Recent Developments at Chemistry World

Dr. Michael J. Shaw
Dustin Pumford
Dec. 12, 2020

Some slides have a lot of text… you can peruse pdf on Science Circle Website. I will skip a lot of text.

An Abstract

- Chemistry World was established as a joint venture between Texas A&M University and the Florida Institute of Technology by Dr. K (Dr. Wendy Keeney-Kennicutt) and Winkelmann Teichmann (Dr. Kurt Winkelman) as part of NSF-funded research to examine the effectiveness of virtual worlds in the teaching of chemistry content. They worked with Xandi Mars and Random Cole, SL designers who are based in Texas and who work extensively with Texas A&M. The results of the study were published in the Journal of Chemical Education. The result is an asset to the chemistry education community in Second Life which supports a realistic teaching environment which includes a laboratory, a classroom, offices to meet with TAs/faculty, and space to "hang out". In addition there is an area for practicing camera skills, and a series of platforms which host two laboratory experiments which include an ideal gas law activity and a precipitation titration activity.
- Amidst the SARS-COVID-2 pandemic in late Spring 2020, Dr. Shaw assumed management of the region. The idea was to use its facilities to supplement the lab activities for a freshman chemistry for engineers course in Fall 2020. In spring 2021, it will be used to supplement an advanced Bioinorganic chemistry class. This tour will highlight the facilities built as part of the original study, will show the current builds of 3D bioinorganic models, and will show the current state of the Solid-State Models activity developed since April 2020. The logistics of implementing these SL activities will be described.

Acknowledgements

- The Science Circle!
- NSF – CHE 1900181
- My research students, esp. Dustin
- Dr. George Richter-Addo
- SIUE Department of Chemistry
- SIUE College of Arts and Sciences
- SIUE Graduate School
- All of you for your attention, and continued support of SC in SL

The story so far…

- Chemistry World
  - Dr. Wendy Keeney-Kennicutt (Texas A&M) and Dr. Kurt Winkelmann (Florida Tech at the time) received funding from NSF to develop the region and report on the use of SL as an educational environment for Chemistry.
    - The National Science Foundation TUES program (Award#1140841)
  - See Dr. Kurt Winkelmann's talk and tour of this region at https://www.sciencecircle.org/kurt-winkelmann/
  - Xandi Mars and Random Cole did the bulk of the work to develop the Chemistry World Region and activities

Previous Results

- *Overall, results of this pilot study suggest that virtual worlds can be effective for teaching chemistry experiments. This is the first account of student learning and attitudes after performing college-level chemistry experiments in the immersive virtual world of SL.*

- https://doi.org/10.1021/acs.jchemed.6b00733

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Development, Implementation, and Assessment of General Chemistry Lab Experiments Performed in the Virtual World of Second Life

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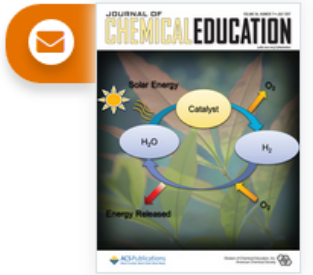
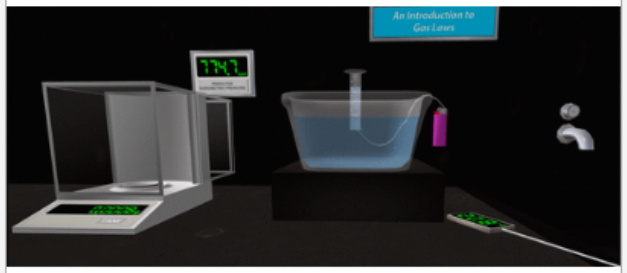
SUBJECTS: Teaching and learning methods,



Journal of Chemical Education

Abstract

Virtual worlds are a potential medium for teaching college-level chemistry laboratory courses. To determine the feasibility of conducting chemistry experiments in such an environment, undergraduate students performed two experiments in the immersive virtual world of Second Life (SL) as part of their regular General Chemistry 2 laboratory course. The experiments' development and implementation are presented with feedback from students and graduate teaching assistants. Students successfully completed the experiments and showed learning gains similar to students performing real world experiments, as shown by pre/postlab quizzes and a laboratory practicum. Student participants held positive views of their experience in the SL chemistry laboratory. Teaching assistants provided an important perspective about using the virtual world for laboratory instruction. Overall, results of this pilot study suggest that virtual worlds can be effective for teaching chemistry experiments. This is the first account of student learning and attitudes after performing college-level



Another plug:

- Second Life as an educational platform
  - See George Djorgovski's talk from last week about Virtech: the Virtual Caltech campus in SL at:
  - https://www.sciencecircle.org/george-djorgovski/

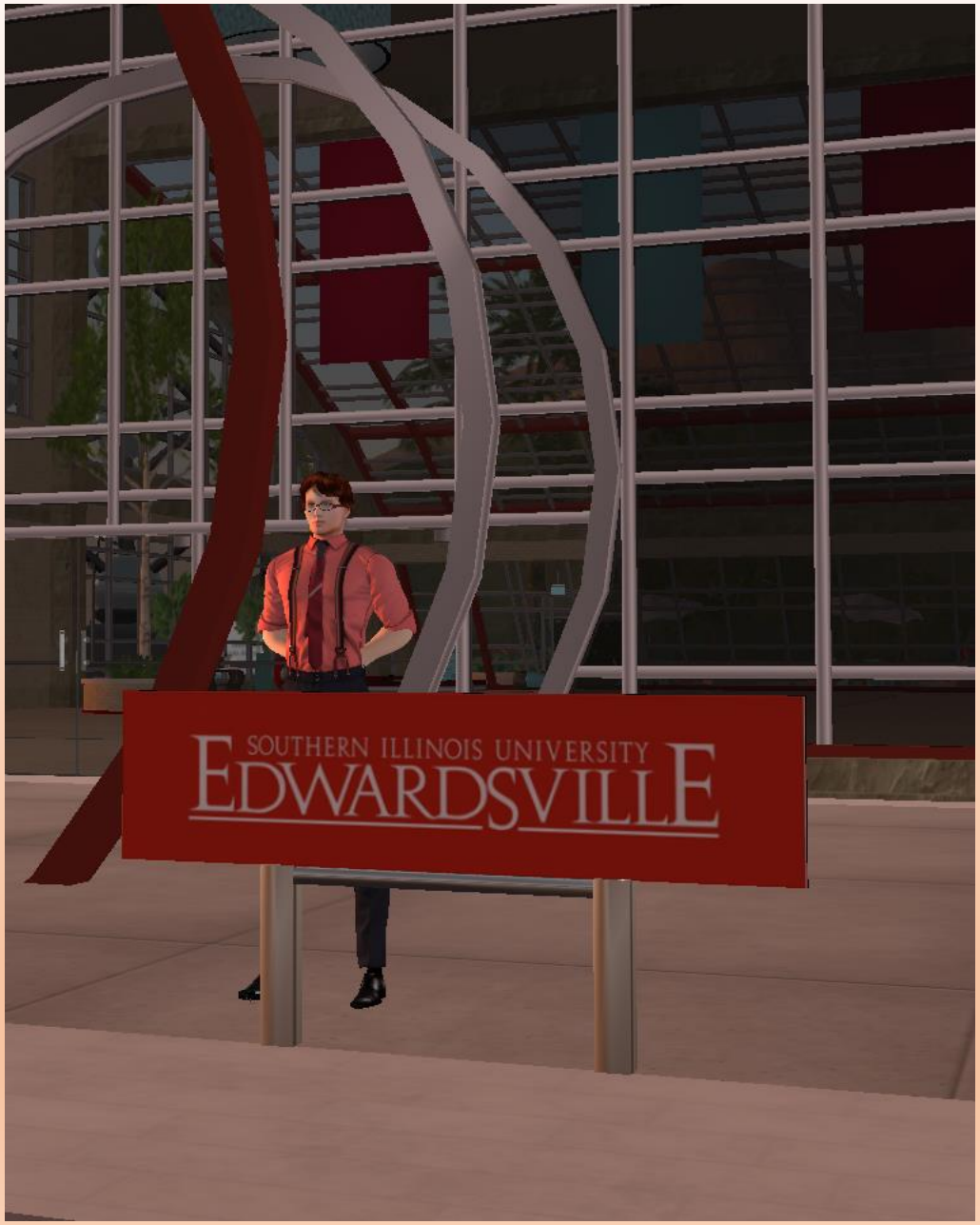
  - Excellent summary of pro's and cons regarding SL

Summer 2020

- I was assigned “Chem 135: Freshman Chemistry for Engineers Laboratory” for Fall 2020 as part of my teaching load
  - Usually, experiments are “in the can” so little development is required
- May 2020!
  - Not clear if in-person activities would be allowed for Fall 2020.
  - Asked Dr. K and Dr. Winkelmann if we could use Chemistry World for classes in Fall 2020…
    - Found out region fees were no longer being paid as Dr. K had retired and the grant was over.
    - My colleagues were highly supportive of using SL to teach online content
    - Obtained funding from SIUE for 2020-2021 and worked with Dr. K. to transfer ownership of region to me.

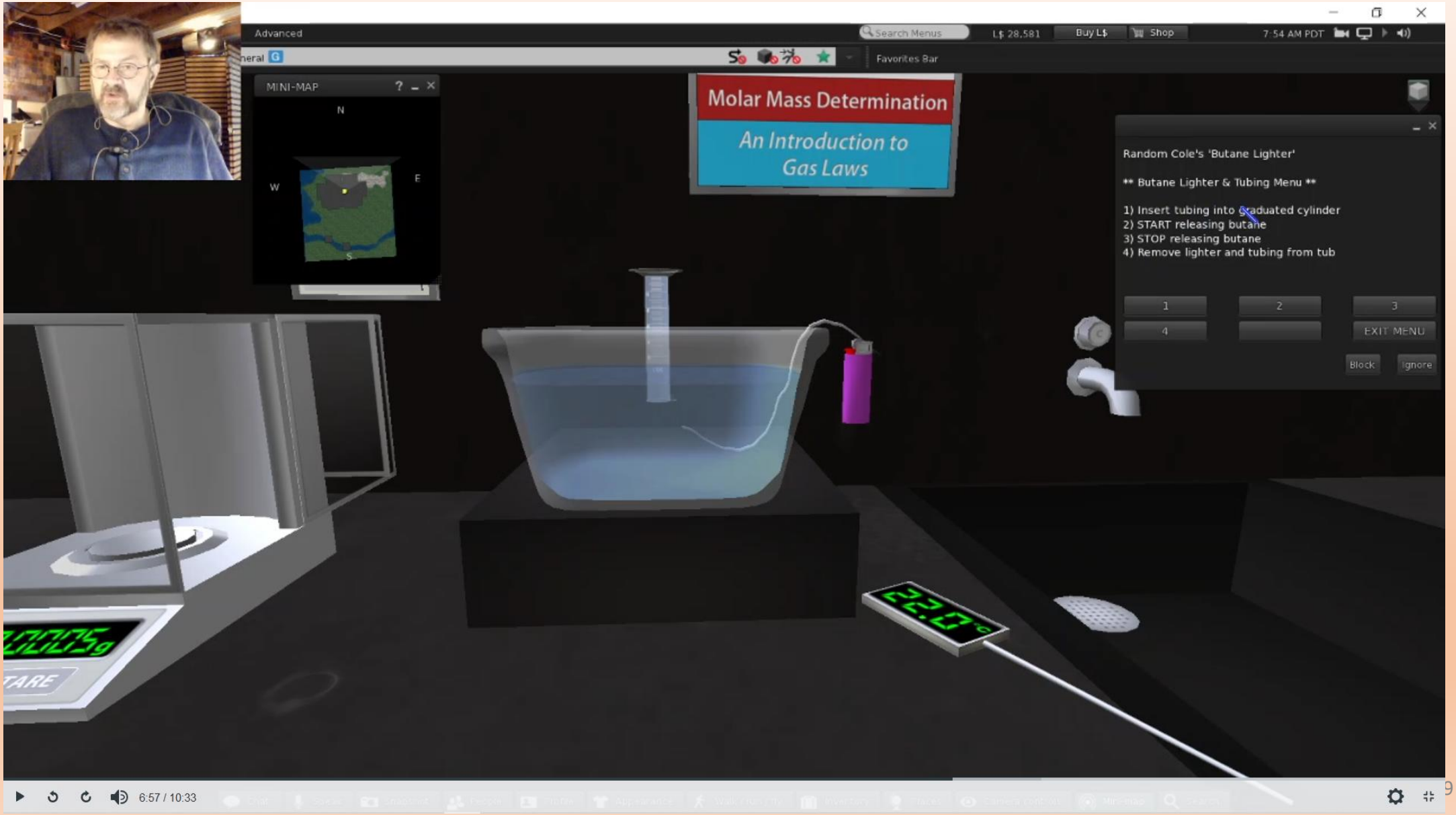
June 2020: Stewardship

- Got necessary approvals from Chair, Information Technology Services, and legal arm of Information Technology Services
- Put up three SIUE signs, worked with SIUE Marketing (they were delighted) to follow my institutions policies.
- Met with Xandi to make some minor changes.
- GOAL: NO MAJOR CHANGES TO EXISTING CONTENT!



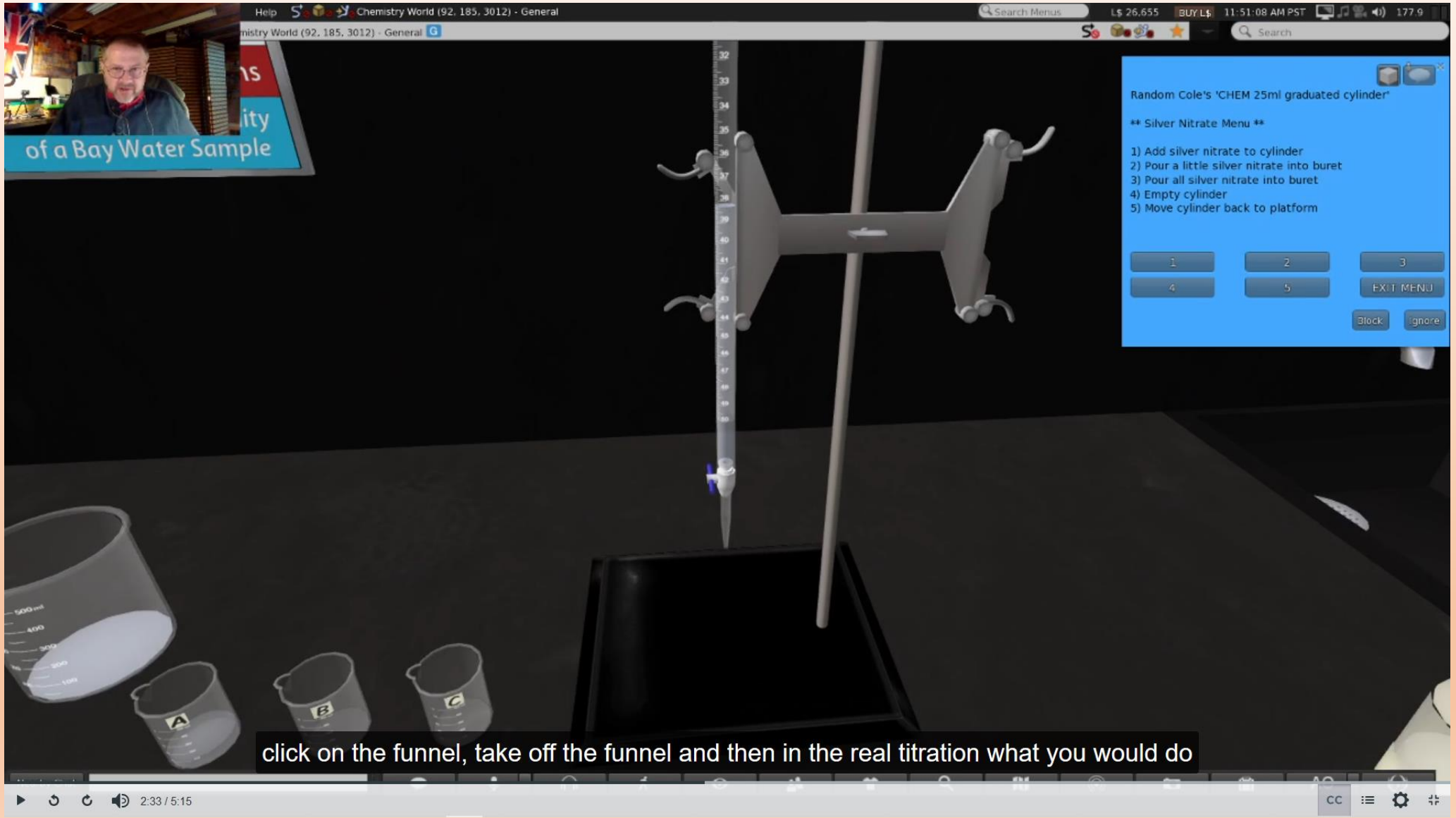
Tour Preview: Gas Laws

https://siue.techsmithrelay.com/blPb



https://siue.techsmithrelay.com/EIVO

Tour Preview: Precipitation Titration



Tour Preview: TA HUD

Additions to region…

- Bioinorganic structures
- Interactive activities
  - The solid-state lab plus video lab manual
  - Objects which rez large temporary structures
    - COVID-19 spike: land impact >2000
    - Orbitals: rez individual models for all orbitals from n = 1,2,3,4

See examples around the bleachers

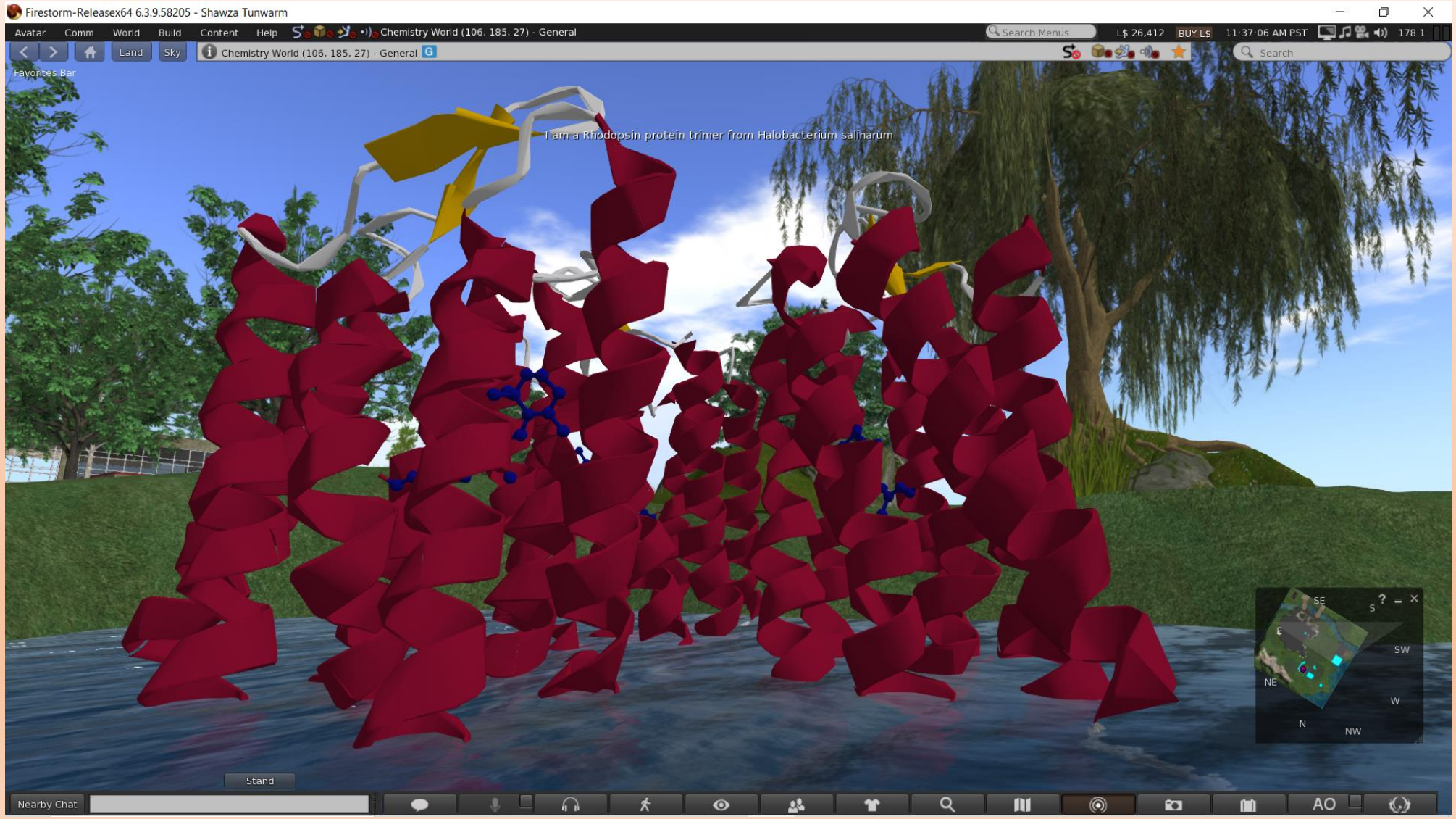
Additions to region

- Bioinorganic structures **"Gee whiz!"**

- Interactive activities
  - The solid-state lab plus video lab manual **Carefully planned based on pedagogy**

  - Objects which rez large temporary structures **"Gee whiz!"**
    - COVID-19 spike: land impact >2000
    - Orbitals: rez individual models for all orbitals from n = 1,2,3,4

4th Year Bioinorganic class in Spring 2021



More Developments in Summer 2020

- Clarifications in July 2020
  - In person labs allowed with reduced capacity: 10 students per section instead of 24.
  - Decided to go ahead with some in-person activities but schedule SL activities for mid- to end of semester.
  - No in-person classes for last 2 weeks of semester, i.e., after Thanksgiving.

- 4 Activities planned – I rewrote lab manual to include:
  - Introduction, and group joining during week of Labor Day
  - Gas Laws and Precipitation Titration Legacy experiments
  - Solid State Modelling Experiment (new)

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PLUS asked students to register for SL accounts starting in July!

Why a solid-state structure experiment?

- Current in-person experiment is frustrating.
  - Have discussed with colleagues for a couple of years
  - We have worked on a Unity-based version, not ready yet.
- The properties of metals and ceramics which are used as electrical and building materials also requires a knowledge of structure for full understanding.
- Need to familiarize students with the basic principles of solid-state structure, including examples of structures
- Future development: include examples of defects which weaken structures or provide catalytic centers.

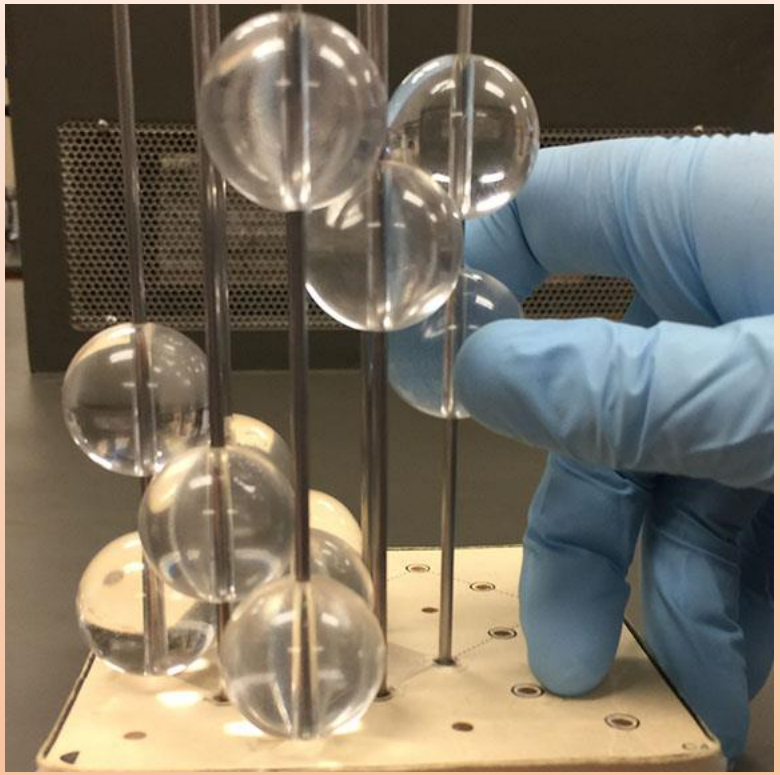


Image credit: Dr. Myron W. Jones

More Influences…

- From Greg Perrier's "Teaching in Virtual Worlds Guide" https://www.sciencecircle.org/Greg%20Perrier/

- In 2018 and 2019, I worked with a group of SC members and colleagues to write 2 proposals for the NSF AISL program.
  - AISL: Advancing Informal Science Learning

- Not funded, but we based proposed activities on *Universal Design for Learning principles**:

* Basham, J.D.; Marino, M.T. (2013) Understanding STEM Education and Supporting Students Through Universal Design for Learning. *TEACHING Exceptional Children*, *45(4)*, 8-15.

Universal Design for Learning process

- Start with pedagogy first.
  - What are the goals?
  - What background support is necessary
- Then decide how to implement with flexible methods and materials
  - Need background materials such as videos, and other support such as TAs and office hours.
  - Decide how the activity will tie back to each of the pedagogical goals
  - Need plans for assessment and timely monitoring of progress
- Finally start building/coding activity

Details details details….

UDL strategy #1: Clear Goals

Desired Learning Outcomes…

(1) Understanding of Unit Cells:
   a. Be able to identify *a,b,c*, and *α, β, γ* for a unit cell
   b. Be able to identify contents of a unit cell, i.e. inside vs. outside, and total number of atoms inside.
   c. Be able to identify some basic Miller indices of planes like (1,0,0), (1,1,0), and (1,1,1) for cubic structures.

(2) Familiarity With Examples of Common Structures:
   a. Be able to identify common cubic structures (Simple Cubic, BCC, FCC).
   b. Be able to identify common close packed structures (FCC, HCP).
   c. Be able to identify tetrahedral holes and octahedral holes.
   d. Be able to extend understanding of cubic structures to common salts such as halite, fluorite and perovskite.

(3) Optional: Familiarity with Structural Defects:
   a. Be able to identify point, edge, screw dislocations.
   b. Be able to identify such dislocations as sites of weakness in a structure, and/or as sites of chemical reactivity (corrosion, catalysis).

Details details details….

Background Support

UDL strategy #2: Intentional planning for learners with variable ability and/or levels of access

(1) Make sure there is sufficient written material in Blackboard to support the activity.
- Links to lab book and textbook content.
- Make sure there is written material in Second Life that directs students to the BB content with URL's in notecards as appropriate. (asynchronous)

(2) Make sure that there are video prelabs and post-lab demonstrations of the activity.
- Notecards with URLs for this content need to be available in Second Life. (asynchronous)

(3) Have TAs walk students through the activity. (synchronous)

- *We ended up doing the "group joiner / familiarization activity " in September as an asynchronous activity.*
- *Gas Laws and Solid State activity could be done remotely by students, but most chose to use the computers we had in the lab to be with their Tas in person*
- *Precipitation titration experiment accomplished with all students and TAs at home (or wherever)*

Excerpt from Plan for Implementation

(1) Pre-lab video or reading in Blackboard with prelab quiz

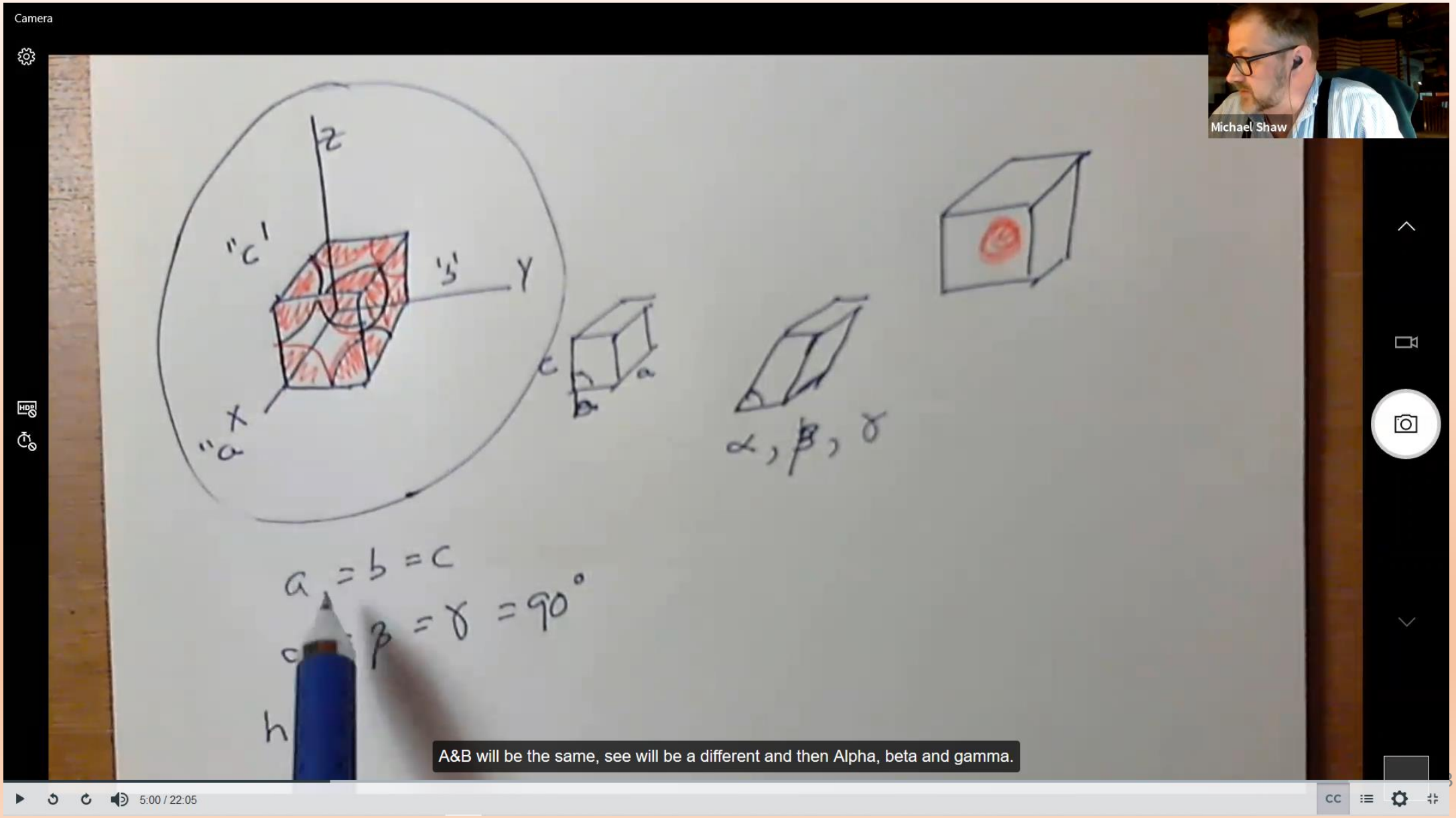
(2) Same links in Second Life site for timely access via a notecard and/or URL giver.
   a. Students can summon a TA using the call button.

(3) Lab Activity: Construction and comparison of cubic unit cells
   a. Balls of radius 0.5 m will be used, so SC structure has a=b=c=1.
   b. Student chooses value of a (a=b=c, $\alpha=\beta=\gamma=90°$ for cubic) by clicking on some basic object which manifests a menu. Another menu option is to reset. Another option yields a skeleton of a cube with sides equal to “a” units long at origin. *(Supports Learning Outcome 1a.)*.

Wrote 3 pages of details of how I wanted the activity to work and how each point tied back to a desired learning outcome

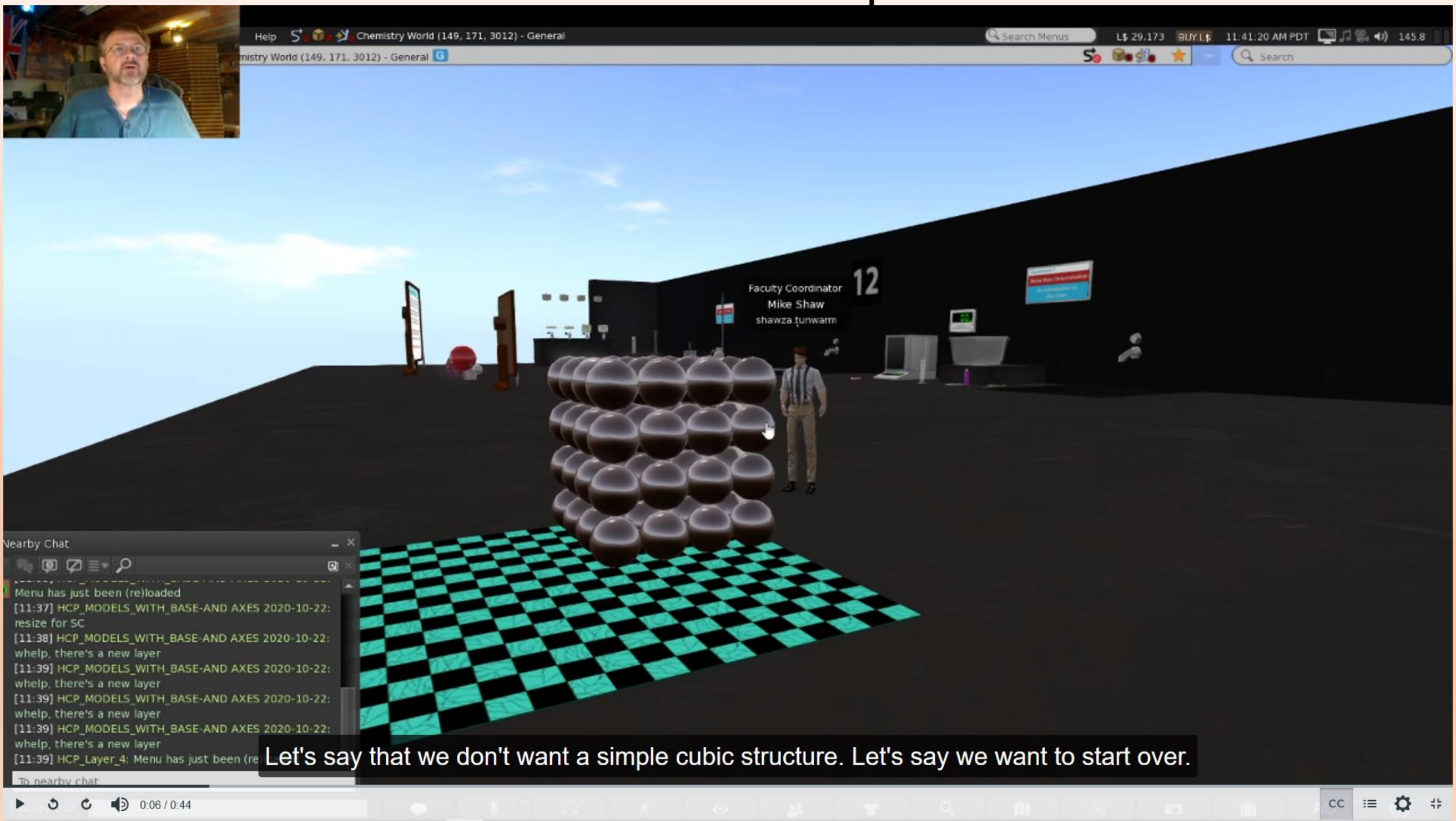
https://siue.techsmithrelay.com/UPnU

Tour Preview: Solid State Experiment



https://siue.techsmithrelay.com/ZBYU

Tour Preview: Solid State Experiment



Details details details….

UDL strategy #4: timely monitoring of progress

Assessment

(1) Post Lab: Complete post lab questions in BB based on the activity within 3 days. Expect Word file with questions answered, and pictures inserted. TA grades as normal.

(2) Need to ask questions which relate students experience to the desired learning outcomes. Develop activities first so as to make the questions relevant.

(3) In-lab assessment. When no questions being asked, TA and/or instructor(s) pop in and ask how things are going, monitor progress. Can have a counter in region to monitor logins and logouts.

Important: Feedback from TAs!

So how did it go? Let's talk to Dustin as we walk.

- How much experience did you have with SL before Summer 2020?
- What are the best aspects of teaching in SL?
- What were the challenges that you and your students faced?
  - Talk about that for each experiment
- Do you think that your students learned in SL as well as they did in the lab?
- Were there any qualitative differences in your experience TAing the old experiments vs. the new experiment?
- What else would you like to share?

Let’s go for a walk…

- Back to landing point and training area
- Note Atrium, tables out back, offices
- Through classroom into lab (home on HUD, H_2O with 1 on it)
- Up to Platform 1 (1 on HUD)

Acknowledgements

- The Science Circle!
- NSF – CHE 1900181
- My research students, esp. Dustin
- Dr. George Richter-Addo
- SIUE Department of Chemistry
- SIUE College of Arts and Sciences
- SIUE Graduate School
- All of you for your attention, and continued support of SC in SL