A Community Outreach Chemistry Lab Success in a Pandemic

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Abstract

This project report highlights a simple yet effective outreach lab benefiting the community partner, specifically the Alameda Point Collaborative (APC) youth program and Saint Mary's College students in a general science course. Building on a partnership focused on reciprocity, a portable lab experiment (Mattson Microscale Gas Chemistry lab) was proposed. Given the pandemic, the major challenge was working through how to incorporate the community engagement without being physically present at APC. To address this, the Saint Mary's students created an instructional video to be viewed in advance of the activity as a replacement for the formal lab handout, which allowed us to participate without being onsite. With the lab chemicals and materials delivered in advance, APC staff did a pilot run to facilitate a more successful joint lab. When both populations (APC youth and SMC students) met through a Zoom meeting, the lab resulted in a successful experiment and a shared learning experience. This lab experience raised everyone's spirits even during the pandemic. In this report, the two authors provide reflections on the student gains and wish to emphasize that civic learning can still occur even in a pandemic.

Introduction

Can one really do a community outreach chemistry lab during a pandemic? How can college students be truly involved and engaged performing outreach when their classes are taught remotely? Can a community partner feel supported when colleges keep pressing onward in the midst of the pandemic?

The students in a Saint Mary's College environmental science course and their stalwart community partner, the Alameda Point Collaborative (APC) ventured together to answer the three questions above and continue a partnership where reciprocity has always been a focal point. The Urban Environmental Issues (UrbanE) course had previously done educational outreach lab work with APC, but because of the pandemic, it needed to be done remotely. This project report discusses their shared laboratory experience.

The UrbanE class studies environmental chemistry issues and investigates the redevelopment of Alameda Point, the former Alameda Naval Air Station (NAS). Since Alameda NAS became a Superfund site in 1999, the course content was regularly aligned with clean-up activities. Several course labs have followed site characterization and clean-up methods (X-ray fluorescence soil screening and a thermal reaction, which mimics how *in situ* chemical oxidation (ISCO) is used to clean up the groundwater onsite) (Bachofer, 2010). Beyond utilizing Alameda Point as a study site, the community engagement aspects of the course have involved some direct service for a community partner, the Alameda Point Collaborative. APC provides services to the homeless on the former Alameda NAS, assisting them with housing, job training, and social services to empower individuals who were formerly homeless. In the past, students have performed educational outreach experiments for the APC youth. This past year, an educational outreach project with APC teens was selected as appropriate in a pandemic.

Educational outreach projects have been a part of many previous course iterations. The outreach labs have ranged from inviting APC youth to Saint Mary's College to do an experiment, implementing a chemistry lab for the local middle school, and learning the chemistry of garden nutrient kits. These outreach projects were typically done in Alameda. Thus, planning to share a lab experience with the APC teens was somewhat routine, yet this year's challenge was to do this lab remotely.

The Alameda Point Collaborative claimed, restored, and reinvigorated the base housing and facilities including one building initially used as a Native American health clinic, which was repurposed as a teen center. The central mission of the APC Teen Center is to inform, inspire, and educate the local youth to become productive members of their community and world. Due to the pandemic, the Teen Center itself took on new role as a remote learning hub for the APC teens. The center needed a full Wi-Fi upgrade and a new fence surrounding the building to provide some privacy and safety, and all the sinks, toilets, and dispensers were changed to be hands-free along with added temperature detectors so that the APC teens could have a COVID-safe instructional space.

Outreach Lab Methodology

Pre-planning

Professor Bachofer and Mr. Cass discussed several laboratory experiments that might be sufficiently portable and educational during the summer of 2020. To give the UrbanE students a vested interest in the outreach, there were a few Mattson gas generation labs as options. The UrbanE students were encouraged to select a gas generation lab similar to their first lab preparing carbon dioxide. The oxygen gas generation lab had a fun aspect of testing the oxygen gas with a smoldering splint (think lighting something on fire, safely) and it was selected.

The oxygen gas generation lab was designed for students ranging from middle school to college. The instructional materials are freely available via the Mattson Microscale Gas Generation website (Mattson, 2019). This resource has three introductory gas labs to prepare either carbon dioxide, oxygen, or hydrogen. The procedure for gas generation and equipment to prepare each gas are nearly identical, except for the reagents. The oxygen gas generation used only hydrogen peroxide, H_2O_2, as a reactant and potassium iodide, KI, as a catalyst. The reaction time required to generate a full syringe of oxygen gas was approximately 10 minutes. This gas was transferred into a test tube and upon adding a smoldering splint, re-ignition occurred.

$$\text{Chemical Reaction} \quad H_2O_2\ (aq) \xrightarrow{KI} O_2\ (g) + H_2O\ (l)$$

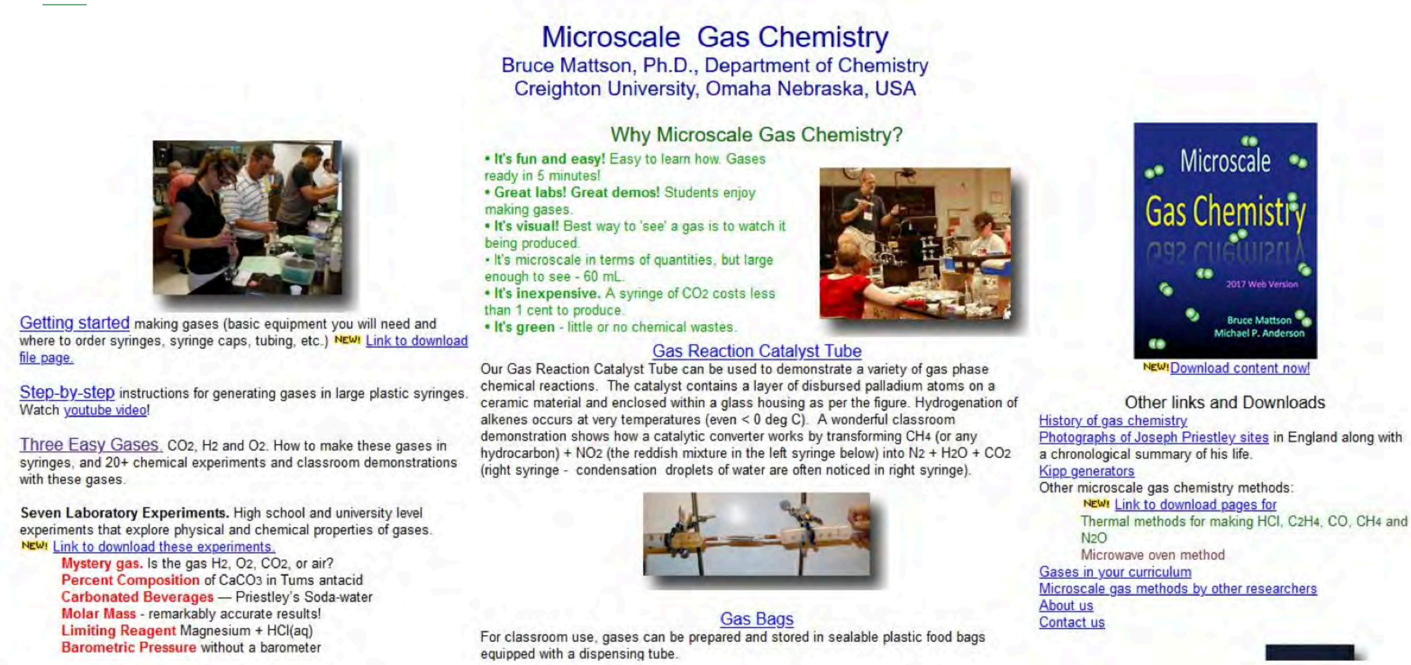
Professor Bachofer had previously used this lab with visiting middle school students on educational field trips to the College, so it was known to be very safe. As the lab equipment and consumables were affordable and easily transportable, APC needed to only provide a safe working space and access to water for syringe work. This implementation built on previous educational labs, so again the only real challenges were the restrictions imposed to keep everyone safe from the corona virus.

UrbanE Student Preparation

The UrbanE students performed a gas generation lab as one of their labs. Three lab periods were devoted to delivering the outreach lab to the APC teens. Specifically, the UrbanE students' carbon dioxide gas generation lab gave them hands-on experience. The UrbanE students generated CO_2 gas following procedures from the Mattson website (Mattson, 2019). During the two planning lab periods, the UrbanE students were asked to recall what was most helpful for them when they did the lab remotely. This reflection activity led them to propose that a video be created, along with a one-page instructional sheet replacing the formal lab handout that they had used. Two sets of students agreed to be filmed doing a setup and generating oxygen gas, one student edited the videos, and another few students revised a bulleted set of directions. They were confident that this would provide multiple instructional tools to make the lab a success. In the meantime, Professor Bachofer and Mr. Cass worked on the final logistics—how long these two groups would meet and the exact date and time (the lab would last approximately one hour and the course class time matched the Teen Center's workday). Cass and Bachofer also planned a discussion for the APC teens on what college is like, and Cass coordinated a starter set of questions. This would prepare both groups of students to have a discussion.

This outreach lab was aligned with productive educational civic engagement aspects outlined by W. Robert Midden (2018). Elvin Aleman and his coworkers also noted that undergraduates exhibit significant gains in

FIGURE 1. This image shows the Mattson Microscale Gas Chemistry web resources and clearly indicates that numerous gas reaction experiments could be explored. The three easy gases (CO2, O2, & H2) are in the left column of materials. Retrieved from http://mattson.creighton.edu/Microscale_Gas_Chemistry.html.



learning when planning educational service-learning projects designed to inspire the next generation of scientists (Godinez Castellanos et al., 2021). Remote hands-on instruction has become a more critical tool during the past year, and many straightforward lab experiences can be instructional and fully portable as noted by Jodye Selco (2020). All of these authors have indicated that faculty can easily provide guidance to undergraduates, and that implementation of hands-on and civic engagement activities empowers all students (Midden, 2018; Godinez Castellanos et al., 2021; Selco, 2020).

Unfortunately, there was not time to request formal institutional review board approval of this project, which means that this article cannot include any student response data. The results and conclusion sections will have only the authors' reflections and insights on the effectiveness of this activity.

Results

After the delivery of individualized laboratory materials, Mr. Cass and other APC staff performed a pilot run using the UrbanE students' video to guide them. This preparation gave them intimate knowledge of the experiment and made the joint lab day a tremendous success.

The APC teens did the experiment a total of three times, twice on the day of the joint Zoom session, plus another time approximately a week later. The experiment was considered a success when the iodide catalyst caused the hydrogen peroxide to decompose forming the oxygen gas. The APC teens, however, evaluated the experiment as a success only if one reignited a smoldering splint in the oxygen gas, generating a burst of flames! With that definition, there was only 50% success on the first trial, yet on second trial, there was 100% success. Only one detrimental incident occurred when the glass test tube broke and one APC teen got a minor cut. The successful demonstration of oxygen gas reactivity with a smoldering splint overshadowed this minor incident, and all students gained from the shared lab experience.

When all were on the Zoom call, a further dialogue began during the second trial's 10-minute gas generation time. Mr. Cass asked the UrbanE students about the challenges of going to college and learning under COVID conditions. This discussion was instructional as the UrbanE students shared their thoughts about college in general and their learning in a pandemic. It gave the APC teens some idea how college could still be accomplished in a pandemic. This outreach lab was so successful that two groups arranged for a subsequent shared meeting so that the UrbanE and APC teens could share thoughts on the challenges of recycling various materials, providing a second linkage to their course content.

There were two big successes from this outreach lab. The APC teens noted that the UrbanE student videos did help them do the experiments and come away with some renewed confidence that doing science, specifically chemistry, was possible. The UrbanE students recognized that they could use their new knowledge to positively impact others.

Co-Instructor Reflections

Mr. Cass's Reflection

In my case, there was a personal reason why this experimental format was beneficial, besides all of the obvious educational reasons. During my interview for Teen Center coordinator, in December 2018, I was playing basketball with some of the APC teens who also happened to be present during the experiment. We chatted while we played and when I asked "What do you guys want to be when you grow up?" one of the students responded to me that he wanted to be a chemist when he grew up. On the day of our experiment, that student reminded me of our conversation in 2018 and how the opportunity to try the experiment firsthand was satisfying.

Recently, I asked what they remembered about the experiment. I was surprised to find that they were able to give me the step-by-step instructions and they remembered a lot about why and how the experiment worked. They noted that they hadn't read the instructions initially, but to finally see the splint ignite was great. In fact, the syringe lab was really interesting and was worth doing over with them. They also commented that the experiment could teach students something deeper than just chemistry: that you can fail at something over and over again but if you keep doing it, eventually you'll get it right.

Prof. Bachofer's Reflection

The impact of this educational outreach lab was quite remarkable. The UrbanE students came away from the hour-long Zoom session impressed and exhilarated that the APC teens had conducted a very successful experiment. The student reflections were filled with positive thoughts and nearly all began with a note that they were initially unsure that we could accomplish this outreach. The students were graded on their contributions to both the outreach lab and discussion. Marque Cass's most impactful question was, "What are you as Saint Mary's UrbanE students likely to take away from this course?" This prompted many students to remark in their reflections that they would be more committed to helping their communities in the future. Again, the reciprocity of this educational outreach was apparent.

The community engagement made this environmental science course more meaningful for the Saint Mary's UrbanE students, and it truly heartened the faculty member in these exhausting times. The major takeaway is that educational outreach can be done in a pandemic and it will truly enrich you and your community.

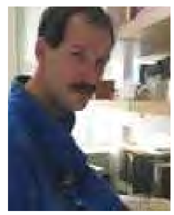
Key Points to Ensure Success

- The college and the community partner were committed to listen and to make plans that would benefit each other.
    - The planning was done in advance and follow-up through emails ensured the project progressed on schedule.
    - The instructor and the supervisor aligned their work expectations to benefit both student groups.
- The lab experiment yielded an easily observable reaction. The lab materials were also very affordable.
- The students were empowered to do tasks connected to the educational content of their courses and recognized that each community was a significant contributor.

Acknowledgement

At Saint Mary's College, this Urban Environmental Issues course serves as a general education science course with an integrated community engagement component. It assists students to fulfill two core curriculum requirements with one course. Via CILSA (Catholic Institute for LaSallian Action), the institution supports faculty and community partners in their efforts to organize and implement the latter curricular objective. This does not eliminate the work that is required to implement it. However, CILSA does assist with the administrative challenges (MOUs), helps to maintain more durable college/community organization partnerships, and provides the faculty with additional training on effective implementation.

About the Authors



Steven Bachofer teaches chemistry and environmental science at Saint Mary's College and has worked with the Alameda Point Collaborative for more than 15 years through his affiliation with the SENCER project. He has also co-authored a SENCER model course with Phylis Martinelli, addressing the redevelopment of a Superfund site (NAS Alameda).

Marque Cass has been in the field of education since before his graduation from UC-Davis, where he earned a BS in Community and Regional Development with an emphasis in Organization and Management. Since January 2019, he has been the youth program coordinator for Alameda Point Collaborative, doing mentoring and advocacy work for formerly homeless families. More recently, he has been elected a community partner liaison with Saint Mary's College, working to help create stronger networks between organizations.

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