

**Association of Environmental Engineering and Science Professors (AEESP)  
Foundation Grant Final Report**

**Fresno, California High Schools Educational Outreach Project:**

**Environmental Science, Engineering, and People: How Learning in Science  
Classrooms Can be applied to Save Lives**

**Prepared by**

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## **Project Overview**

The project, titled: “*Environmental Science, Engineering, and People: How Learning in Science Classrooms can be Applied to Save Lives*”, was initiated in August 2021 and concluded in May 2022. The goal of the project was to motivate and inspire high school students to pursue academic and career pathways in environmental engineering and science through hands-on learning in the classroom. Teachers for mathematics and chemistry courses from Fresno, California area high schools were participants in this project. The project was designed to meet the Next Generation Science Standards (NGSS) for grades 8-12, focusing on several specific Science and Engineering Practices NGSS learning objectives and standards [1].

The implementation of this project involved presenting two identical workshops aimed at training high school teachers to implement the lessons learned and hands-on activities from the workshop in their classrooms. The activities engaged workshop participants through hands-on learning and application of mathematics and water chemistry concepts in disinfection of water by conducting experiments to: 1) determine disinfectant demand and 2) engage in problem-solving activity to demonstrate how mathematical tools and models can be applied to water disinfection. The workshops were designed to be delivered in virtual mode of instruction, in consideration of the COVID-19 pandemic related restrictions and safety concerns.

The AEEESP Foundation Grant provided the funds necessary to purchase supplies for teachers’ engagement and demonstration of hands-on activities during the workshop, as well as assembling of water testing kits and associated lesson plans for teachers to take back to their schools for use in their own classrooms.

The workshop events were successfully implemented. Workshop outcomes and lessons learned will be beneficially used to develop future outreach projects in order to reach and positively influence K-12 students into higher education and careers in environmental science and engineering fields.

## **Background and Motivation**

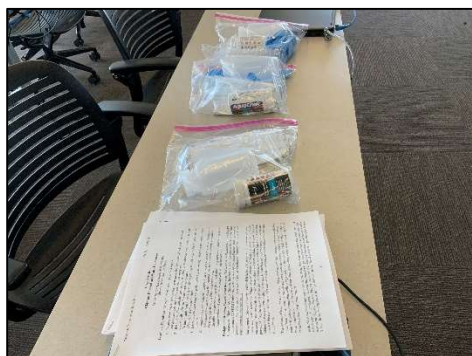
The region of Central Valley, California experiences disparities in educational outcomes in public schools, with math and science performances ranking below the State and national averages. In Fresno County public schools, only 31% of students reported feeling “like they do things at school that make a difference”, as reported by the findings from the organization, “Children Now” [2,3]. Additionally, the California Department of Education considers investments in professional development of teachers and creation of more challenging curriculum programs as critical areas of attention [4]. This understanding provided motivation for this project to help high school teachers of science and mathematics make connections between what students learn in the classroom with “real-world” applications. Developing a curriculum on water disinfection using simple tools and resources that can be easily implemented in the classroom as well as in a virtual mode of instruction were among the goals of this project, with consideration of COVID-19 pandemic impacts on schools and instructions. The target audience for the workshop were high school teachers of standard and/or Advance Placement (AP) mathematics, chemistry, and environmental science classes.

## **Project Implementation**

Workshop advertisement: A workshop flyer was developed and advertised, through email communications, to officials within the school district involved with STEM education and professional development of teachers, as well as several area high schools and teachers. The advertisement reached 20 different school

districts, about 75 teachers within and surrounding the Fresno area school districts. An online enrollment portal was established for participants to register for the workshop, which was offered at two different dates during fall 2021 semester. Participants were given the option to participate in the workshop either virtually, through zoom video conferencing, or in-person, at Fresno State University. Incentive for workshop participation was that the workshop is free, and participants will be provided with materials and supplies for hands-on activities learned during the workshop.

Workshop Materials and Lesson Plan Development: Workshop materials included development of pre- and post- workshop questionnaires; lesson plan development to include lecture and activity segments; and activity kit assembling (Figure 1).

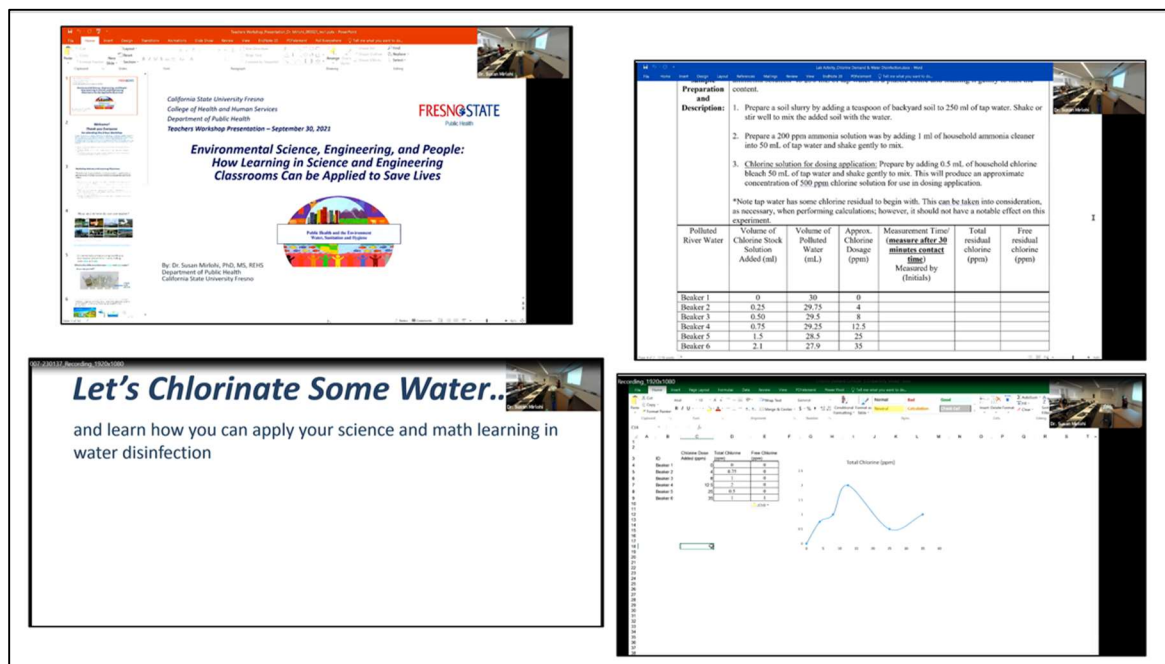


**Figure 1** – Workshop activity kit: Hach water chemistry testing kit, water sample bottles, volume measurement tools; lesson plan and instructions.

Workshop Delivery: During fall 2021 semester, two identical workshop events were presented to introduce the teachers to an innovative, simple, and low-cost, hands-on activity that aimed to train the teachers in motivating their students through engagement and real-world applications in environmental science, water chemistry and engineering. Specific goals of the workshop were to: 1) Highlight and discuss the role of disinfection in reducing global burden of waterborne diseases; 2) demonstrate how classroom science and engineering knowledge are critical tools for environmental scientists and engineers in designing and operating wastewater and drinking water treatment systems, which ultimately are responsible for saving numerous lives by ensuring access to safe drinking water around the world; and 3) through hands-on activities, demonstrate application of chemical and mathematical sciences and engineering principles in water disinfection systems, focusing on chlorine as the most common disinfectant in water treatment.

The hands-on activity involved determining the chlorine demand of a simulated polluted water sample. Participants learned about what chlorine demand is, the difference between total combined and free residual chlorine, break-point chlorination, the roles of pH and temperature in chlorine disinfection, and how to measure total and free residual chlorine concentrations in the water sample using colorimetric test kits. Participants recorded their experimental data from the chlorine demand experiment and created a graph to determine break-point chlorination point and identify relationship between variables of disinfectant concentration and measured disinfectant residual, and other experimental variables such as pH and temperature (Figures 2).

Attendees included both in-person and virtual participants. The workshop lecture and activity contents were directly connected to specific NGSS learning objectives. Each workshop was completed during a combined 90-minute lecture and activity period. Workshop activity kits were mailed to virtual participants for use in their classrooms. Pre- and post- workshop questionnaires were given to the participants to determine the teachers' perception of activities and outcome of the workshop in terms of potential for implementation in public school classrooms.



**Figure 2** – Workshop delivery included virtual and in-person participants. Activity included chlorine demand determination of polluted water for disinfection purposes.

**Workshop Outcomes:** Pre- workshop questionnaire results indicated that participating teachers were interested in learning how to communicate scientific information with students without losing their interest in the topics that may be difficult to comprehend. The following are some representative examples of what teachers communicated during the workshop:

- “I expect to get an idea on how to present scientific materials to my students and applicable activities they can do.”
- “I want to show the importance of environmental science to my students.”
- “I hope to gain confidence in doing real-life applicable lab activity to bring to my classroom.”
- “I would like to learn how to teach environmental science in a way that does not overwhelm students and show the hope/change that can come by learning this information”.
- “I would most like to learn how to teach my students about the importance of safe water & cleaning.”

Post- workshop questionnaire results indicated that participating teachers improved their own understanding of the concepts and were motivated to use the gained knowledge in their classrooms with the goal of motivating their students by connecting concepts to real-world applications. The following are some representative examples of what teachers communicated during the workshop:

- “I will attempt to use this activity to teach my students about chlorine and its benefits.”
- “I would like to teach my students about how science impacts many parts of their lives, like drinking water.”

The workshop event was effective in providing a real-world context for teaching applications of science to high school teachers. Teachers felt informed and appreciated having the benefit of the provided supplies and test kits to use in their own classrooms.

**Broader Impacts:** The findings of the workshops were communicated to future teachers through presentation at Fresno State University to students currently under training to become future teachers in STEM fields. Additionally, the workshop findings were presented at the American Chemical Society

conference in March 2022, under the Division of Chemical Education, program session, Engaging Students with Real-World Context [5].

### **Conclusions and Lessons Learned**

This project was successful in meeting its intended goals of reaching high school teachers in Fresno, California community, and providing interested teachers with knowledge and resources to implement engaging hands-on activities in their science classrooms. Ongoing impacts of the COVID-19 pandemic had some effect on recruitment of teachers for this workshop; however, the outreach activity was successfully executed through a hybrid mode of delivery to provide for both in-person and virtual participation.

Future activities will involve working with students, in addition to teachers to directly implement this and similar workshop events within and outside the classroom, providing more students and teachers with real-world context in applications of science and engineering.

### **Acknowledgment**

Special acknowledgment is given to the Association of Environmental Engineering and Science Professors (AEESP) Foundation for funding support that enabled purchase of necessary supplies for the workshop activities and associated water quality testing kits for distribution to area high school teachers.

### **References**

1. The Next Generation Science Standards; APPENDIX F – Science and Engineering Practices in the NGSS <https://www.nextgenscience.org/get-to-know> Accessed October 30, 2020.
2. 2020 California Children’s Report Card: <https://www.childrennow.org/portfolio-posts/20-report-card/>
3. 2022 California Children’s Report Card: <https://www.childrennow.org/portfolio-posts/2022-california-childrens-report-card/>
4. California Department of Education: <https://www.cde.ca.gov/re/cc/>
5. Mirlohi S. (2022). "Motivating the next generation of learners through “real-world” applications: How learning in science and engineering classrooms can be applied to save lives ". Annual National Conference of the American Chemical Society (ACS); San Diego, California; Division of Chemical Education; Session: Engaging Students with Real-World Context; March 24, 2022.