementary School since 2012 as part of their Science Week activities. In the design of the activities for the current project and their development, we had the opportunity to apply the lessons learned during our citizen science and outreach project (UTBiome).

In this project, the UTBiome team had the opportunity to serve 150 students from 3rd, 4th and 5th grade. Given the demographics of our collaborator institution, more than 70% of the students served belonged to underprivileged populations.

A total of five activities were proposed by the researchers in our team to our collaborator teachers. They reviewed the lesson plans we provided and gave us feedback. The activities were also timely coordinated with the teachers so they could be better aligned with the classroom curriculum. After lesson plan completion and approval, the activities were carried out at UTES.

Figure 1. Students sampling the microbiome of the keyboard of their classroom computer as proxy for human microbiome imprint.

An important objective of these activities was to make the cutting-edge research we conduct accessible to the students. Thus, the activities focused on five topics: (1) Microbes in the built environment (Figure 1), DNA as microbial identity card; (2) Drinking water quality and microorganisms; (3) Nano-scale perspective; (4) Nanoscale adsorption phenomena; and (5) Soil decontamination. With our activities, we wanted the students to learn and practice the scientific method and how to test the hypotheses generated. To do so, each student collected a simple dataset and compared their observations during the activities.

Specifically, in activity 1 and 2, we had the opportunity to engage the students in experiments designed to learn about microbes and their relationship with indoor air quality, about the relationship between microbes found in the built environment and human health, and the significance of microbes in drinking water quality (Figures 1 and 2). In those activities, we developed hands-on experiments to evaluate the microbial component of the indoor air quality, to show how DNA can be used to delineate the microbiome of the built environment, to evaluate the relationship between bacteria in water distribution systems and water quality, and to measure and evaluate the disinfectant residual in a variety of water sources. We also developed lessons and experiments (activities 3 and 4) in relation to nanoparticles and the nano-scale level. In those, we wanted the students to gain an understanding of perspective on the micro- and nanoscale and how features too small to see can affect properties at the macroscale that they can see (Figure 3). We also designed hands-on experiments to help the students to evaluate how nanomaterials can be very effective for water treatment. Last, but not least, we also developed an experiment for decontamination of oil polluted soils. The students learned how soils can become contaminated with chemicals and why this could be damaging for human health. We discussed different methods to remove chemicals from soil and implemented a hands-on experiment with columns simulating soil contaminated with organic compounds (Figure 4).

Figure 2. Students after finishing the built environment activity involving surface sampling and plate culturing

The activities were evaluated by the students and our collaborator teachers. All the activities were very appreciated by them. Students excitedly spurred questions and stimulated discussions on the topics. At the end of the activities, the students were queried about their opinion of the activities, what they preferred and what they did not like. Their input will be taken into consideration in the design of future activities. Our team also discussed the activities with the teachers after the sessions and their input was also recorded. Our collaborator teachers at UTES wrote this about their experience:

Figure 3. Students during the nano-scale introductory session

"When you came to work with our 3rd graders, 4th, and 5th graders during STEAM class, it was one of the highlights of our year! The students were so excited that scientists from "Big UT" took the time to come and teach them. Plus, your lessons were so engaging and really made them think critically. They loved getting to work with real scientific things like Petri dishes, test tubes, gloves, etc. They felt like they were real scientists right alongside you. I want to speak specifically about one child. This child is in 3rd grade and is usually very unsure of herself and hardly speaks out in class.

During this lesson, I could tell she was very engaged in the learning process. At the end, she came up with a way to apply what you had taught her to a new experiment that she designed on her own. She actually raised her hand and shared that idea with you and the rest of the class! You told her that she was "thinking like a real scientist now and that she could be one." She beamed with pride. Now she talks more in class and takes risks answering questions that are challenging. Your team made a real difference with all of these kids and this is one specific example of how it impacted one in particular. I hope that in the future our Little Longhorns are able to continue learning from JP's team as it had such an impact. Thank you!"

Figure 4. Students evaluating the pace of soil-simulating columns decontamination under different conditions

Another one of our collaborator teachers made a blog post about the experience, which also includes a good collection of pictures that captured the student's enthusiasm and engagement during the activities. The blog post can be found in:
http://www.steamlonghorns.com/2017/04/science-big-ut-came-to-teach-our-3rd.html.

Finally, as we look ahead, our team is developing formal surveys to evaluate the impact of our activities on the student academic development and progress. These surveys will be applied in the next course of activities. We are also working on proposals to obtain resources from other funding agencies. Our team wants to thank AEESP for the opportunity given to our students and our team.