Demonstration: Remote Operation of Console Controlled Labs for Undergraduate Science

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ABSTRACT

Remote Web-based Science Lab (RWSL) is a made-in-BC innovation originally aimed at reintroducing distance learning for laboratory science courses for Years 1 and 2.

Although it is common for laboratory equipment to be controlled through computer consoles even in introductory science labs, the RWSL labs offer this experience where the controlling interface and the student can be geographically separated from the equipment.

RWSL is one of the key supports that provide for the implementation of online science courses where the students are not required to report to the on-campus laboratory. Our experiences and challenges in implementing RWSL mediated distance courses are described in a companion presentation (Evans & Sato 2013) at this conference.

WHAT IS RWSL?

Remote Web-based Science Laboratory (RWSL):

- is a software and robotic interface students control over the web
- interacts with and manipulates lab equipment remotely
- collects authentic real-world scientific data in real time

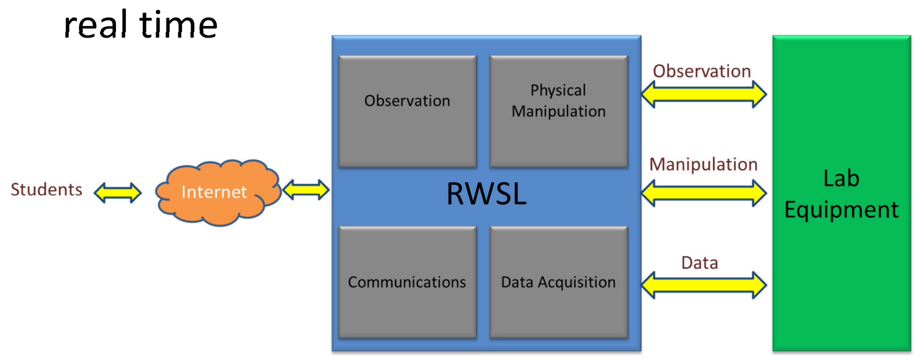

Fig. 1: RWSL Building Blocks (from NANSLO)

SOME IMPLEMENTATION MODES

Remote labs can be implemented in a variety of ways.

1. Remote Student Mode:

A student from anywhere takes an online course with a lab component

- Some experiments are performed using lab-kits at home
- Some experiments are performed remotely through RWSL

Here, the home labs with lab-kits support the tactile experience and the RWSL provides access to equipment not practicably shipped to students' homes.

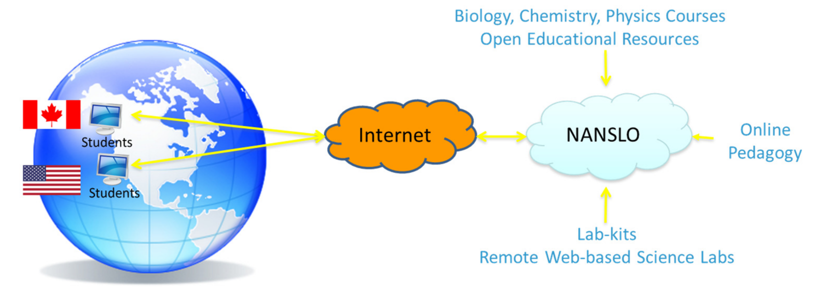

Fig. 2: RWSL implementation by NANSLO (NANSLO)

This is the model envisioned by the *WASc* project and adopted by the *North American Network of Science Labs Online* (NANSLO) consortium.

2. Remote Equipment Mode:

A student enrolls in a F2F course on campus

- Some experiments are performed in the traditional laboratory on campus
- Some experiments are performed remotely through RWSL

Here, what is remote is not the student who take advantage of equipment not available at her campus/institution or experiments that must be performed at special locations.

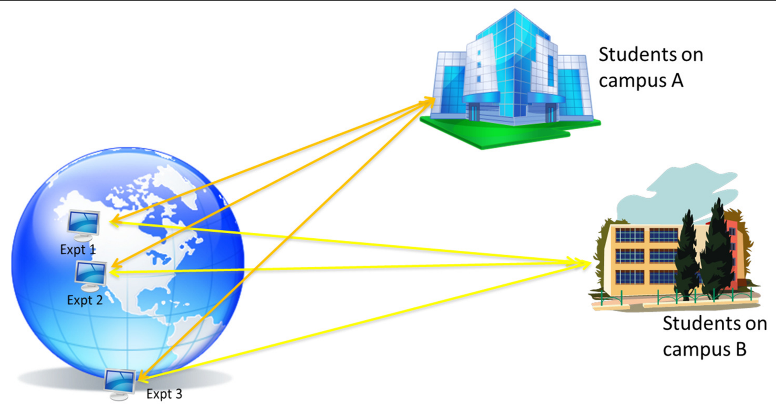

Fig. 3: Remote Equipment shared across campuses/institutions (Sato 2012)

3. Hybrid Mode:

- Instructor choses the best combination that plays to the strengths of each component for optimum learning outcome and student experience

DEMOSTRATIONS TODAY

Electron charge to mass ratio: "*e/m*"

Today, we know that electrons have electric charge of magnitude $e = 1.60 \times 10^{-19}$ C and a mass of $m = 9.11 \times 10^{-31}$ kg. In the 1890's, however, only the charge was known. The historical significance of this type of experiment is that J.J. Thomson's measurement of the ratio between *e* and *m* allowed us to determine the mass of the electron, which turned out to be very small. To this day, physicists lovingly call this the "*e/m* experiment."

A stream of electrons is shot into this vacuum chamber and curved into a circular path under the magnetic influence of the Helmholtz coils. By measuring the radius of curvature while the magnetic field is varied, the experimenter determines the value for *e/m*.

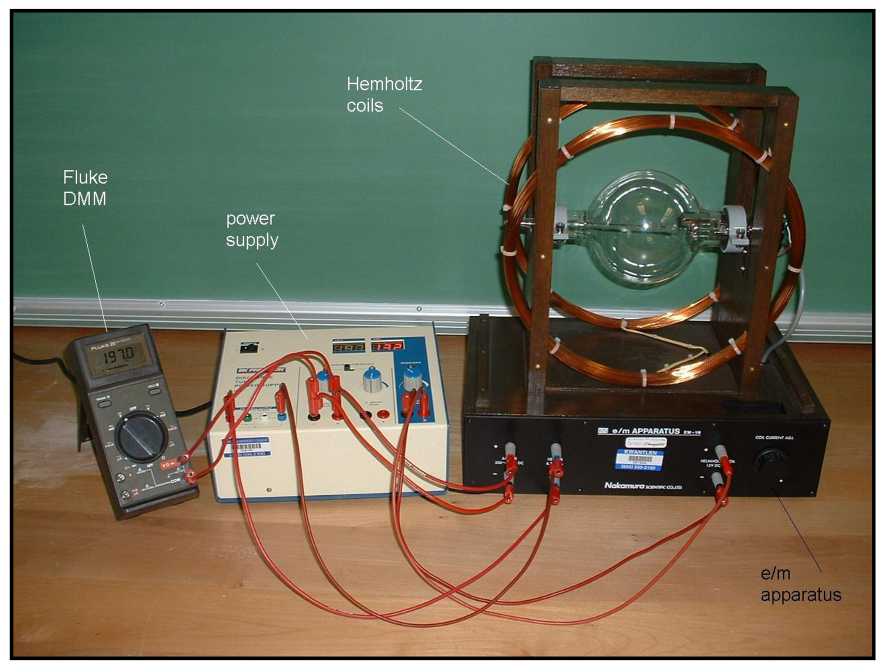

Fig. 4: Kwantlen's *e/m* apparatus (Lang 2012)

Microscope:

The microscope allows us to see small things. This one is controlled via RWSL. Though invented by a physicist, we see it used in biology courses.

Fig 5: RWSL microscope in Denver (NANSLO)

Electroluminescence in LEDs

Light Emitting Diodes (LED) now take centre stage in the lighting appliance industry but physicists have had a long standing relationship with them.

In this lab, students study their optical spectra, electronic properties and the solid state physics underlying LEDs.

Today's demonstration will showcase the RWSL spectrometer in this application.

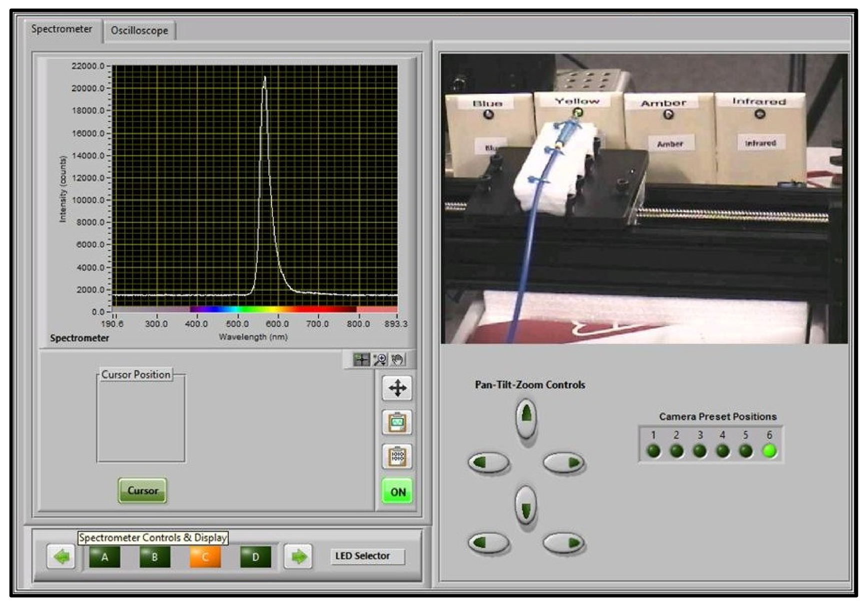

Fig 6: RWSL Spectrometer at NIC (Evans & Nowell 2013)

Airtrack:

The airtrack is the one dimensional analogue of Air Hockey. Air is fed into the core of the track by a high volume pump and allowed to escape through a large number of pinholes, providing a cushion of air for a "glider" to float on. The aim is to remove effects of friction while students investigate the dynamics of the glider.

One of many experiments performed with the airtrack is simply to tilt the track and measure the increasing speed of the glider as it floats downhill.

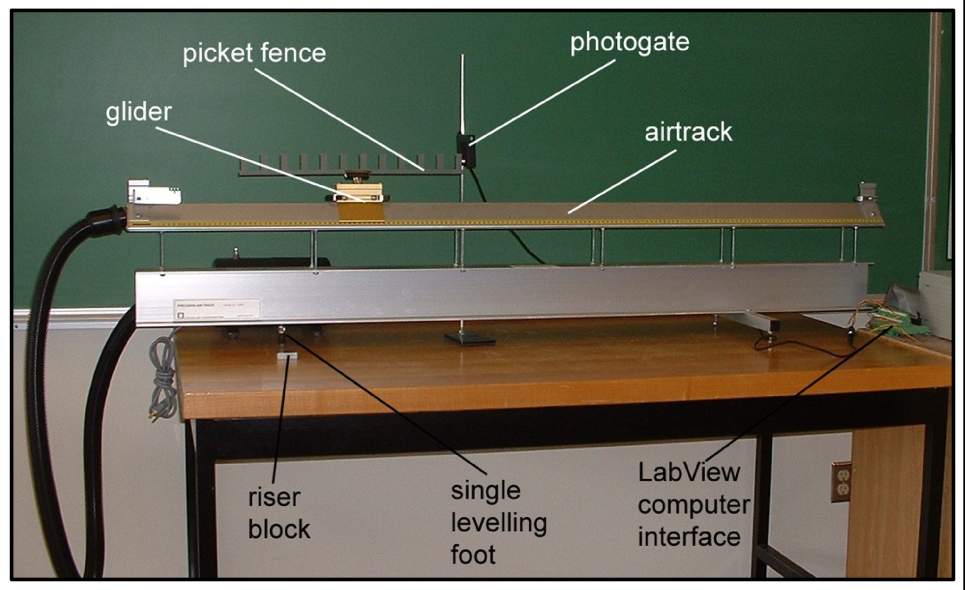

Fig 7: Airtrack (Kwantlen Polytechnic Univ. 2013)

WOULD YOU USE IT IN YOUR CLASS?

You are now among the select few who have test driven RWSL labs for yourself.

Would you be inclined to try using labs like these in your own class?

Place pin here

Yes **Maybe** **No**

RWSL LABS DEVELOPED

Principal Equipment	Experiments	Discipline
Spectrometer	Emission Spectra, Electroluminescence	Physics
	Atomic Spectra, Spectrophotometry	Chemistry
	DNA melting	Biology
Microscope	Microscopy, Cell Cycle, Plant Anatomy	Biology
Titration	Carbonate/bicarbonate	Chemistry
Oscilloscope	Speed of: sound in air, light in air & optic fibre, RF signal in coax cable	Physics
Airtrack	Kinematics, collisions	Physics
e/m	Electron charge to mass ratio	Physics
Magnetic Force	Magnetic Forces	Physics

… and more on the way

ACKNOWLEDGEMENTS & REFERENCES

WASc – Web-based Associate of Science Program Development Project created the Remote Web-based Science Laboratory (RWSL) and is a collaboration of North Island College (NIC), College of the Rockies (COTR), Kwantlen Polytechnic University (KPU), Thompson Rivers University – Open Learning (TRU-OL), Tatlayoko Think Tank Ltd. (TTT) & Vancouver Island University. WASc has been funded through grants from the Inukshuk Wireless Fund and by BCcampus. http://rwsl.nic.bc.ca/

NANSLO – North American Network of Science Labs Online is a collaboration between Western Interstate Commission for Higher Education (WICHE), Colorado Community College System (CCCS) and BCcampus, funded by a grant from EDUCAUSE through the Next Generation Learning Challenges. http://www.wiche.edu/nanslo

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Go here for useful links and downloads
www.kwantlen.ca/science/physics/faculty/takashi_sato/ETUG2013.html

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