Teaching Science Courses With Laboratory Classes for Remote Learning

Elmer-Rico E. Mojica
Department of Chemistry and Physical Sciences, Pace University, One Pace Plaza, New York, NY 10038

Southern Luzon State University
July 24, 2020

Pace University

Science

- It is the study of facts.
- It also about discovering the world around us, of knowing things, and having new and wonderful idea.
- Scientific learning that takes place in classrooms alone is not true learning.
- Hands-on learning is very important for fostering scientific learning in early childhood: science lab experiments.

Laboratory Class

- Laboratories are an essential component of science courses.
- The laboratory is an exciting place where students investigate, analyze, and reflect. They test and apply theories and make abstract concepts concrete.
- Experimentation provides students with real-world contexts to apply scientific concepts, develop critical thinking skills, and engage in scientific processes.

Goals of Laboratory Class

•Develop intuition and deepen understanding of concepts.

•Apply concepts learned in class to new situations.

•Experience basic phenomena.

•Develop critical, quantitative thinking.

•Develop experimental and data analysis skills.

•Learn to use scientific apparatus.

Science Teaching Reconsidered, National Academy Press, 1997

Goals of Laboratory Class

- Learn to estimate statistical errors and recognize systematic errors.
- Develop reporting skills (written and oral).
- Practice collaborative problem solving.
- Exercise curiosity and creativity by designing a procedure to test a hypothesis.
- Better appreciate the role of experimentation in science.
- Test important laws and rules.

Science Teaching Reconsidered, National Academy Press, 1997

Laboratory Class Approach

- ***Expository*** –Students follow prescribed directions to verify a preordained results. (traditional instruction or cookbook approach)

- ***Inquiry*** – Students are provided with materials, information and a question to answer, but are given latitude tin how to go about designing the experiment or interpret the results which is not preordained (open-inquiry)

Laboratory Class Approach

- ***Discovery*** – The instructor has a particular outcome in mind and directs student towards that outcome, encouraging students to make predictions, formulate hypothesis and design and evaluate the experiment themselves. (guided-inquiry)
- ***Problem Solving*** – Students are given more ownership over the process of discovery while incorporating a greater dimension of teamwork and interdependence

Online Laboratory Class

Lab kits, in combination with household items, provide the means to conduct experiments at home on a smaller scale and without the need for expensive equipment.

Field-based experiments provide students with real-world opportunities to collect and analyze data from their locations (Reuter, 2009; Waldrop, 2013).

Online Class

Computer simulations provide alternatives to complex experiments that might be too large, expensive, or dangerous for physical manipulation or not feasible for a large number of students.

Remote instrumentation gives students online access to scientific apparatus for manipulation, data collection, and analysis

Online Class


nature

Subscribe

OUTLOOK · 03 OCTOBER 2018

Simulated labs are booming

Blowing up your lab is usually discouraged, but it's part of the experience when you're learning online.

Nicola Jones

https://www.nature.com/articles/d41586-018-06831-1

Online Class

How are we going to teach laboratory classes?

Laboratory Class Options

Options for Laboratory Classes
- did not do labs
- virtual labs/simulations
- used videos related to experiments
- home-based experiments

Objective is to make laboratory useful to reinforce the concepts discussed in lecture.

Virtual Labs (Fee)

Beyond Labz
labarchives
jove
CloudLabs
eScience Labs
Labster
Chem101
HANDS-ON LABS
PraxiLabs

Simulations (Free)

LabXchange
ChemCollective
MERLOT Materials
AACT
PhET INTERACTIVE SIMULATIONS
Apps on Physics
The OpenScience Laboratory

Simulations

https://libguides.mines.edu/oer/simulationslabs

HPLC simulations:
http://www.multidlc.org/hplcsim/hplcsim.html

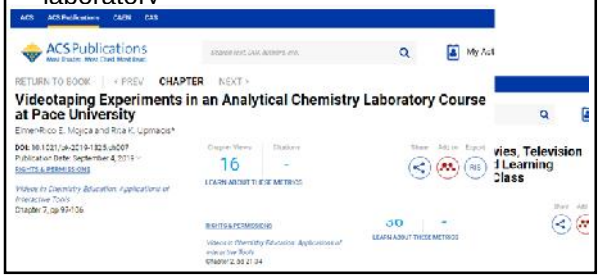
Mass Spec simulations:
http://svmsl.chem.cmu.edu/vmsl/default.htm

IR simulations:
http://www.cheminfo.org/Spectra/IR/Exercises/Browse_Spectra/index.html

Videos Based On Experiments

Best option that we have

- Have used videos to reinforce lecture and laboratory



Videos Based On Experiments

- Lot of videos available in YouTube and we were able to use them for our Gen Chem lab courses and my instrumental analysis lab courses.
- Watching videos is different than doing hands-on lab.
- However, results from a study show that the lack of a hands-on experience did not negatively affect the performance of the online students (Abdel-Salam et al, 2006).

Abdel-Salam, Kauffman,& Crossman *European Journal of Engineering Education, 2006,* 31(6), 747-756

Students' Reactions

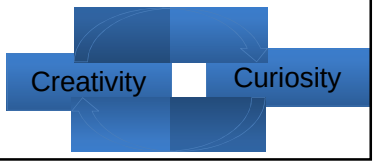
- *The videos were helpful because I got to see the experiment that I was writing up. Reading the experiment in the lab manual first, set me up to understand the concepts, but watching the video made me feel as if I was the one doing the experiment myself.*
- *Yes, the use of videos are helpful for the lab. Sometimes, it is difficult to read a procedure. Seeing it being done is always helpful.*
- *The videos do help me the lab. And I'll Google some other relevant and useful information and videos to help.*

Home-Based Experiments

- Commercially available lab kits in combination with household items, provide the means to conduct experiments at home on a smaller scale and without the need for expensive equipment.
- You can also develop your own.
- Safety issues?
- Legal liabilities a big problem here in the US.

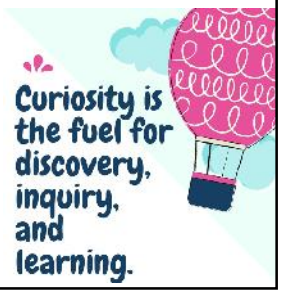
Lab Best Alternative

- Mimic commercial lab kits but use everyday household materials.
- By using these materials, teachers have to use their creativity and take advantage of students curiosity.
- Curiosity is the key to creativity.

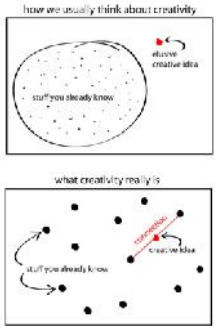


Curiosity

- Make students curious.
- Curiosity makes learning more effective and enjoyable.
- Curiosity is just as important as intelligence in determining how well students do in school.

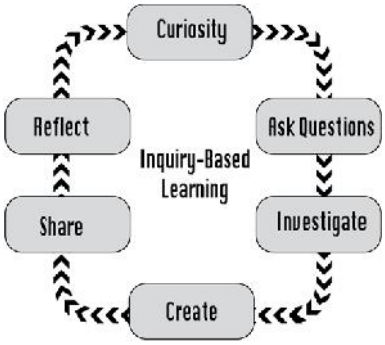


Curiosity



https://seewhathappensblog.com/2011/10/26/forget-creativity-lets-demand-curiosity/

Inquiry-Based Learning



Inspiring Curiosity: A Librarian's Guide to Inquiry-Based Learning (ISTE 2018).

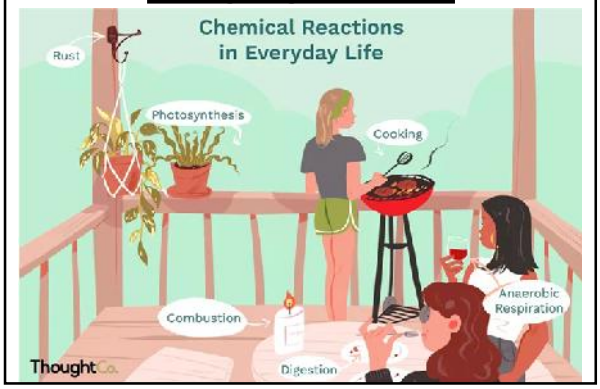
Home-Based Experiments

- Avoid adapting the traditional lab experiments directly to online environment
- Think SAFE (Safety, Affordability, Feasibility, "Engageability")
- Key to have a successful distance learning activity is its DESIGN.
- Focus on learning objectives

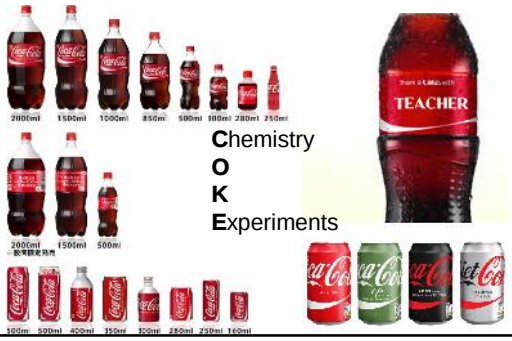
Designing Home Experiments

- Conceive: What do I wish to accomplish in this experiment/activity?
- Design: How I will accomplish the experiment?
- Implement: How it will done by the students?
- Operate: Does it work the way it was planned?

Everyday Science



Coca Cola



Chemistry
O
K
Experiments

Soaking Experiment

Sugar Recovery

Mixing Experiment

Mixing Experiment

Floating Experiment

Students' Reactions

- *For the home based experiments I did make the connection of the type of experiments we were doing to the material learned in lecture and lab experiments. I also liked that they were quick and easy.*
- *Getting some of the materials right now especially due to Covid prevented me from completing the home-based experiments.*
- *I think that the home experiments were designed to be more simple as we could take a basic experiment and perhaps see a connection to the more complex labs while providing for an easier time of completion.*

Students' Reactions

- *I did do the home based experiments. It was helpful and also pretty interesting to do. I was able to observe and relate the experiments to what we had already discussed in the lecture.*
- *I think the home experiments have been helpful with providing a hands on feel more than the laboratories did.*
- *The home experiment felt very childish, as if I was too old to be doing them.*

Coke + Mentos

Balloon Barbeque

Balloon and Volcano Reaction

https://www.youtube.com/watch?v=X4vWDDmKQTM

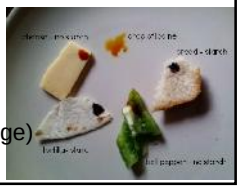
Color the Flowers

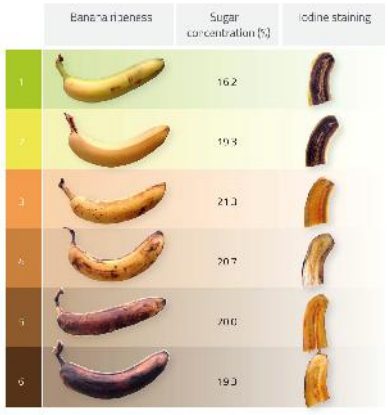
Color the Veggies

Density Rainbow

Chemistry

- Bigas to kanin
- Ripening of fruits (mapakla to matamis)
- Browning of some fruits
- Use of carburo
- Pancake/hotcake
- Egg
- Frying (pancake, fish, meat)
- Nilagang karne (with papaya)
- Shrimp/Crab (dark grey to orange)
- Betadine-starch



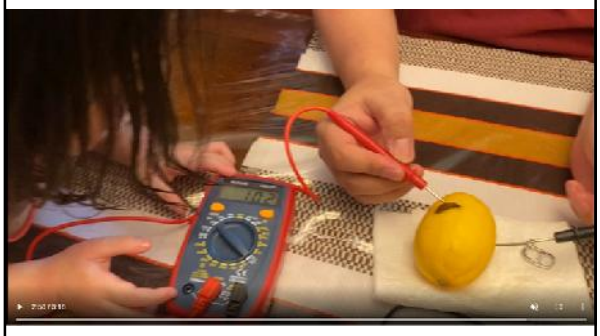


https://www.scienceinschool.org/content/go-bananas-biochemistry

Lemon Battery

Potato Battery

Lemon Battery



Potato Battery

Lemon Battery

Potato Battery

Pinay scientist creates lamp that runs on saltwater

Last Resort

- If materials cannot be supplied, teachers can perform the experiments, video it and show to the students.
- Better, just look for the videos in YouTube.
- You can look on other sites where the videos are available.
- To economize data plan (Internet use) make/find videos that are short.

Useful Websites

- Filipino Science Hub
- Pueblo Science
- YouTube Channel: Craft for Kids, Raising da Vinci, MaxHax, Go Experimental, Malmesbury Education
- My personal webpage: https://projectchemunity.weebly.com/

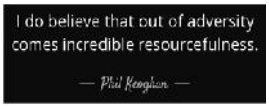
Things to Explore

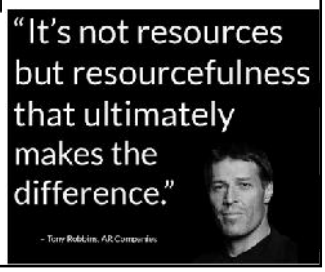
- Cell phone as weighing balance and spectrometer

Designing Lab Experiments

- What do students need to learn from lab courses?
- What is the most important thing the students need to know in a given experiment?
- How are you going to know if they learned?
- Apply “begin the end” concept.
- Modify the learning outcomes.
- Focus more on data processing/analysis and interpretation, communication (writing) skills and use of imagination (design experiments).

Final Thoughts





Acknowledgements

- Maria Luisa A. Enal
- Southern Luzon State University
- Everyone who attended the webinar