Teaching Labs Remotely with Real Lab Instruments

Friday, August 23, 2013
Remote Science is All Around Us

- **Hubble Telescope**
  - 1990 (23 years)

- **Little Hercules**
  - 2000 (13 years)

- **Curiosity Rover**
  - 2011 (2 Year)

Image credit: NASA and
This Confocal Microscope is Run by a Computer
What is the Difference Between 1m and 1000 km?
Remote Web-Based Science Lab (RWSL)—How it works

- Observation
- Manipulation
- Data

Internet (Students) ➔ RWSL ➔ Lab Equipment

- Video Observation
- Physical Manipulation/Instrument Control
- Communications
- Data Acquisition
Remote Web-Based Science Lab (RWSL)—How it works

- **Cameras/JAVA/HTML**
- **Internet (Students)**
- **VOIP software**
- **LabVIEW**
- **Observation**
- **Manipulation**
- **Data**
- **Lab Technicians**

**RWSL**

- **Video Observation**
- **Communications**
- **Data Acquisition**
- **Physical Manipulation/Instrument Control**
Why do we need the RWSL?

• Online Science Courses are increasingly popular in the U.S.*
  – Average of 3% growth per year from 2002 through 2011
  – Online Enrollments increased from 1.6 million to 6.7 million
  – Science students represented 32% of all online enrollments in 2011 (up from 10% in 2002)

*Source - I. Elaine Allen, PhD and Jeff Seaman, PhD, "Changing Course: Ten Years of Tracking Online Education in the United States", Babson Survey Research Group and Quahog Research Group, LLC., January, 2013

• No agreed-upon standard for teaching labs online
  – Many faculty think it isn’t possible to do so
  – Internet is littered with failed/failing attempts

• We owe it to our students to offer authentic online science experiences
Whom do we Currently Serve?

- Colorado Community College System
- Demographics
  - The average age of our students is 28.
  - 30 percent of our students are minorities.
    - CCCS serves 52 percent of all minority undergraduate students in higher education in Colorado.
  - 56 percent of our students are female.
  - 67% of our students are part time.

- Career and Economic Improvement
  - Students see an average increase in wages of 17% after completing a CCCS degrees/certificate program
    - Forty-eight percent of the degrees/certificates awarded by CCCS are in the health sciences.
      - Health Sciences students had a 97 percent increase in earnings.
Future Plans

• Expansion of the Denver and North Island College facilities
  – Improving procedures based on feedback
  – Standardization/Modularization of LabVIEW code
  – Additional equipment and lab procedures (2\textsuperscript{nd} semester)
  – Access through Citrix – allows multiple platform access
  – Improved Scheduler - connection protocol/API

• Additional Laboratory Facility
  – Great Falls College, MSU

• Networking Facilities Together
  – Transactional scheduling system

• Serving other School Systems in other States/Countries
Existing Experiments and Equipment

• Physics
  – Air Track
    • Motion Studies

• Chemistry
  – Spectrophotometer
    • Absorbance and Emission studies

• Biology
  – Microscope
    • Introduction to Microscopy (characterization)
    • Mitosis/Meiosis
New Equipment and Experiments

• Chemistry
  – Gas Chromatograph
    • Chemical Identification
  – Acid/Base Titration

• Biology
  – Lots of microscopy
  – pH and buffering solutions
  – Spectrometry flow cells
    • Enzymatic activity, membrane osmosis
Microscope Comparison

Home Lab Kit ~$125

NANSLO Lab ~$58,000
THE MICROSCOPE INTERFACE
Student View 1

RWSL Microscope Lab: Java Version
Student View 2
Student View 3
Student View 4
What does this do for our students?

- Gives them access to **real** state-of-the-art lab equipment
- Lets them engage in authentic instrumental experimentation.
- Allows them to collaborate with classmates
- Prepares them for a future of online science
Questions?

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