February 15, 2013:
Online Learning Resources in Chemistry and Statistics

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University of Michigan, Ann Arbor

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www.crlt.umich.edu/slam
Online Learning Resources in Chemistry and Statistics

Brenda Gunderson, Nancy Kerner, and Ginger Shultz
University of Michigan - Ann Arbor
MELO
Michigan Education Through Learning Objects

General Chemistry, Psychology, Statistics, Physics, Physical Chemistry, Math, Writing, Spanish, Organic Chemistry, History
Project Goal

To improve education by integrating quality cross-discipline and course-specific Learning Objects (LOs) into undergraduate courses.

Learning Resources
Any web-based teaching tool (tutorial, collection, ....)

Learning Objects (LOs)
Interactive web resources that lead students to learning goals via informed pedagogy
Initial Perceived Barriers to using technology in teaching or learning

Don’t know how to implement
Extra work, little connection
Takes too much time
I spend too much time on it
Students don’t know how to use it
Don’t have tech support
Too complicated
Too expensive
I don’t have the skills
Doesn’t work on my computer

carat.umich.edu/carat/itsurs/2005_survey
The Proposed Solution
Train (Graduate) Students

- Educate (graduate) students across disciplines to access, evaluate, design LOs; and to create quality course-specific and cross-discipline LO collections.
- (Graduate) students disseminate LOs to relevant faculty for integration into undergraduate courses.

The trainee becomes the trainer

See “Bottom Up Faculty Development” at conference.merlot.org/2009/Sat_Program.html
The Proposed Solution
Determine Faculty Needs/Preferences

- What are the difficult concepts?
- Syllabus topics?
- Type of LO preferences?
The Proposed Solution
Unique Collaborative Approach

Project Faculty Mentors
- Coordinators/instructors of large gateway courses.
- Guidance on best practices to enhance teaching/learning

Other Faculty
- Provide schedule of topics and concepts
- Provide insight on muddy points and desirable LOs

Graduate Student Instructors
- Interest in tech + pedagogy
- Train to find, evaluate, package, author online LOs

Staff
- Provide basic grant support
- Some technology support
The Funded Project!

- Enhancing Undergraduate Education Through the Deployment of Quality Learning Objects (2008-2010)
- Infusing Curricula with Adaptable Learning Objects to Improve Student Engagement and Learning (2011-2013)

MELOs

Funding

NINI Grant (New Initiatives/New Infrastructure) from UM LSA-ITC (Instructional Tech Committee)
Proposed Solution Changes

Project Faculty Mentors
- Coordinators/instructors of large gateway courses.
- Guidance on best practices to enhance teaching/learning

Other Faculty
- Provide schedule of topics and concepts
- Provide insight on muddy points and desirable LOs

Graduate Student Instructors
- Interest in tech + pedagogy
- Train to find, evaluate, package, author online LOs

Add Staff
- Provide basic grant support
- Some technology support
- OER support
- Assessment/Analytics
Initial Outcomes

• LO course collection
  – Selection based on course needs and goals
  – Located in MERLOT as Personal Collection
  – Provided within syllabus or on website

• LOs tagged for course integration
  – Choice based on needs vs type of LO
  – Choice focused on LOs that address difficult concepts or skills
Perceived Barriers Alter to using technology in teaching or learning

*Potentially* useful online learning objects exist, *but need some adaptation* to be a useful match for course
Stats 250

- Introduction to Statistics and Data Analysis
- Prereq = HS Algebra
- 3 hrs lecture + 1.5 hr computer lab (4 credits)
- # enrolled W13 ~ 1750 students
- Fr = 15%
  Soph = 50%
  Jr = 25%
  Sr = 10%
Example Barrier
Imperfect LO!
Simulating Confidence Intervals

Solution: Create a **video wrapper** demonstrating features of a learning object (with Jing)

http://www.rossmanchance.com/applets/ConfSim/ConfSim.html
Instead of:

LO
Students will see:

- Objectives
- Directions
- Assessment

LO
The Fully Wrapped LO: PreLab 3

Lesson03:

In this lesson, you will generate confidence intervals for estimating a population proportion. You will be able to set the value of the (usually unknown) population proportion, the sample size, and the confidence level. You also are able to decide how many samples will be generated and a confidence interval based on each sample will be computed and displayed. The applet graphs the intervals and those which did contain the true proportion are shown in green, while the intervals that did not contain the true proportion are in red. The true proportion is shown by a blue line on the graph. Trying different settings will allow you to make comparisons and draw some important conclusions about how confidence intervals work.

Objectives

Lesson:

Watch the following video about how to use the confidence interval simulator.

Video Wrapped LO

Simulation Link:

The simulation may be found here.

Assignment:

Check Ctools for due date and submission details.

For each of the questions below, use the applet to help you address the question. Submit your 1-2 sentence summary for each question directly inline to your GSI Ctools site Assignment for prelab3 (or as instructed on your class Ctools site).

1. Set the confidence level to 99% and the sample size to 100.
   (a) What is the long run proportion of confidence intervals that contain the population proportion?
   (b) Does this long run proportion depend on the sample size $n$? (Try some other sample sizes keeping the confidence level at 99%)

2. What happens to the length of the confidence intervals as the confidence level increases? Compare some intervals at the 90%, the 95%, and the 99% confidence levels (keeping the population proportion and the sample size $n$ the same).

3. What happens to the length of the confidence intervals as the sample size increases? Compare some intervals made using samples sizes of $n = 30$, $n = 50$, and $n = 100$ (keeping the population proportion and the confidence level the same).

http://sitemaker.umich.edu/stats250.prelab/lesson_3
Stats 250 PreLab Summary

- **GSIs loved them!**
  Students came more prepared for upcoming discussion topic.

- **GSI comment:** "My students came to lab with questions. They were curious as to why they observed the results they did in the prelab, and wanted to ask questions and better understand. Making them think before lab about discussion topics was very beneficial for class interaction."

  **Key:** Students coming to labs Better Prepared!

- **Students liked them!** Able to cover PreLabs at own pace, came to labs prepared to discuss and learn.

- **Student comment:** "They are pretty useful, but the applet based ones are the most useful."
Survey Results

Results of PreLab Survey Questions

~ 50% Agree/Strongly Agree Applet Prelabs (video wrapped LO) prepare them for lab discussions

<table>
<thead>
<tr>
<th>PreLab Survey Question</th>
<th>% reporting Agree or Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPSS PreLabs prepare me to work on lab modules</td>
<td></td>
</tr>
<tr>
<td>SPSS PreLabs provide enough detail to complete assignments</td>
<td>90%</td>
</tr>
<tr>
<td>I like the opportunity to learn SPSS at own pace</td>
<td>80%</td>
</tr>
<tr>
<td>Applet PreLabs prepare me for concepts discussed in lab</td>
<td>50%</td>
</tr>
</tbody>
</table>
More video-wrapped LOs available for students
Link through Ctools --> can track usage

Welcome to the Stats 250 review page!

Use the links at the top of the page to navigate to applets and videos that will help you review some important additional review materials are available on Ctools.
Perceived Barriers Alter to using technology in teaching or learning

Quality online learning objects that address key course concepts do NOT exist!
Example Barrier

LO did not Exist!

Students *struggle* with recognizing what statistical procedure should be used to address a given research question.

**Name That Statistics Scenario**

Name that Scenario Handout

Bobby and Barney are the owners of a bakery. They are considering packaging their "mini" chocolate chip cookies in individual bags for vending machine sales. Before they embark on this endeavor, they have many plans to formulate and decisions to make. Bobby is in charge of production and Barney is in charge of marketing. They need your help. For each issue below, select the most appropriate statistical analysis technique for addressing that issue.

1. Is the average number of chocolate chips in our cookies higher than the average number of chocolate chips in our competitor's cookies?
   - A. 1-sample t-test for a population mean
   - B. Paired t-test
   - C. 2-sample t-test for the comparison of two population means
   - D. 1-sample Z-test for a population proportion

2. We have two different package sealing options. Is the percentage of defective seals under the first option different from the percentage of defective seals under the second option?
   - A. 1-sample t-test for a population mean
   - B. Paired t-test
   - C. 2-sample t-test for the comparison of two population means
   - D. 1-sample Z-test for a population proportion

3. We have two scales to choose from. We weighed the same 10 bags of cookies on each scale. Do the two scales produce different weights on average?

Did not find a Learning Object that did this well!
Name That Scenario

Authored LO (Statistics)

Name That Scenario

This site gives you a chance to practice recognizing the appropriate situations in which to apply various statistical procedures. You will be presented with a series of ten real world statistics scenarios. Your task is to select the most appropriate statistical procedure for each scenario.

DIRECTIONS

1. Select at least two of the following procedures.

2. Choose "First Scenario" to begin.

---

One Proportion
Two Proportions
One Mean
Paired
Independent T-test
ANOVA
Regression
Chi-sq Goodness of Fit
Chi-sq Homogeneity
Chi-sq Independence

First Scenario
Clear selection

http://sitemaker.umich.edu/name.that.scenario/nts
New Yorkers and Bostonians disagree about baseball and clam chowder, but what about pizza? 150 randomly selected New Yorkers and 120 random selected Bostonians are asked to identify their favorite toppings on pizza from: plain, meat, veggie, or Hawaiian. We wish to determine if the preferences are the same.
New Yorkers and Bostonians disagree about baseball and clam chowder, but what about pizza? 150 randomly selected New Yorkers and 120 randomly selected Bostonians are asked to identify their favorite toppings on pizza from: plain, meat, veggie, or Hawaiian. We wish to determine if the preferences are the same.

Regression is NOT the correct answer...

There are two populations, New Yorkers and Bostonians (disregarding overlap from former New Yorkers in Boston and vice-versa, something hopefully taken care of in proper random sampling), and one categorical variable, favorite toppings. Each population will have a distribution of preference, and we can compare them with a Chi-Squared Test of Homogeneity.

http://sitemaker.umich.edu/name.that.scenario/nts
4. On a scale of 1 to 5, 1 being definitely disagree and 5 being definitely agree, how strongly do you agree with each of the statements below?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Strongly Agree (5)</th>
<th>Rating Average</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name that Scenario was easy to use.</td>
<td>0.0% (0)</td>
<td>2.7% (1)</td>
<td>0.0% (0)</td>
<td>40.5% (15)</td>
<td>56.8% (21)</td>
<td>4.51</td>
<td>37</td>
</tr>
<tr>
<td>Name that Scenario helped me to learn.</td>
<td>0.0% (0)</td>
<td>5.4% (2)</td>
<td>16.2% (6)</td>
<td>40.5% (15)</td>
<td>37.8% (14)</td>
<td>4.11</td>
<td>37</td>
</tr>
<tr>
<td>Name that Scenario is a fun way to learn.</td>
<td>0.0% (0)</td>
<td>8.1% (3)</td>
<td>18.9% (7)</td>
<td>43.2% (16)</td>
<td>29.7% (11)</td>
<td>3.95</td>
<td>37</td>
</tr>
<tr>
<td>The questions in Name that Scenario were high quality.</td>
<td>0.0% (0)</td>
<td>5.4% (2)</td>
<td>16.2% (6)</td>
<td>45.9% (17)</td>
<td>32.4% (12)</td>
<td>4.05</td>
<td>37</td>
</tr>
<tr>
<td>The questions in Name that Scenario were too easy.</td>
<td>2.7% (1)</td>
<td>54.1% (20)</td>
<td>32.4% (12)</td>
<td>2.7% (1)</td>
<td>8.1% (3)</td>
<td>2.59</td>
<td>37</td>
</tr>
<tr>
<td>The questions in Name that Scenario were too difficult.</td>
<td>2.8% (1)</td>
<td>50.0% (18)</td>
<td>30.6% (11)</td>
<td>11.1% (4)</td>
<td>5.6% (2)</td>
<td>2.67</td>
<td>36</td>
</tr>
</tbody>
</table>

Answered question: 37
Skipped question: 1
### Student Survey

#### Question 5
How confident would you say you were in identifying the correct procedure to use for a given scenario at each of the following times?

<table>
<thead>
<tr>
<th></th>
<th>Not at all Confident</th>
<th>Somewhat not Confident</th>
<th>Somewhat Confident</th>
<th>Very Confident</th>
<th>Rating Average</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before using Name That Scenario</td>
<td>10.8% (4)</td>
<td>40.5% (15)</td>
<td>43.2% (16)</td>
<td>5.4% (2)</td>
<td>2.43</td>
<td>37</td>
</tr>
<tr>
<td>After using Name That Scenario</td>
<td>5.6% (2)</td>
<td>2.8% (1)</td>
<td>58.3% (21)</td>
<td>33.3% (12)</td>
<td>3.19</td>
<td>36</td>
</tr>
</tbody>
</table>

Answered question: 37
Skipped question: 1

### Question 6
Do you plan to use Name that Scenario again to help study for Stats 250?

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>Probably not</td>
<td>5.4%</td>
<td>2</td>
</tr>
<tr>
<td>Maybe</td>
<td>16.2%</td>
<td>6</td>
</tr>
<tr>
<td>Probably</td>
<td>18.9%</td>
<td>7</td>
</tr>
<tr>
<td>Yes</td>
<td>59.5%</td>
<td>22</td>
</tr>
</tbody>
</table>

Answered question: 37
Skipped question: 1

---

**Gained Confidence in skill**

**Plan to use again**
Assessing Impact: Pre to Post Quiz Scores (NTS user vs non-user)

Lab 1: NTS Pre Quiz (8 points)
Demo of NTS Learning Object

NTS LO available over next week
(via Ctools tracked usage)
Opt-IN
~ 70% of students used it

Lab 2: NTS Post Quiz (8 points)
Assessing Impact: Pre to Post Quiz Scores (NTS user vs non-user)

Change in Quiz Scores, Fall 2012

Used NTS: 70%, mean improvement 1.30 pts
Did not use NTS: 30%, mean improvement 0.65 pts
(p-value < 0.001)
Assessing Impact: Exam 2 Total and Specific NTS Question

Mean Score on Exam 2 (out of 75 points)  
Fall 2012

<table>
<thead>
<tr>
<th>Did Not Use NTS</th>
<th>Did Use NTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.24</td>
<td>59.71</td>
</tr>
</tbody>
</table>

Mean Score on NTS Question (out of 6 points)  
Fall 2012 Exam 2

<table>
<thead>
<tr>
<th>Did Not Use NTS</th>
<th>Did Use NTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.59</td>
<td>4.96</td>
</tr>
</tbody>
</table>
Assessing Impact: NTS LO Usage

- Between pre & post test in labs
- Exam 2 Nov 15 PM
- Final Exam Dec 13 PM

Number of Clicks to NTS LO
Chemistry 125/126

• A large (~ 2000 students per academic year) introductory chemistry course with:
  
  o Laboratory (2 or 3 hours)
  o Discussion (0 or 1 hour)
  
  o Pre-lab lecture (1 hour)

GOAL – To provide the necessary background knowledge and skills needed for lab and discussion components
The large (450 seat) lecture and lecture hall is NOT conducive to **personalized** active learning.
Students are heterogeneous with respect to learning styles

Kleinman, Griffin, and Kerner; J. Chem. Educ., 1987, 64 (9)
The higher the students’ academic level the higher the course grade!

Enrolled chem.125/126 students are primarily freshman!
Transforming Lecture

How?

How can I support student’s with insufficient background knowledge and skills?

How can I support enrichment for the well prepared and knowledgeable student?
Transforming Lecture

Stepping Stones to Pedagogical Innovation

- Video capture of demonstrations (Summers 08-09)
Video Capture Benefits:
• Enlarged video demos in sync with live demos
• Split screen comparisons of test variables
• Address needs of vision impaired students
• Demo slow reactions using time lapsed media

Transforming Lecture

Stepping Stones to Pedagogical Innovation

- Podcasts
  1. Video demos are folded into lecture slide presentations ...
  2. Lecture Podcasts become available. (Recorded using Blue Review).

IMPALA Informal Mobile Podcasting and Learning Adaptation-
http://www.impala.ac.uk;
http://www.podcastingforlearning.com
Transforming Lecture
Podcasts Yield Positive Shift in Grades

- Summer 2010 students could view podcasts before (and after) the “live” lecture
- Identical term exams given summer 2009 and 2010
- Student composition similar to prior summer term

<table>
<thead>
<tr>
<th>Summer 2009 Exam Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Total%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer 2010 Exam Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Total%</td>
</tr>
</tbody>
</table>
Average Grade Pre and Post 2010 Summer Interventions
Chem125 Podcast Survey*

What are the **major strengths** to using podcasts? (What about the podcasts helped you learn?)*

- You can always **rewind when you miss something or don’t fully understand**. That’s a great advantage.
- I could go over certain parts that I did not completely understand over and over again and **pause the lecture if I am falling behind**.
- It allows us to go back and review material at any point or **prepare for the lecture better**.

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- CRLT Summer 2010 Survey
- 53% of class viewed podcasts multiple times
Transforming Lecture
Stepping Stones to Pedagogical Innovation

Chem 125 Learning Object Hunt!

SUBMIT COMPLETED FORMS TO: chem125hunt@gmail.com

Hello everyone!

This is a site dedicated to Learning Objects relating to the Chemistry 125/126 course at the University of Michigan, specifically online learning objects. An Online Learning Object is a digital resource that can be used to improve the teaching and support of learning of a given subject matter. There is a link to the MERLOT website where there is an ever increasing collection of links to Learning Objects dealing with material from nearly every subject. Currently, we are looking to involve the winter 2010 class in a learning object scavenger hunt, where students can search the Internet to find QUALITY learning objects. Once a learning object is submitted, it will be posted on this website, and will no longer be able to be submitted. There are also current learning objects on this site which can help aid with the content of the course.

To submit a website, please review the "Learning Object Hunt Information" and then fill out the "Learning Object Submission Form" found to your left, and submit it to chem125hunt@gmail.com. Everyone that submits a website can earn up to 3 additional GSI points, and be in the running to receive 10 additional points for the best site (as chosen by you!). You will have until the April 9th to submit a website. Keep in mind that it can deal with any of the...
<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Learning</td>
</tr>
<tr>
<td>Resources</td>
</tr>
<tr>
<td>Cross-discipline LOs.pdf</td>
</tr>
<tr>
<td>OnlinePeriodicTableResources.pdf</td>
</tr>
<tr>
<td>Experiment1LOs.pdf</td>
</tr>
<tr>
<td>Experiment2LOs.pdf</td>
</tr>
<tr>
<td>Experiment3LOs.pdf</td>
</tr>
<tr>
<td>Experiment4LOs.pdf</td>
</tr>
<tr>
<td>Experiment5LOs.pdf</td>
</tr>
</tbody>
</table>
Transforming Lecture

Multimedia Online Materials

- Interactive website with personalized learning path
- Interactive exercises
- Videos
- Podcast bits intro concepts…
- LOs

http://www.umich.edu/~chem125/softchalk/exp1_final/
Preparing a solution of known concentration

What is a mole?

The first thing you will need to understand when making a solution is the concept of a mole. A mole is a number $6.02 \times 10^{23}$ to be exact. All chemistry calculations are calculated in moles. The concept of a mole is just like the concept of a dozen. There are 12 objects in a dozen, just like there are $6.02 \times 10^{23}$ objects in a mole. When working with different elements, they all have different atomic weights.

The atomic weight is how many grams of that element will make up one mole (or $6.02 \times 10^{23}$ atoms) When this is applied to a ionic or molecular compound, the molecular or formula weight of the compound is determined by combining the atomic weight of all the atoms in the compound. The atomic weights for each atom can be found on any periodic table.
Which aspects of this interactive online presentation were most helpful to your learning as you prepared for lab. Why?

- The **interactive visuals** because they **allowed me to see the concepts in action and understand** what was explained.

- I definitely liked **seeing the process done in demos. I am a visual learner** and trying to understand the procedure from reading the lab manual is not helpful.

- **Liked how you could go at your own pace.**

**Questions**

a) Valuable addition to lecture  
b) Helped me to feel more prepared for the lab experiment  
c) Helped me to successfully complete the lab experiment  
d) Enhanced my understanding by introducing me to needed terminology  
e) Enhanced my understanding by introducing me to needed skills  
f) Were a valuable addition to lecture  
g) Could replace the classroom lecture  
h) Were easy to navigate
Chemistry 216: Synthesis and Characterization of Organic Compounds (or Second Term Organic Chemistry Lab)

850 students
50 sections
30 GSIs
1 instructor
2 credits

1 hour lecture

4 hour lab session
Most Challenging CHEM 216 Content: Spectroscopy

- Notoriously difficult to teach and learn
- Major point loss on CH 216 exams is attributed to spectroscopy questions

Spectrum obtained from SDBS website: http://riodb01.ibase.aist.go.jp/sdb/cgi-bin/direct_frame_top.cgi
Most Challenging CHEM 216 Content: Spectroscopy

Students learn to use spectral data to predict the structure of small molecules.

Spectrum obtained from SDBS website: http://riodb01.ibase.aist.go.jp/sdbs/cgi-bin/direct_frame_top.cgi
Most Challenging CHEM 216 Content: Spectroscopy

NMR (Nuclear Magnetic Resonance) Spectrum

Acetaminophen (Tylenol)

Students synthesize information to predict structure

One answer – multiple solutions!

Spectrum obtained from SDBS website: http://riodb01.ibase.aist.go.jp/sdbs/cgi-bin/direct_frame_top.cgi
Online resources exist for Spectroscopy, but must be adapted for Chemistry 216.

- All offer practice beyond what is offered in an typical organic chemistry textbook.
- Most Organic Chemistry focused Spectroscopy LOs provide an answer, but not a solution.
How do we elucidate the problem solving process using technology?

1. Screencasts Tutorial – *How does an expert solve this?*

2. “Documented Problem Solution” writing – *How do I solve this?*

3. Online Discussion Board – *How do my peers solve this?*
How does an expert solve this?

http://screencast.com/t/DGjsrbM9
Chose one of the compounds below and explain what you would expect its H-NMR and C-NMR would look like. How many unique signals? What is the splitting in the H-NMR? Where would you expect the peaks to be in the spectrum? If someone has already commented on one structure, chose another. If they are all taken, look at the other analyses your peers have provided and determine whether you agree or disagree.

A
\[
\begin{array}{c}
\text{OC}_2\text{H}_5 \\
\end{array}
\]

B
\[
\begin{array}{c}
t-\text{Bu} & t-\text{Bu} \\
\end{array}
\]

C
\[
\begin{array}{c}
\end{array}
\]

D
\[
\begin{array}{c}
\end{array}
\]

E
\[
\begin{array}{c}
\end{array}
\]

How do my peers solve this?

https://voicethread.com/?#u1910045.b2924514.i15443680
**Small Scale Implementation: Fall 2011**

<table>
<thead>
<tr>
<th>Fall enrollment:</th>
<th>Treatment group:</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 lab sections, 359 students</td>
<td>3 lab sections, 47 students,</td>
</tr>
<tr>
<td>12.5 GSIs</td>
<td>3 GSIs</td>
</tr>
</tbody>
</table>

- **The treatment group** was given weekly homework and some of which included documented problem solving and is accompanied by screencast tutorials. Each student participates in an asynchronous problem solving session on Voicethread.

- **The remaining students** are also given regular homework composed of the same or similar spectroscopy problems.
1. Draw the structure of a molecule with the formula $\text{C}_5\text{H}_{12}\text{O}_2$ that corresponds to the following NMR spectrum.

![NMR Spectrum]

**Integral = 6**

2. Explain, in your own words, how you arrived at your answer. Write as if you were explaining how to solve the problem to a classmate. Feel free to draw on or label the spectrum above.
“I guessed...”

“Limited Explanation
30% Treatment
48 % Control

“I know this isn’t the right answer...”

“There are only two peaks so I knew there were only two distinct groups of H’s”

“Thorough Explanations
52% Treatment
24% Control

“Since there are two sets of 6 equivalent H’s I know there must be symmetry....”
Student Comments

“I thought the VoiceThread and learning objects were incredibly useful, and helped prepare me for the exam. The feedback from them were also helpful, and helped me know what to study. The only way they could be improved would be to maybe have immediate feedback.”

“It forced me to practice IR and NMR when I would have otherwise neglected to do so, which was helpful. VoiceThread should be required to be video because it forces you to explain it out loud, which takes more understanding than simply writing it.”

“It was useful to see what other students had written in the discussion..”
Large Scale Implementation Winter 2012

Course enrollment:
52 lab sections, 796 Students, 27 GSIs

Treatment group:
19 lab sections, 269 students, 19 GSIs

- The spectroscopy assessment and exam scores are not statistically significant when the performance of the treatment group was compared to remaining students. However, the performance did vary significantly between individual lab sections.

- CTools usage data was used in combination with exam data to probe learning gains.
Correlation of Exam Performance to Learning Object Use

- LO usage positively impacted exam performance
- Exam included other content in addition to spectroscopy
Evaluation of individual spectroscopy questions indicated the effect of Learning Object usage was most significant on difficult questions.
12 Faculty & 5 Staff
34 Graduate Instructors
Thousands of Students
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