

Final Project Report: Connecting Environmental Engineering Applications to the High School Advanced Placement (AP) Chemistry Curriculum at Palmyra Area High School

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This project involved visiting Palmyra Area High School's Advanced Placement (AP) Chemistry class to teach students about nitrogen cycle management and water hardness. Throughout three class sessions, high school students:

1. completed work relating the AP Chemistry topics of redox chemistry and thermodynamics to nitrogen management and water hardness
2. tested water samples for nitrate and hardness
3. learned about environmental engineering applications.

This project reinforced concepts learned as a part of their AP Chemistry course. In particular, students explored how redox chemistry and thermodynamics are used when managing the nitrogen cycle and how water hardness is treated in water treatment systems. These principles directly connect to the AP Chemistry curriculum: Unit 4 Chemical Reactions, Unit 8 Acids and Bases, and Unit 9 Applications of Thermodynamics [1]. The AEESP Foundation Grant provided the funds necessary to purchase supplies for the hands-on activities: a colorimeter, sample vials, and filters.

Background

Every year Advanced Placement (AP) exams are offered near the end of the academic year, usually in early May. As is the case for most schools, Palmyra Area High School's academic year continues until early June, leaving approximately one month for additional classroom instruction post-exam. This time is typically used to review topics covered earlier in the school year. Therefore, it presents an opportune time for students to learn how chemical principles are used environmental engineering.

AP Chemistry students represent an ideal target group for environmental engineering due to their interest in science and academic achievement. The students taking AP Chemistry are juniors or seniors and are, and many are considering science-related college majors. These students have laboratory experience and possess skills in collecting and analyzing data.

Project Goals

The goals of this project were to (1) teach AP Chemistry students about the environmental engineering field and how it connects to their chemistry studies (2) create a unique model that other environmental engineering professors can use to conduct similar outreach to their local high schools.

Implementation

Before the COVID-19 pandemic hit, the PI worked with one of her students to develop handouts to use in the classroom with the high school students. That student had completed Introduction to Environmental Engineering and Water and Wastewater Engineering courses. She had also taken AP Chemistry in high school and was familiar with the topics covered in that curriculum. She worked with her professor to create two handouts with solution sets covering redox chemistry and thermodynamics in the nitrogen cycle and water hardness calculations. The high school teacher later reviewed these handouts to ensure the content was on-level and aligned with the AP Chemistry curriculum.

The original plan for the project was to visit the AP Chemistry class in May 2020 in-person and conduct hands-on activities. As a result of the COVID-19 Pandemic, the class switched to asynchronous remote learning. The PI and AP Chemistry teacher worked together to adapt the activity for virtual learning. As a modification, the PI recorded a video introducing environmental engineering, nitrogen cycle management, and how AP Chemistry topics connect to the field. In addition, she provided handouts that were used as assignments by the AP Chemistry teacher.

In 2021 the AP Chemistry class had remote and in-person learners. The PI was not allowed to visit the high school in-person, so the activity was adapted so that the teacher could implement the hands-on component in class without the in-person support of the PI. The PI collected five water samples and dropped off the activity materials with the teacher. The PI also instructed the AP Chemistry teacher on how to use the colorimeter and water hardness kits.

In addition to the water samples provided by the PI, the teacher also invited his students to bring their own water samples to test as well. During the hands-on class, students measured nitrate using a colorimeter (Figure 1a) and water hardness using a titrant kit (Figure 1b). The students did not know in advance which sample was which and had to make educated guesses and providing rationale based on the data they collected.

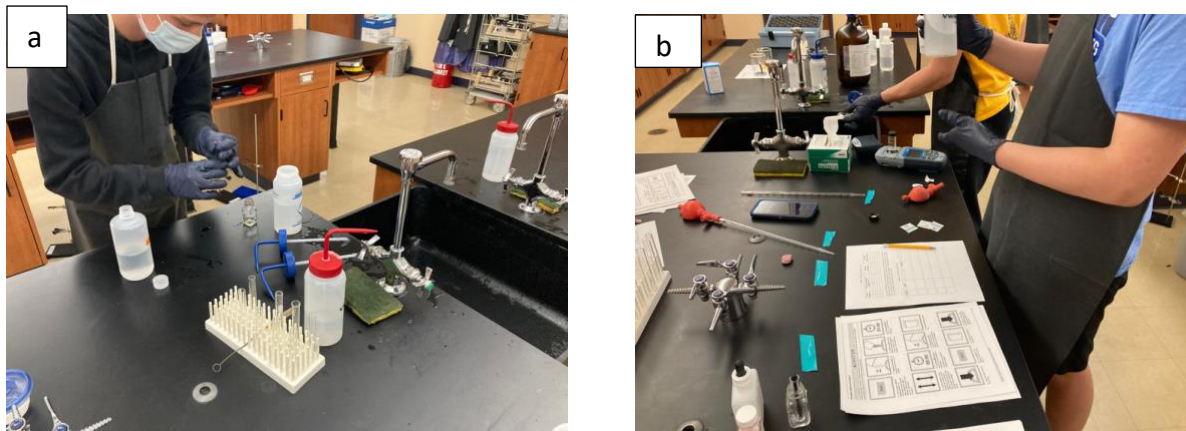


Figure 1. (a) students measure nitrate concentration of water sample using a colorimeter (b) student prepares a sample for measuring hardness

During a later class, the professor talked with the class virtually, discussing nitrogen cycle management and the lime/soda ash and ion exchange water softening. This virtual class visit served to close the loop on the activities and allow for the students to ask questions and interact with the environmental engineering professor.

Conclusions

Despite the challenges presented by the COVID-19 Pandemic, this project was successfully implemented with modifications over two years. The students demonstrated a high level of engagement with the project. The students particularly enjoyed the hands-on activities and asked thoughtful questions about the field of environmental engineering, the hands-on activities, and the nitrogen cycle. Consequently, the teacher invited the PI to return next year and complete the activities again. This project highlights the possibilities of outreach to high school AP science courses. While this project examined an outreach activity with an AP Chemistry course, AP Environmental Science or AP Physics courses also connect to environmental engineering and should be considered as well. Future work will involve exploring additional topics such as chemical and biochemical kinetics. Also, the PI will seek additional opportunities to share these activities with other AP Chemistry classes in the region.

Acknowledgment

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Reference

[1] College Board, "AP Chemistry," 2021. [Online]. Available:
<https://apstudents.collegeboard.org/courses/ap-chemistry>. [Accessed 24 May 2021].