



# Development of an Electronic Chemistry Laboratory Workbook for Teaching Analytical Laboratory Skills

Christina S Gilpin  
Select-O-Sep, LLC

and

Joseph G Solch  
Roger K Gilpin  
Wright State University



The blue hyperlinks in this presentation are not active but demonstration software is available from the presenting author.

## Introduction

- The results of this current project were presented in a talk given just a few minutes ago but now, I'd like to present the
  - Why
  - What
  - How
- Take a few minutes to demonstrate a couple of the experiments we had the students complete to achieve the results



## WHY

- Teaching “science as a noun”
  - Memorize for test
  - Inadequate preparation
- Inquiry based teaching/learning
  - Active participation
  - Observe, record, analyze
  - Sometimes develop their own approaches
  - Work in teams



## Can't Deny

- Traditional laboratory experience is essential
  - Hands on experience
  - Working in groups
  - Observe, record, analyze
  - Develop own approach
- U S Schools are behind those of other countries
  - Dependence on foreign trained scientists
  - Multiple causes (teacher's training)
- Complexity of sciences
  - More difficult to design experiments
  - More costly



- Education Standards
  - All students must be included
- Encourage use of technology in math and Sciences
  - National Association of Science Teachers
  - Science for All Americans
  - U S Department of Education
- This is Why we chose to follow the course we did



## How

- Developed custom software/hardware
- Electronic Chemistry Laboratory Workbook (ECLW)
- Since idea first presented
  - Skeptics
  - Refining how/where it is used
  - Refining the software/hardware
  - Used by more than 3500 students (9 – 12 and Post Secondary)



## Overview of Results Presented Earlier

- Improvement in:
  - Skill level
  - Overall grades
  - Retention
- More confidence
  - In the traditional laboratory
  - Interaction with peers



## Sample Experiments Used

### – **Understanding and Using Simple Laboratory Equipment**

- ECLW\_A01 “Collecting and Recording Data”
- ECLW\_A02 “Precision and Accuracy of Mass Measurements”
- ECLW\_A04 “Using a Burette”
- ECLW\_A07 “Using and Reading Simple Volumetric Glassware”
- ECLW\_A08 “Practice Filling Volumetric Glassware”

### – **Data Analysis**

- ECLW\_B01 “Graphing Data and Developing Correlations”
- ECLW\_B02 “Using Spreadsheets to Graph and Understand Data”
- ECLW\_B03 “Sample Variability and Simple Statistics”
- ECLW\_B04 “Measurement Errors and Testing Data”
- ECLW\_B06 “Evaluating Data Between Different Laboratories”

### – **Conversions and Simple Physical Measurements**

- ECLW\_C01 “Length, Volume, and Mass Conversions”
- ECLW\_C02 “Temperature and Different Temperature Scales”
- ECLW\_C03 “Density of Metals and Alloys”
- ECLW\_C09 “Measuring the Conductance of Cations and Anions”



## Sample Experiments Used

### – **Elements, Compounds, and Mixtures**

- ECLW\_D01 “Isotopes and Atomic Mass of Elements”
- ECLW\_D04 “Characterization of Ionic and Covalent Compounds Using Conductance Measurements”
- ECLW\_D07 “Analyzing Inks by Thin-Layer Chromatography”
- ECLW\_D08 “Analyzing a Complex Mixture by Liquid Chromatography”

### – **The Mole, Concentration, and Simple Chemical Reactions**

- ECLW\_E01 “Measurements of Fluoride in Toothpaste Using an Ion Selective Electrode”
- ECLW\_E06 “Acid-Base Reactions: 1) Titration of a Strong Acid with a Strong Base”
- ECLW\_E07 “Acid-Base Reactions: 2) Titration of a Strong Base with a Strong Acid”
- ECLW\_E08 “Use of a pH Meter and pH Measurements”
- ECLW\_E09 “Effect of Continuous Dilution upon the pH of a Strong Acid”



## Each Experiment

- Written and On-screen instructions
- ‘Story’ that relates what is being done to real world situations
- Requires a formal written report
- Built in errors
- Each student receives their own unique set of data
- Each time an experiment is opened there are different variables



- Some experiments have options
  - Tactile on/off
  - Hardware Interface
  - Computer Keyboard operations
- Available
  - Web Site
  - Mini-Server
  - CD



## Practice Filling Volumetric Glassware

- Usually performed with Reading a Meticus
- Many students don't know or maybe don't remember
- Reinforces skills in reading and filling glassware accurately
- Uses either the interface control or computer keyboard
- Practice retrieving/downloading programs
- [Practice Filling Volumetric Glassware](#)



## Collecting and Recording Data

- “Reasons for this activity:
  - Follow Instructions
  - Accurately record all data
  - Difference between what is observed and what is assumed
- Computer controlled
- “Collecting and Recording Data”



## Density of Metals and Alloys

- Interface
- Computer
- Basics of weight (i.e. tarring, calibrating, recording)
- Density by water displacement
- Density of Metals and Alloys



# Cation

- Uses both Interface and Computer Keyboard
- Measuring the Conductance of Cations and Anions



## Titration Strong Acid/Base

- Uses all three options
- Practice and Test Mode
- Titration Strong Acid/Base



## Summary

- Is this the 'perfect' solution – No
- It is an attempt:
  - to better prepare students
  - increasing students skills
  - fight the ever rising costs
  - integrate technology into a science laboratory in a meaningful way
- Does it work?
  - For the classes where this has been used over the last several years
  - For the high school classes that have been participating
- Our results show it has and continues to do so.



## In closing

- Thank students and teachers who have been participating in this project
- Thank Institute Education Sciences\* for their funding support

- \*This funding in no way should be construed as an endorsement of this method of teaching nor any product that may be developed.





Questions may be addressed to:

[crgilpin@selectosep.com](mailto:crgilpin@selectosep.com)

Please place Pittcon2010 in the subject line

