Using InterChemNet for lab curriculum development and evaluation

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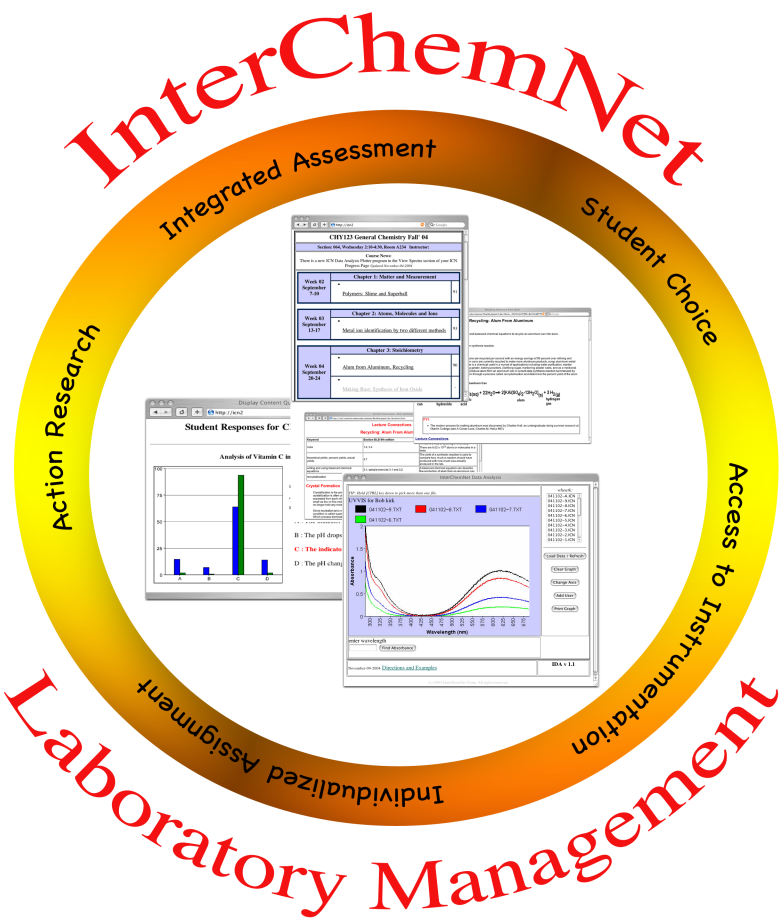


www.interchemnet.com

Abstract

InterChemNet (ICN) is a web-based laboratory management and curriculum delivery system that incorporates spectroscopic instrumentation, student choice, and assessment of student learning. Data from studies evaluating spectroscopy curriculum modules in terms of assessment of student learning are presented. We discuss the use of ICN as a tool for action research in the laboratory setting, focusing on two modalities that can be facilitated with this technology: parallel curriculum improvement cycles and multi-campus assessment.

InterChemNet is…

… **individualized assignment**, offering multiple student pathways through the curriculum.

…**student choice**, allowing student choices of mastery and discovery-based laboratory exercises.

…**access to instrumentation,** incorporating full spectrum UV-vis and FTIR spectrometers into General Chemistry curriculum.

…**integrated assesment**, an interactive online course management system designed specifically for the laboratory.

…**action research**, with integrated pre- and post- testing and automated output of statistical data.

*Stewart, Barbara; Kirk, Robert; LaBrecque, David; Amar, François G.; Bruce, Mitchell R. M. *J. Chem. Educ.* **2006** *83* 494.

InterChemNet Discussion Points 1:

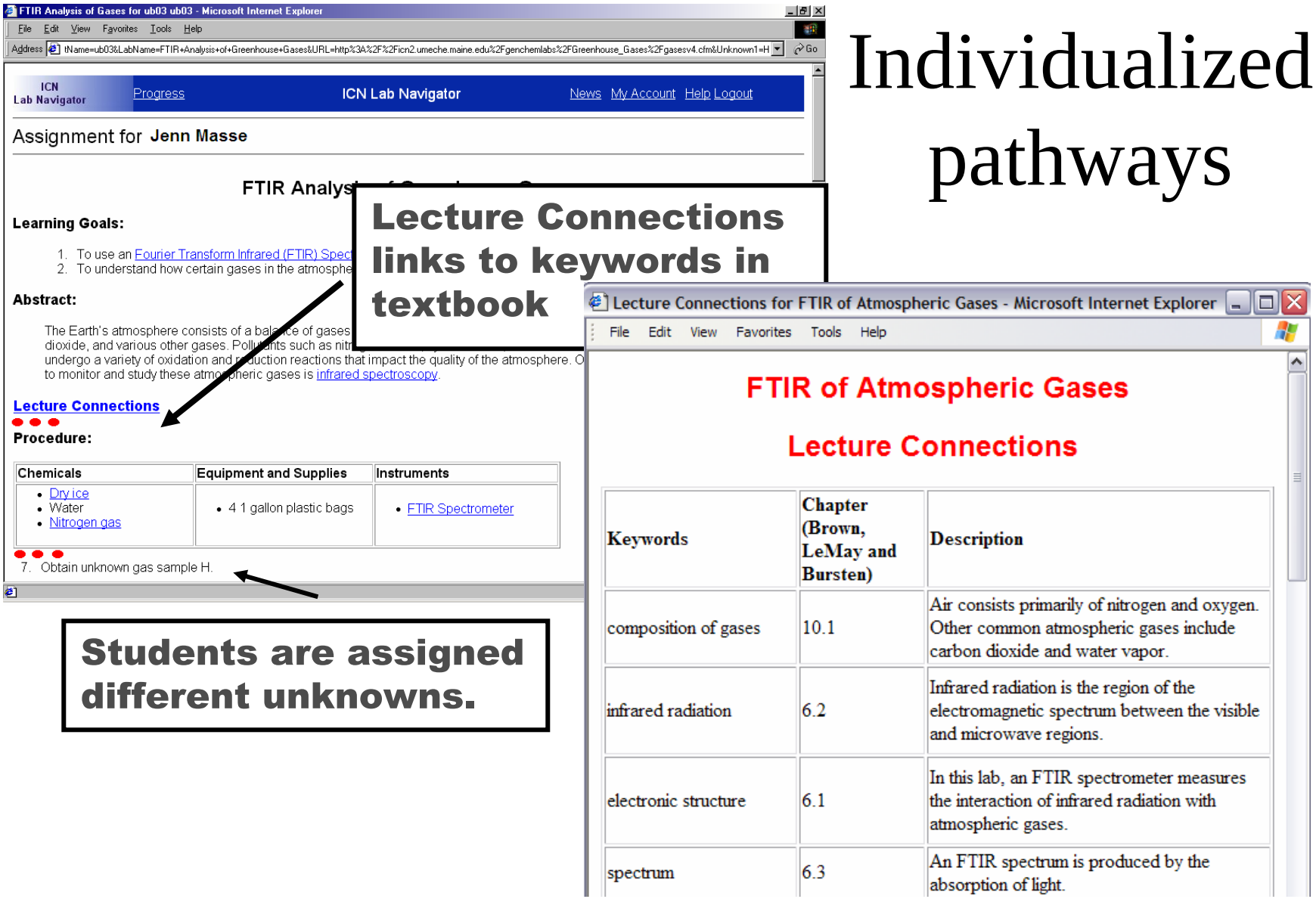
Observations:

We find that in our large lab program, students often do not make good connections automatically between the "lecture" part of the course which stresses "theory", "problem solving set-up", and "categorizing data" (e.g. a combustion reaction) vs. the "laboratory" where hands-on experience gives students a sense of "process", "techniques", and "interpretation". ICN was developed to learn how to make better connections between lecture and lab.

Discussion Point:

Where do you think would be the most important place for us to start this investigation? What have been some of your solutions to help students "make the connection" ?

Individualized pathways



InterChemNet Discussion Points 2:

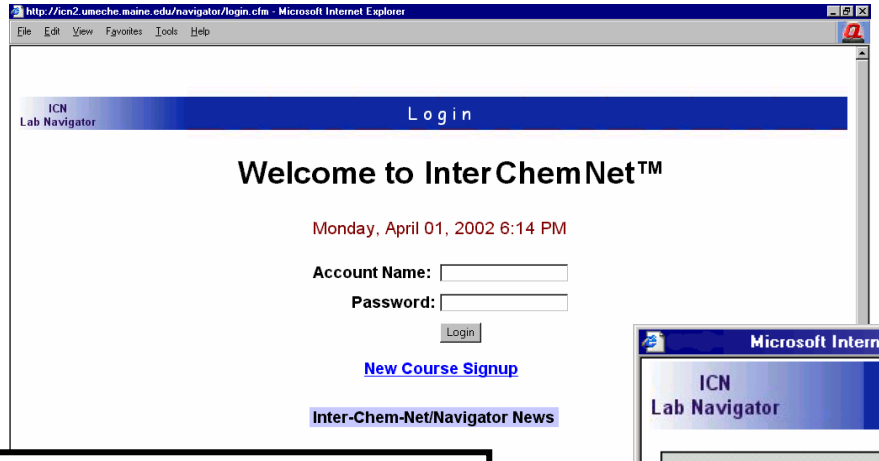
Observations:

When all of our students in gen chem lab perform the same set of cookbook procedures, there appears to be very little student interest or involvement in the underlying chemical concepts. ICN offers students choices of experiments that each cover the same chemical concept.

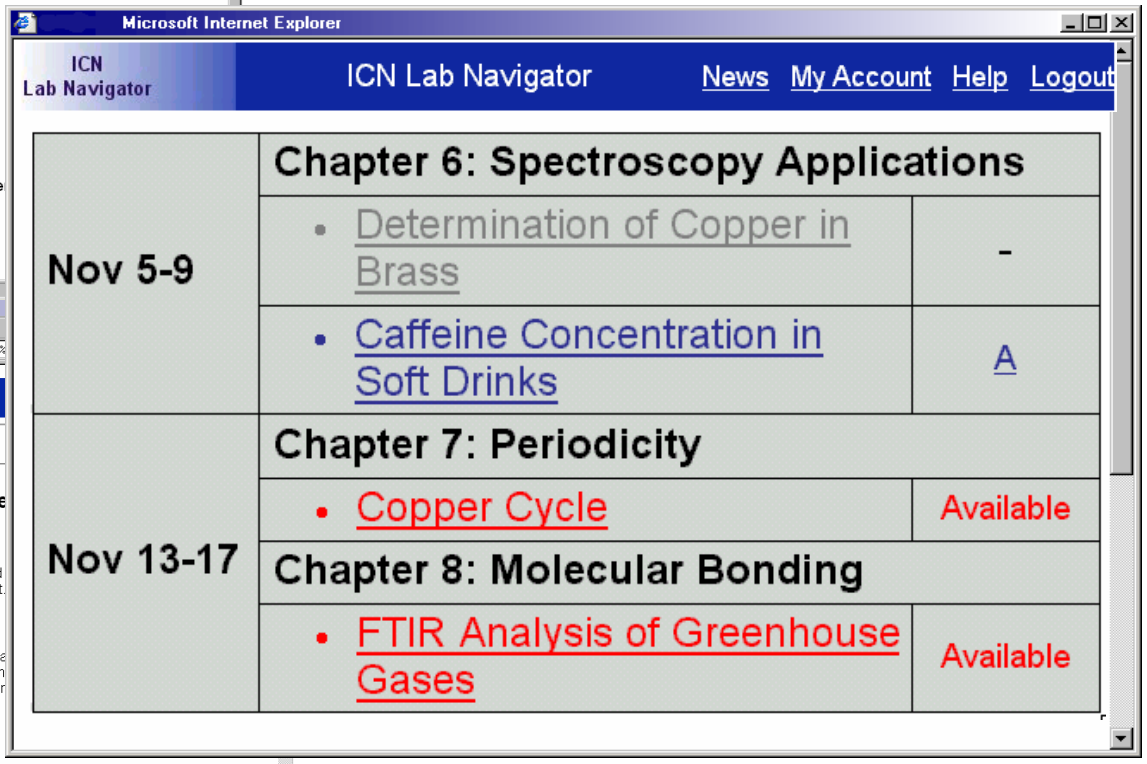
Discussion Points:

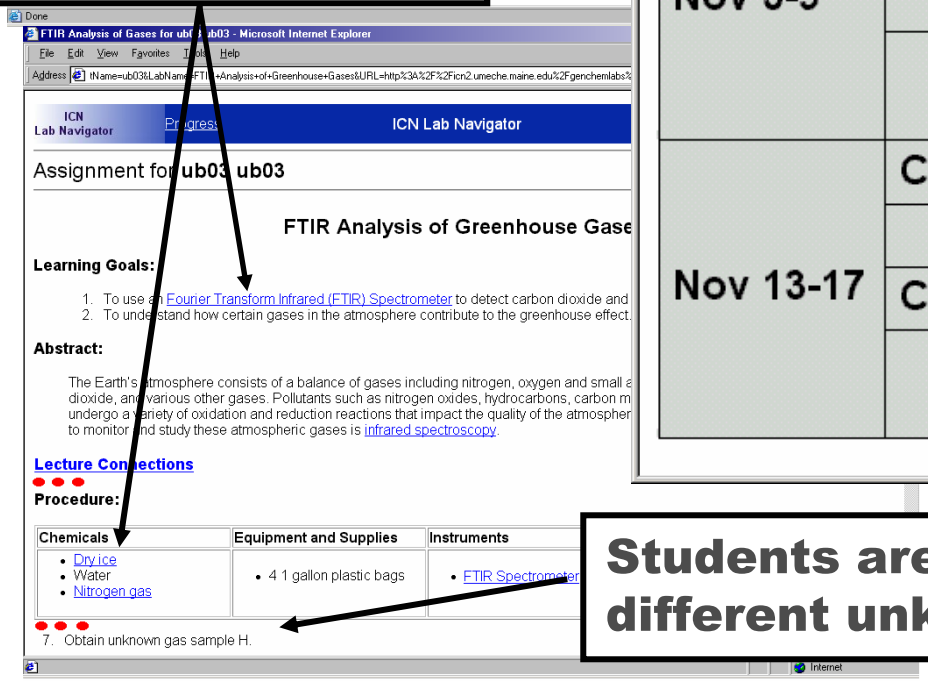
Do you think choice would help your students?

Choice in the laborotory



Links to video clips and MSDS





Students are assigned different unknowns.

InterChemNet Discussion Points 3:

Observations:

We would like to do a better job preparing our students for authentic research experiences. ICN introduces instrumentation (UV-vis and FTIR spectrometers) to provide some of these research tools for students that are necessary to conduct authentic research.

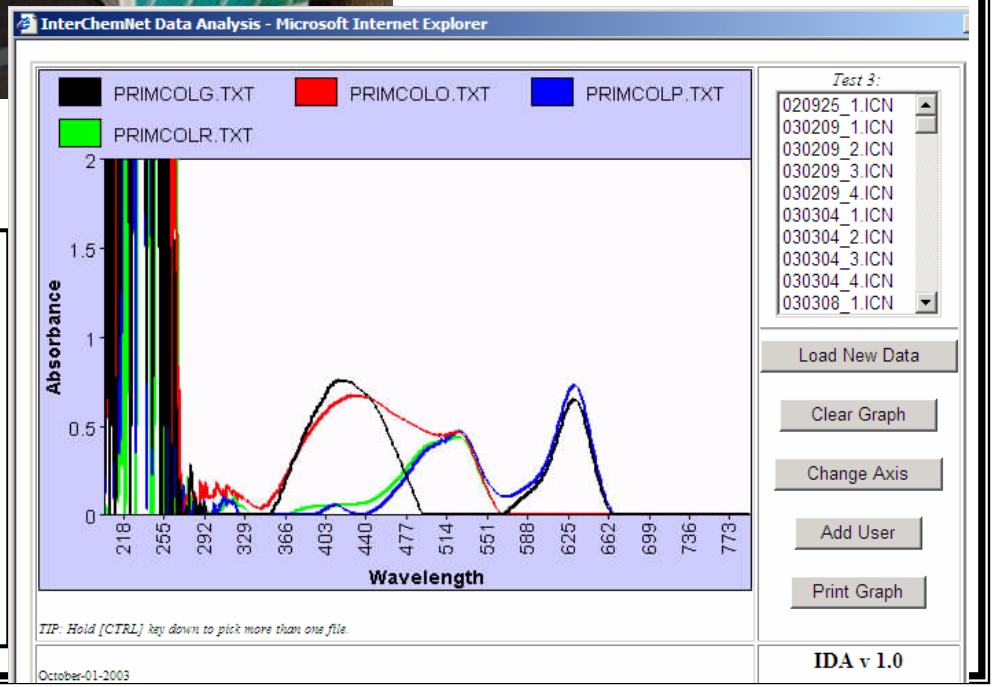
Discussion Points:

What is the best way to turn good lab techniques and access to instrumentation into an understanding of what authentic research is all about?

Students collect and analyze UV-visible and FT-IR data

Students master traditional techniques such as titration, separation, and filtration

Student-friendly interface allows collaboration



Instrumentation with on-line analysis tools

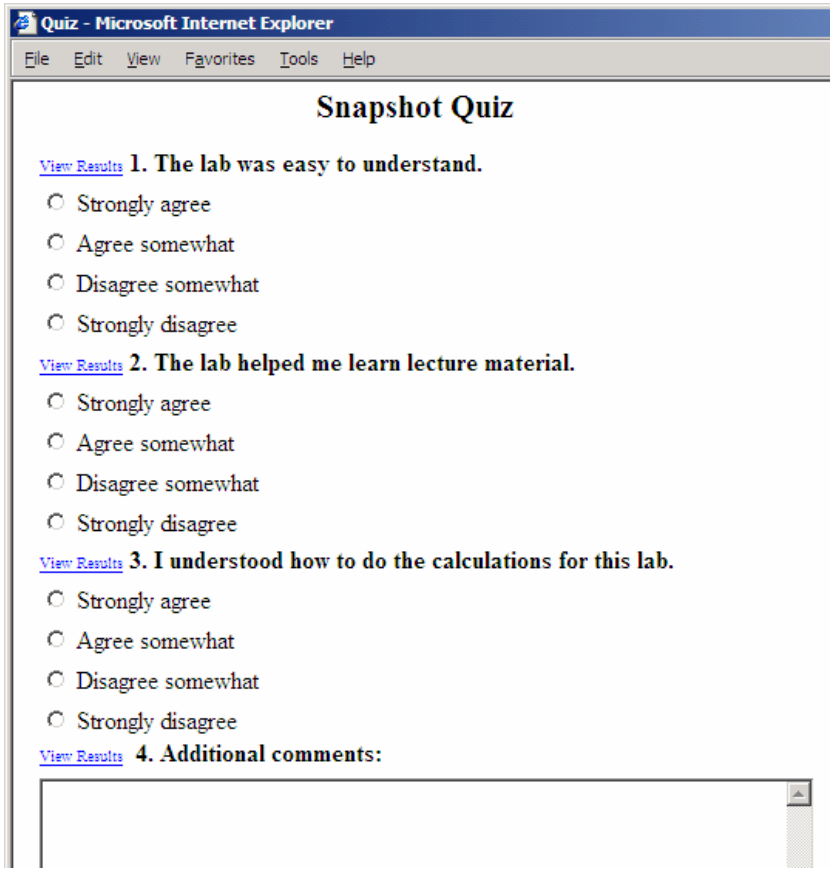
InterChemNet Discussion Points 4:

Observations:

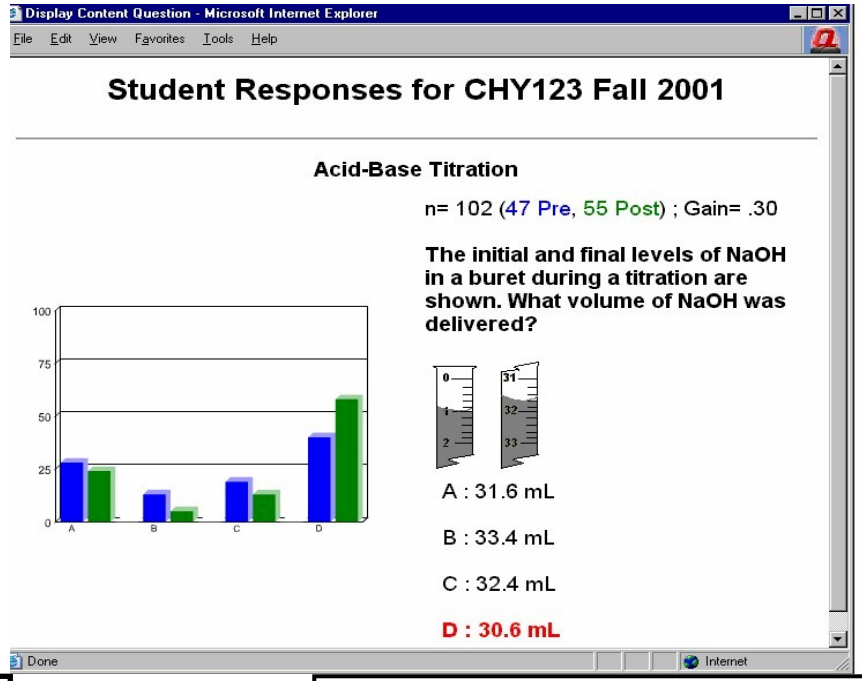
We found that there are many barriers to performing assessment of our lab curriculum. ICN lowers this barrier by integrating assessment into the delivery of the curriculum… but it doesn't eliminate it!

Discussion Points:

What are the barriers to assessing your lab curriculum?



Automated tracking of student responses



Instructors can monitor student attitudes and learning

Integrated assessment

InterChemNet Discussion Points 5:

Observations:

It's great to get assessment data… but once you get it, what do you do with it? Action research starts when you have the data, and you have to figure out how to use it to point your curriculum in a new direction.

Discussion Points:

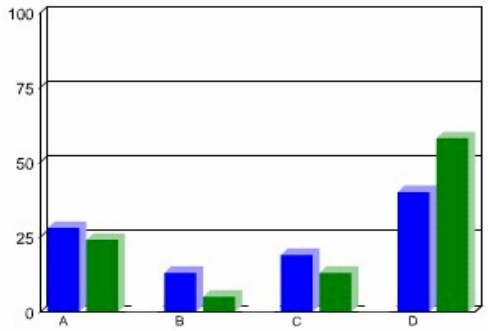
Do you believe this type of curriculum development will strengthen the general chemistry course (lab and lecture)?

Sort Results - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Lab Title	Question	Pre	Post	Gain
Acid Base Titration	The initial and final levels of NaOH in a buret during a titration are shown. What volume of NaOH was delivered	0.40	0.58	0.30
	The endpoint of a titration is reached when:	0.72	0.87	0.54
Copper Cycle	Which of the following is a redox reaction?	0.33	0.42	0.13

Action Research



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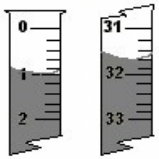
Acid-Base Titration

n= 102 (47 Pre, 55 Post) ; Gain= .30

The initial and final levels of NaOH in a buret during a titration are shown. What volume of NaOH was delivered?



A : 31.6 mL

B : 33.4 mL

C : 32.4 mL

D : 30.6 mL

Done Internet

Action Research is a fancy way of saying let's study what's happening at our school and decide how to make it a better place--

Emily Calhoun (1994)

[http://www.coe.fau.edu/sfcel/define.htm]

InterChemNet is a tool for action research that

- integrates pre- and post- assessment of student learning and attitudes.
- allows a variety of question types: multiple choice, open response, numerical…
- supports questions with embedded graphics
- automates analysis with built in data display.
- stores raw data for further analysis.

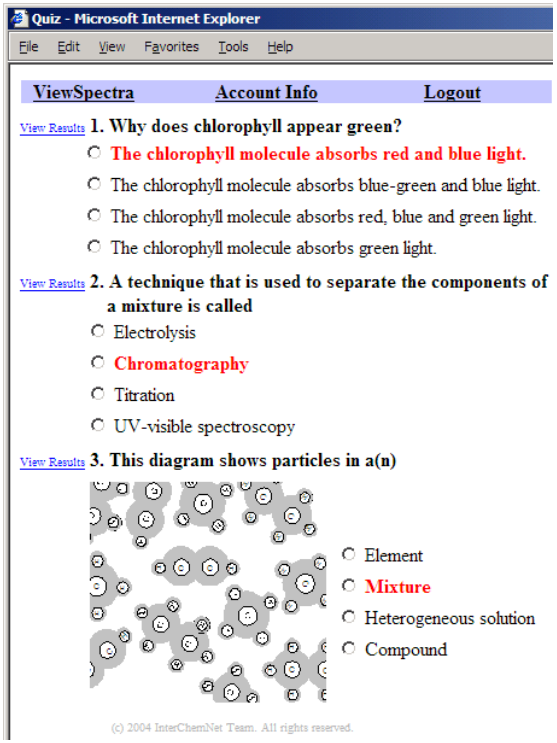
An example: Chromatography of Plant Pigments

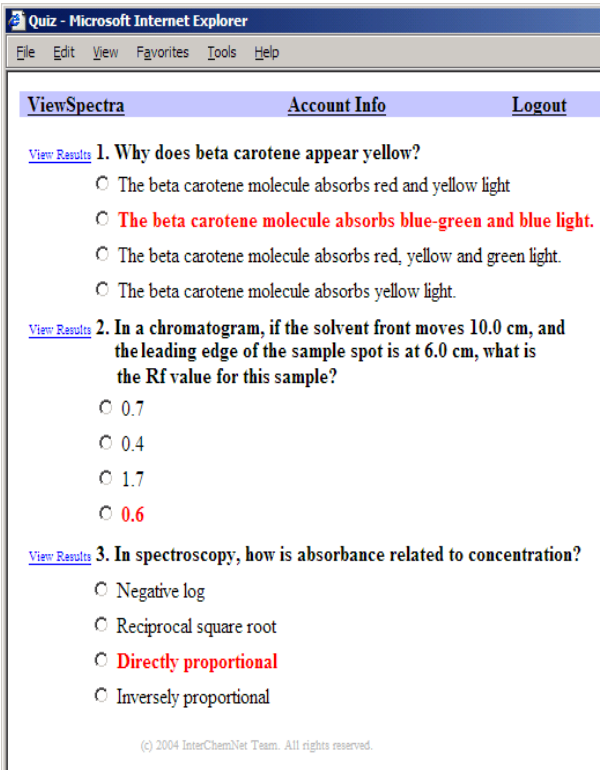
• This laboratory was offered at two different universities using the same pre- and post- assessment protocol with six questions. Each student was asked 3 questions randomized from the pool before and after the lab.

•Note mix of skills or techniques questions and conceptual questions.

• Gain index is

$$\text{gain} = \frac{\%CorrectPost - \%Correct\,\text{Pr}\,e}{100 - \%Correct\,\text{Pr}\,e}$$





Results of institutional comparison

Chlorophyll in Plant Pigments	Gain-Group A	Gain-Group B
In a chromatogram, …what is the Rf value for this sample?	0.59	0.32
A technique that is used to separate the components of a mixture is called	0.14	0.14
In spectroscopy, how is absorbance related to concentration?	0.09	0.15
Why does chlorophyll appear green?	-0.16	-0.05
Why does beta carotene appear yellow?	0.55	0.17
This diagram shows particles in a…	-0.37	0.17

Stewart, Barbara N., Ph.D. Thesis, University of Maine, 2004

Results are largely comparable across institutions with students performing better on “skills” questions than “concept” questions.

Questions to Explore

- How can technology help students working in the laboratory increase understanding of concepts traditionally associated with “lecture”?
- Can multiple concepts be explored simultaneously?
- How could a variety of approaches be tried and assessed in parallel if large numbers of students were involved?
- What factors must be accounted for in such a study?

We present the results of a very preliminary attempt to answer these questions below.

Parallel Curriculum: Percentage of Cu in Brass

Four treatments of this lab delivered via InterChemNet to 226 students in Fall, 2004 and 55 students in Spring, 2005:

a. Control: lab unchanged from previous year.

b. Enhanced visuals: extended sequence of still photos documenting procedures linked to lab handout delivered on Web via ICN. [Not used in Spring 2005]

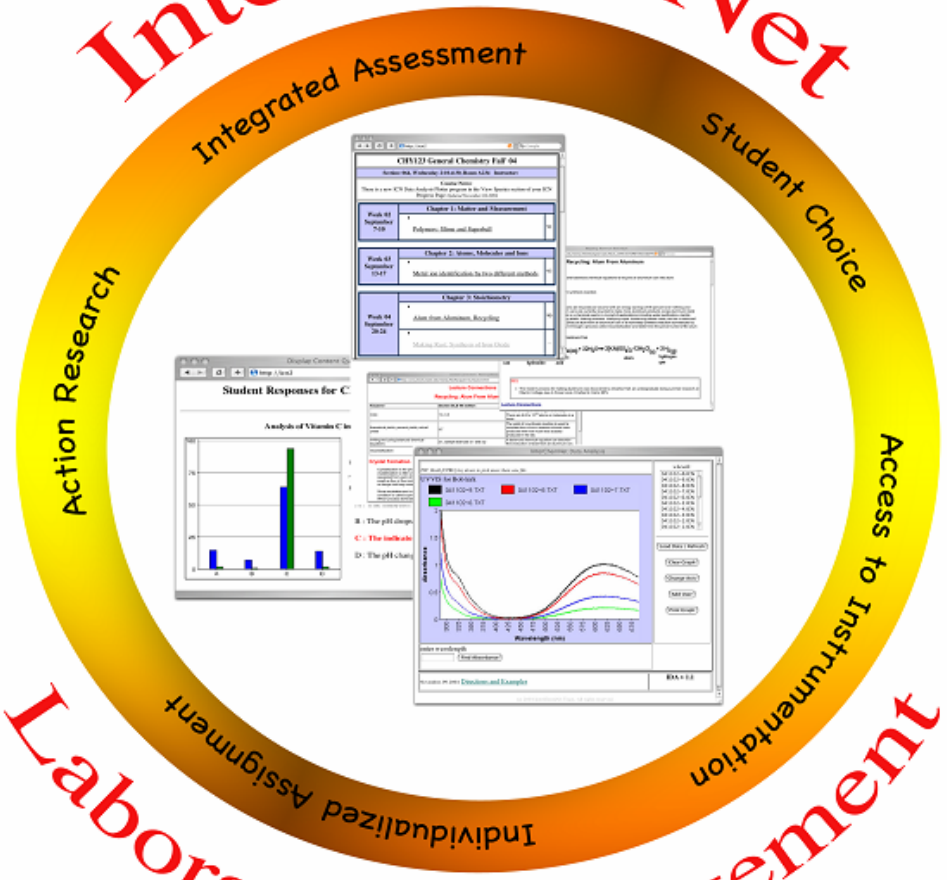
c. Information: students given additional explanation (via handout) of material that would specifically be assessed.

d. Intervention: students complete a guided inquiry worksheet covering material to be assessed.

Conclusions and Further Work

- InterChemNet makes data gathering easy especially for technology based interventions.
- Conceptual change/development remains harder than technique acquisition.
- Further development of strategies to ensure student compliance in use of computer-based materials.
- Further development of research protocols for parallel interventions (both intra- and inter-institutional)
- Fall, 2005: revise interventions and assessment materials, extending over several weeks of work.

InterChemNet



Laboratory Management

www.interchemnet.com

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