

Virtual and Augmented Reality in STEM Teaching and Learning

July 23rd Registrant Q & A

1. How do you teach fluid mechanics labs using virtual reality? I am interested in learning about that. **Priscilla: I will cover it in my presentation.**
2. How to do the virtual lab? How to effectively teach a virtual lab? **From Tumay Tunur: I believe there is no short answer to these questions. There is growing literature on the subject. I would be happy to discuss it over Zoom or offer a workshop on it.**
3. Usage of Virtual Reality in Education: Pros and Cons as a student, a faculty, and an administrator? **Tumay Tunur: I hope I covered some of that in my talk.**
4. In the near term (during the next academic year), what virtual reality tools can faculty use to bring back some of the pros of in-person instruction while social distancing? **From Tumay Tunur: Utilizing platforms such as AltSpaceVR or Mozilla Hubs gives students an immersive classroom experience.**
5. While the traditional 'boring lecture' is not recommended via Zoom, instructors are also hearing that Zoom lectures are unnecessary. I find that hard to believe, b/c my students really appreciate that 'face to face' time to ask questions and have them answered. What does the panel think about delivering lectures via Zoom? **From James Lindholm: I agree that zoom as the sole delivery vehicle is probably not optimal, but I really like using it for my upper-division undergraduate courses that are capped at 24 students. Keeping my camera on, using the whiteboard function, and sharing my screen periodically with appropriate images on ppt, allows me to replicate the dynamic I usually have in class.**
6. Is there research on the efficacy of VR as a teaching tool? What are the costs involved in using VR - for students and for teachers? How do you address accessibility for students with disabilities? **Priscilla: for accessibility concern: we have captions for any voice over; also eye tracking technology is coming along the way now.**
7. How can one promote equity and accessibility in virtual and augmented reality STEM teaching?
8. Any potential funding opportunities to encourage CSU faculty to develop and use VR-based teaching tools and/or for SLOs assessment - if so, I would like to join a team for a funding proposal. **From Tumay Tunur: I would like to join such a team as well! Priscilla: Me too :)**
9. Is there research on the efficacy of VR as a teaching tool? What are the costs involved in using VR - for students and for teachers? How do you address accessibility for students with disabilities? Are there additional funds to support virtual Supplemental Instruction?
10. What unique qualities can AR and VR offer to STEM that warrant the time and cost required to develop tools with these technologies? **From James Lindholm: As I describe in my talk, in an ecological context VR allows me to 'immerse' students in the subtidal marine environment in a way that no other technology I've encountered can do (other than SCUBA, of course). I have invested heavily in underwater housings to collect the VR imagery using research funds. The software for processing the imagery is not too expensive. There are a variety of options for viewing VR...some expensive, and some basically free.**
11. Are there virtual or lab simulations that illustrate heating to constant mass techniques? **Priscilla: Not yet, but we can create one.**
12. Is there an affordable solution or grants that can provide enough headsets for an entire class?
13. How are you doing VR during COVID-19? What advice would you give newbies? What equipment do you use and why? **From James Lindholm: I'm using in underwater VR videos to provide students with 'field' experiences. They will be prompted in a marine ecology lab to place georeferenced transects on a topographic map of selected dive sites. I will then go into the field**

to collect VR imagery at the locations they specified...effectively engaging them in the field even though their sitting at home.

14. How do faculties cover the cost for employing any software or hardware related to VR? How much university and college would spend on these cutting-edge technologies (before the semester starts)? **From James Lindholm: I've used only grant and donor funds for my VR activities so far.**
From Vivien Luo: startup funds, professional development funds, grants, donations from private industry
15. "I appreciate the Physical Chemistry and Physics fields represented among the many of the speakers; are there any Biology examples that some of the other speakers might be able to bring in? **Priscilla: yes, we just created one cell culture VR experiment earlier this year.**
16. Are there data to support how engaged students are with VR labs? What feedback has previous students given? **Priscilla: We have collected some data for Spring 2020, but data is still under analysis.**
17. How we could take advantage of Virtual and Augmented Reality while our students barely have access to one computer in the whole household! Can cell phones be used instead of desktops or laptops? **From James Lindholm: Yes...we design our class VR projects to be undertaken on a headset, a computer screen, a tablet, or a smartphone.**
18. What VR resources are available to students on my campus? **From Tumay Tunur: At CSUSM campus, students can use the XR labs within Inspiration Studios at any time, additionally certain departments such as Kinesiology have their own XR labs for student learning and research.**
19. How can we integrate photogrammetry and LIDAR into VR applications? **From James Lindholm: Along those lines, we conduct georeferenced VR transects over fine-scale topographic maps of the seafloor. The data extracted from the imagery can then be analyzed relative to particular attributes from the topographic maps.**
20. Do you see these technologies/approaches coming to the forefront of online educational labs? **Priscilla: I believe they will come. Just give it maybe 5 years.**
21. "Ideas for helping students work on complex problem sets in the lab; it's easy in person to go around and help students individually, but much harder virtually. We can put students in small groups in breakup rooms, but there are still the questions of answering individual questions and encouraging each student to understand the problems him/herself, instead of just copying what the small group does. How to handle this?
From Vivien Luo
Some suggestions:
 1. Try to answer questions via live Zoom Q&A sessions (with the entire class or group) and post the recordings online, or via publicly posted class wide messages so everyone can read or watch. This minimizes the time you have to spend on answering the same questions again and again.
 2. Have individual students record a video describing their thought process behind a solution. Usually this forces the student to have a deeper understanding of a problem.
22. Software that can allow me to impose a mathematical object rendered. I just saw a video where the author used Geogebra to create a 3-D object and then project it into a video showing a real-life office. Person touched the object as if it really existed, but with NO fancy headset. **Priscilla: I believe that Geogebra is an AR app. The manipulation of the 3-D virtual object is through the App.**
23. How to organize visualization experiences in classes with high (200-500+) students.
From Vivien Luo: It really depends on the design of the experience. But flexibility is usually one of the benefits virtual experiences can bring. If you can design the activity in a way that not all

students have to be in the experience at the same time, then the number will no longer be an issue.

24. How much assistance did you get to create your VR/AR experience and where did you get help from? How did you fund the development of your VR/AR experiences? From James Lindholm: I undertook all my initial VR activities under the umbrella of research (no financial help from the stateside), and then applied the output from those research activities in the classroom.