Virtual Labs: Beyond the Pandemic

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Those of us who teach or manage science labs will never forget the month of March 2020. The uncertain, vague threat of having to close our teaching labs, followed by the announcement that all operations had to be moved online. We had been told for years that there was no use for online labs, and now we had no choice but to finish the semester remotely. I was ready.

Back in the summer of 2016, a colleague of mine sent me a link to a virtual reality (VR) documentary that he had produced, featuring a local artist (Earnest, 2016). The documentary included a visit to the artist's studio. I remember looking in every direction while wearing a VR helmet and being amazed at the realism and immediacy of the experience. I felt as if I could reach and touch everything, as if the artist was right there in the room with me. I started to think what it would be like to do this in a lab. What if we could put our best TA in our best lab and create an experience like this one, but for chemistry? That is how the organic chemistry VR project at NC State got started.

For most scientists, being in the lab is a defining experience, and any idea that reduces the amount of time that students spend on hands-on lab work is summarily rejected. The way to get this project started and funded was to show that some students are unable to be in the lab, for a variety of reasons: pregnancy, military deployment, temporary or permanent disabilities, to name a few (at that time a global pandemic was not being considered as an option). With this in mind and the support of a diverse team from the University's Distance Education and Learning Technologies Applications Unit (DELTA), I set out to produce a set of VR labs for organic chemistry.

Our first lab took a whole year. Not only did we have to produce the content, which we sourced from students and TAs, but we also had to solve a whole host of technical issues. Some of the things we wanted in our VR labs had never been done before. The first-person point of view approach that we decided on required that the labs were filmed with a camera right in front of the actor's face. Creating a flat whiteboard display inside a curved VR environment was very challenging. However, we kept going, and were able to test our first VR lab in 2018.

The student response to our pilot test was overwhelmingly positive. Results indicated that there were no significant differences in learning outcomes between the students that viewed the VR simulation and a control group that attended a traditional lab. This indicated the possibility of using this tool to offer this organic chemistry lab experiment via distance education. Students that tried the VR experience reported a high degree of satisfaction with the product and no significant usability barriers (Dunnagan et al, 2019).

When the COVID-19 disruption happened, we had been offering the Organic Chemistry I lab as a distance education class on a very limited basis, exclusively for students that were not able to be present in a traditional lab. Once the stay at home orders were issued, none of our students or instructors could be in the lab, and I realized that we had a product that could be used to finish the semester without diminishing the quality of the educational opportunities offered to our students (Dunnagan and Gallardo-Williams, 2021). Since these materials were created as an open access resource, we were able to share them with other institutions. At the time of this writing there are 48 universities across the world using our VR organic chemistry labs as part of their online course offerings. Each of our institutional partners was able to select the content they needed and were able to generate their own companion materials for the labs. Research on the distribution and reach of these resources, as well as their versatility in the hands of different instructors, is currently underway.

One of the immediate outcomes of this forced large-scale trial was the realization that many students prefer this mode of instruction for their labs. Surveys of students' perceptions of learning in the labs (Galloway and Bretz, 2015) indicated that many of them felt less rushed and less intimidated when completing their labs online as compared to traditional in-person labs. Although the VR lab experiences enabled us to keep offering the labs to all our students during the COVID-19 pandemic, we are now considering our post-pandemic plans. I know that, for our program, 2020 will be an inflection point in the way that we teach organic chemistry labs. We cannot move forward without acknowledging all the lessons that we have learned during this difficult year. We cannot simply go back to offering in-person labs to all our students because students' needs vary. Incorporation of VR labs offers instructors a new tool to complement existing approaches. Online labs have very small carbon footprints, if we consider the amount of resources that must be transported and spent to teach an in-person lab. At this time, let us reconsider why and how we teach labs, carefully balancing the tangible benefit to each student from the range of experiences we are able to offer. Depending on the course, and on the individual student's circumstances, perhaps a combination of in-person and virtual experiences can be a good compromise that addresses both the desire to be in-person in labs and the inclusive benefits for students that we have come to understand during the pandemic disruption.

References

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