Application of Virtual Lab Simulations for Complementing Laboratory Teaching

Innovative and Effective Teaching During COVID-19

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“Laboratory teaching assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. Laboratory training is also frequently used to develop skills necessary for more advanced study or research.”

Lab-Based Learning. (n.d.). Centre for Teaching and Learning, Queen’s University. Retrieved August 28, 2020, from https://www.queensu.ca/ctl/teaching-support/instructional-strategies/lab-based-learning

Gage, N. L., et al. (1963). *Handbook of Research on Teaching*. Chicago: Rand McNally & Co.

Five Objectives of Lab-based Learning

Concepts

Understanding and practice the use of hypothesis and theoretical models

Cognitive Abilities

Developing critical thinking and problem-solving skills

Understanding Nature of Science

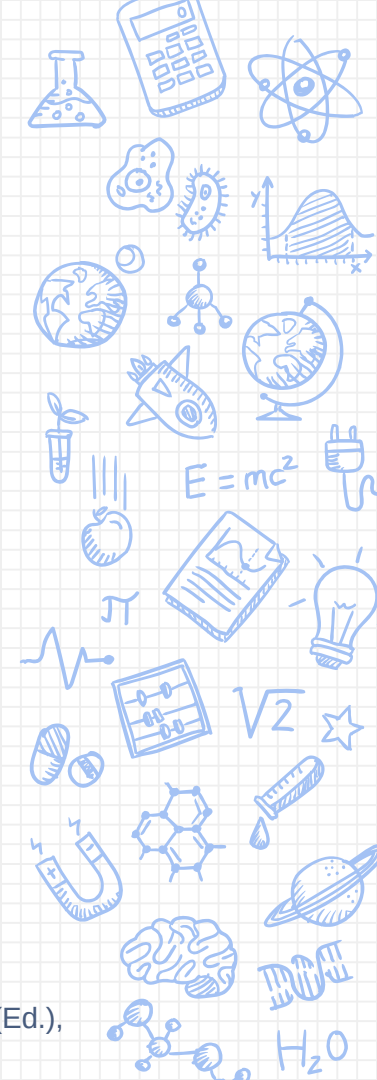
Experiencing how scientific enterprise work

Skills

Manipulative and intellectual skills

Attitudes

Develop confidence, satisfaction, curiosity



Shulman, L. S., & Tamir, P. (1973). “Research on teaching in the natural sciences.” In R.M.W. Travers, (Ed.), *Second handbook of research on teaching*. Rand McNally.

Objectives of Laboratory Teaching

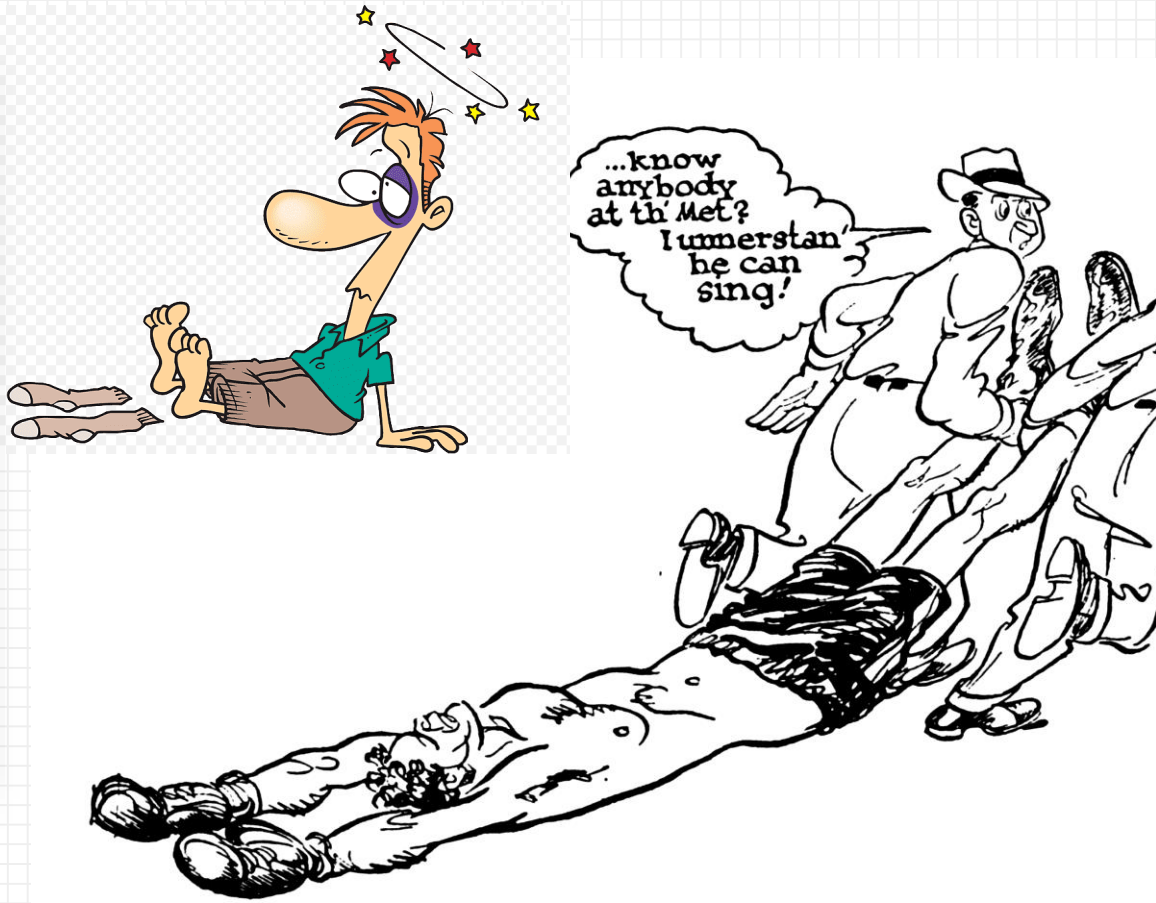
- Teaching experimental methods
- Supporting theoretical information of lectures
- Affective goals including scientific attitudes

Lorenzo, M. G., Reverdito, A. M., Blanco, M., & Salerno, A. (2012). Difficulties of undergraduate students in the organic chemistry laboratory. *Problems of Education in the 21st Century, 42*, 74-81. Retrieved from https://search.proquest.com/docview/2343809604?accountid=16720

Laboratory sessions 3 and 4

ELISA Test Performance

1. Label eight 1.5 mL microcentrifuge tubes with samples or controls and your group number.
2. For **nuts, potato chips, milo, milk, positive and negative controls**, take 50 µL of sample or control extracts and mix it with 450 µL of sample diluent in corresponding tubes (10-fold dilution).
3. For **wheat bread and biscuits**, take 10 µL of sample extracts and mix it with 490 µL of sample diluent in corresponding tubes (50-fold dilution).
4. Complete a sample plate plan on page 9 showing the location of all standards, negative control, positive control and food samples.
5. Pipette 100 µL of each standard, diluted controls and sample extracts into the appropriate wells.
6. Incubate the plate at room temperature for one hour on a platform shaker.
7. Discard the content from the well and wash each well 6 times with deionized water. (**Washing steps in ELISA are very important. Make sure you have appropriate skills in these washing steps**)
8. Add 100 µL of gluten conjugate to each well.
9. Incubate the plate at room temperature for one hour on a platform shaker.
10. Discard the gluten conjugate from the well and wash each well 6 times with deionized water.
11. Add 100 µL of TMB Substrate to each well.
12. Incubate the plate at room temperature for 10 minutes.
13. DO **NOT** DISCARD THE TMB SUBSTRATE FROM THE WELL. Add 100 µL of Stop Solution to each well.
14. Read the plate with microplate reader at 450 nm.



Reality

https://www.nextpng.com/en/transparent-png-nbese; http://cartoonsnap.blogspot.com/2008/

Difficulties faced by Students

- Comprehension of overall design and workflow
- The roles of each step and materials used
- Blind-doing the laboratory work
- Unable to comprehend the meaning of the data
- Frustration Resulted

Five Objectives of Lab-based Learning

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Cognitive Abilities ✖

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Understanding Nature of Science ✖

Experiencing how scientific enterprise work

Skills ✖

Developing Manipulative and intellectual skills

Attitudes ✖

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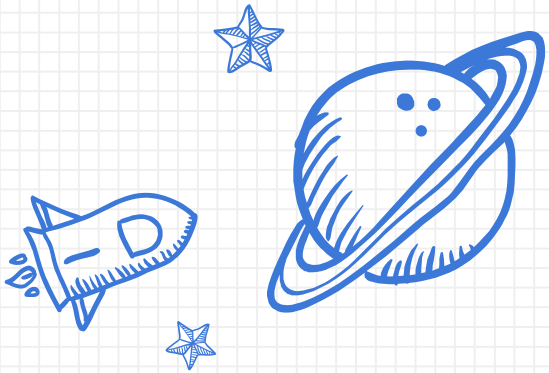
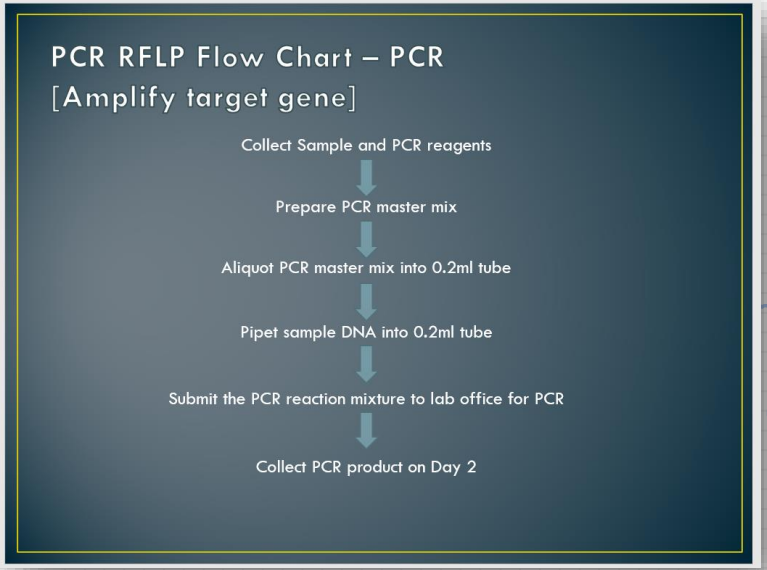


Familiarisation and Realisation of Experimental Procedures is Crucial for Creating a Sucessful Lab Experience for Students and Achieving the Objectives of Lab-Based Learning and Teaching

Engaging Students

Pre-lab Flow Chart

- Unable to prepare a correct flow chart
- Reiterating lab procedures
- Passive learning if students are unable to draw a correct flow chart
- No evaluation of students' competence



Engaging Students

Virtual Lab Experience

- Do the lab once
- Raising students' interest
- Performing lab impossible in real-life
- Gauging of student's competence

Seeing is Believing; Doing is Knowing

Virtual Lab System

- Computer-based / VR google-based
- Covering topics physics, chemistry, biology, engineering, and medicine of total 140 simulations
- Organised into course packages

Components of VR Lab Simulations

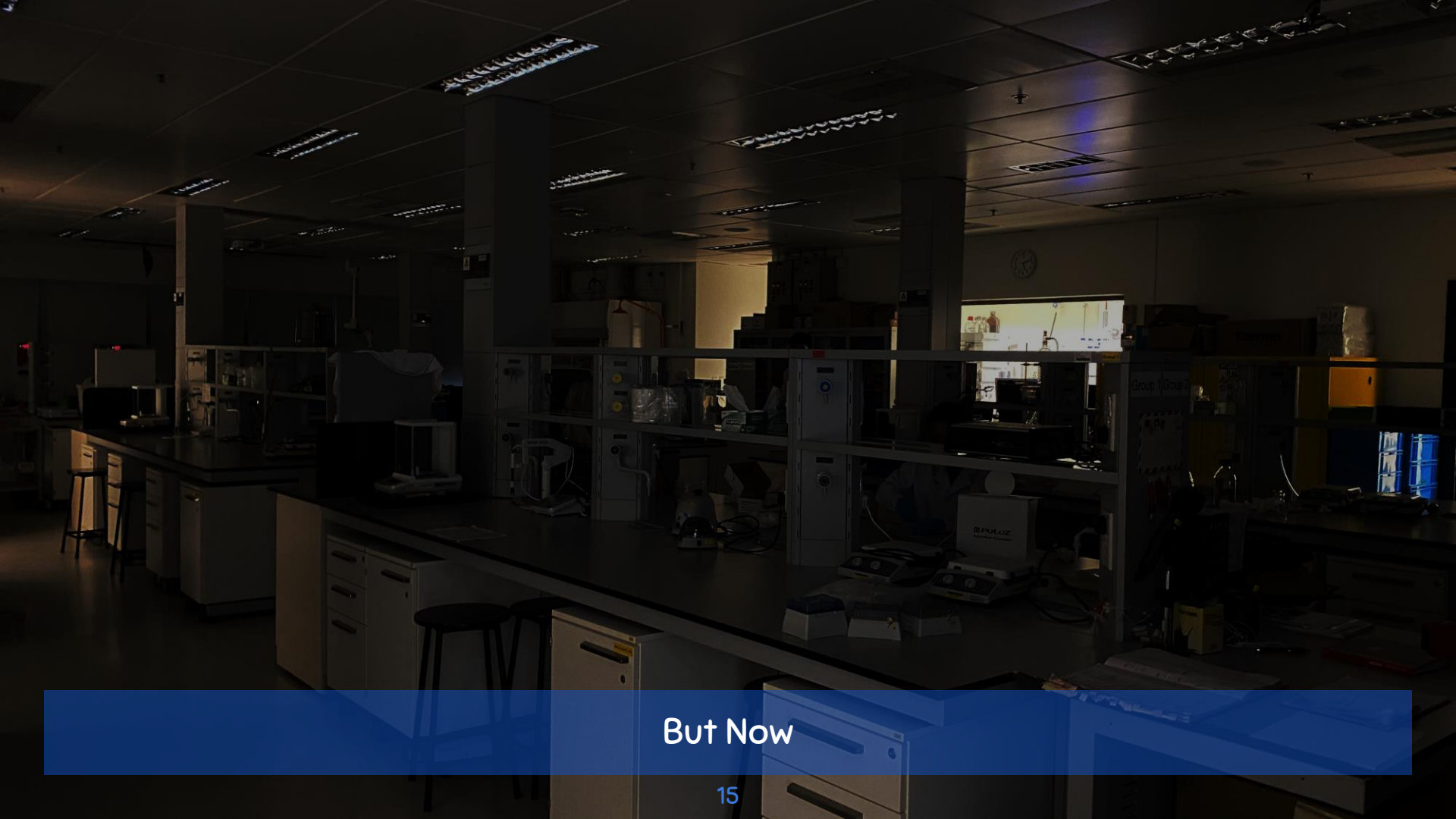
- Simulation management dashboard
- Theoretical knowledge
- Simulation with a storyline
- Check-point Questions
- Student performance analytics

Parameters Useful For Gauging Students Competence

- Check-point Questions
- Number of Attempts
- Student's Score
- Supplement with flowchart

Students Feedback (Sample Size = 36)

	Completely Agree	Agree	Disagree	Completely Disagree
I gained relevant knowledge by using the simulation.	12 (33.3%)	19 (52.8%)	4 (11.1%)	1 (2.8%)
I found the simulation motivating	15 (41.7%)	19 (52.8%)	1 (2.8%)	1 (2.8%)
I feel more confident about my lab skills after the simulation	8 (22.2%)	25 (69.4%)	2 (5.6%)	1 (2.8%)
I feel that I can apply what I have learned in the simulation to real world cases	7 (19.4%)	27 (75.0%)	1 (2.8%)	1 (2.8%)

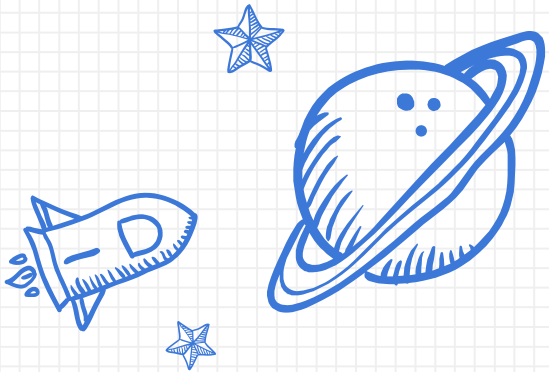


But Now

Responses during COVID-19 (Sample Size = 34)

- Using different simulations to students as a mean of engagement

	Completely Agree	Agree	Disagree	Completely Disagree
I found the simulation help maintaining my interest in doing lab-work during the COVID-19 epidemic	9 (26.5%)	21 (61.8%)	4 (11.8%)	0 (0.0%)
I feel more confident about doing the real-lab	7 (20.6%)	19 (55.9%)	7 (20.6%)	1 (2.9%)
I found the simulation help maintaining my interest in studying during the COVID-19 epidemic	6 (17.6%)	23 (67.6%)	5 (14.7%)	0 (0.0%)



Virtual lab simulations may help engaging students and to maintain their interests and confidence in lab-based learning and studying in general

Acknowledgement

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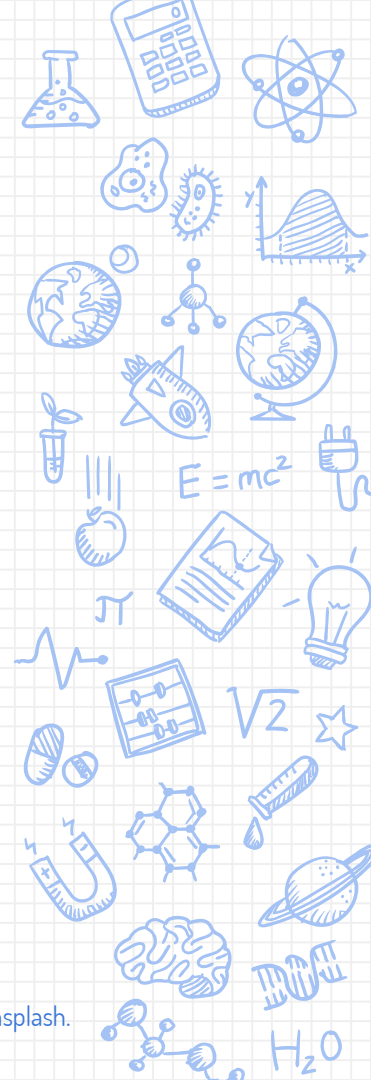
- Support from the Dean of the School of Science and Technology, OUHK and colleagues of the Department of Science, OUHK
- Support from our students



THANK YOU!

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