



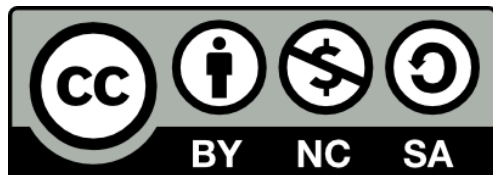
STUDENT LEARNING AND ANALYTICS AT MICHIGAN

---

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

Brenda Gunderson (Statistics), Nancy Kerner and Ginger Shultz (Chemistry)  
University of Michigan, Ann Arbor

---



THIS WORK IS LICENSED UNDER A  
CREATIVE COMMONS ATTRIBUTION-NONCOMMERCIAL-SHAREALIKE 3.0  
UNITED STATES LICENSE.

Copyright © 2013, the Regents of the University of Michigan



STUDENT LEARNING AND ANALYTICS AT MICHIGAN

---

[www.crlt.umich.edu/slam](http://www.crlt.umich.edu/slam)



STUDENT LEARNING AND ANALYTICS AT MICHIGAN

# 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, ....)

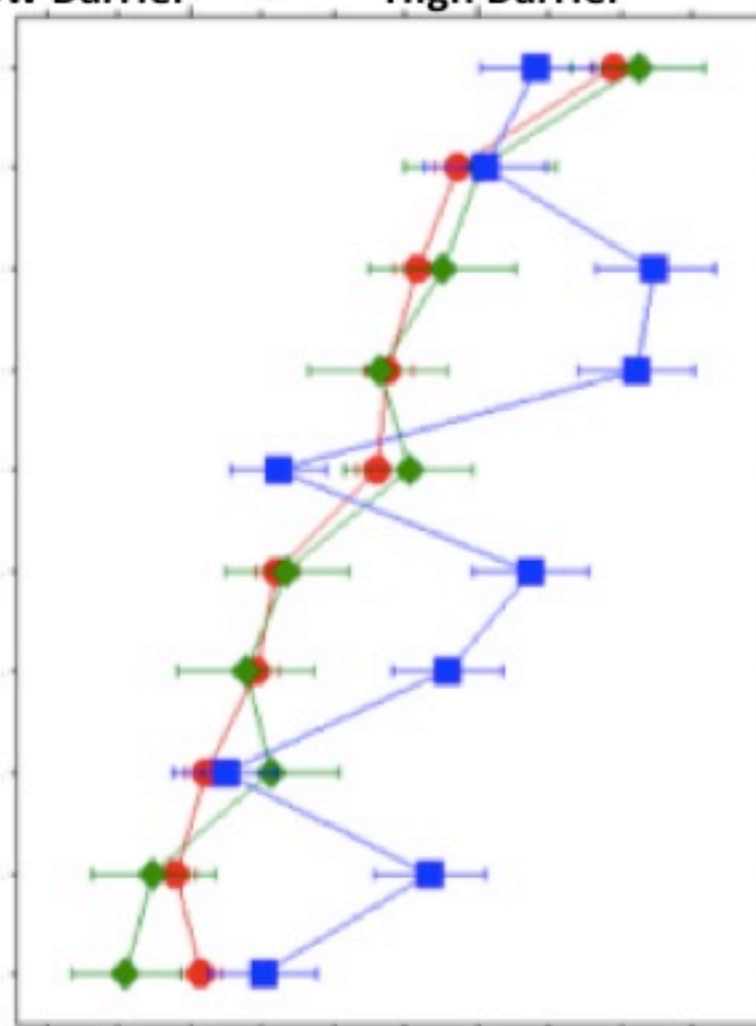
## **Learning Objects (LOs)**

Interactive web resources that lead students to learning goals via informed pedagogy

# Initial Perceived Barriers to using technology in teaching or learning

Low Barrier ← High Barrier

- 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



■ Faculty    ● Students    ◆ Students who teach

# 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

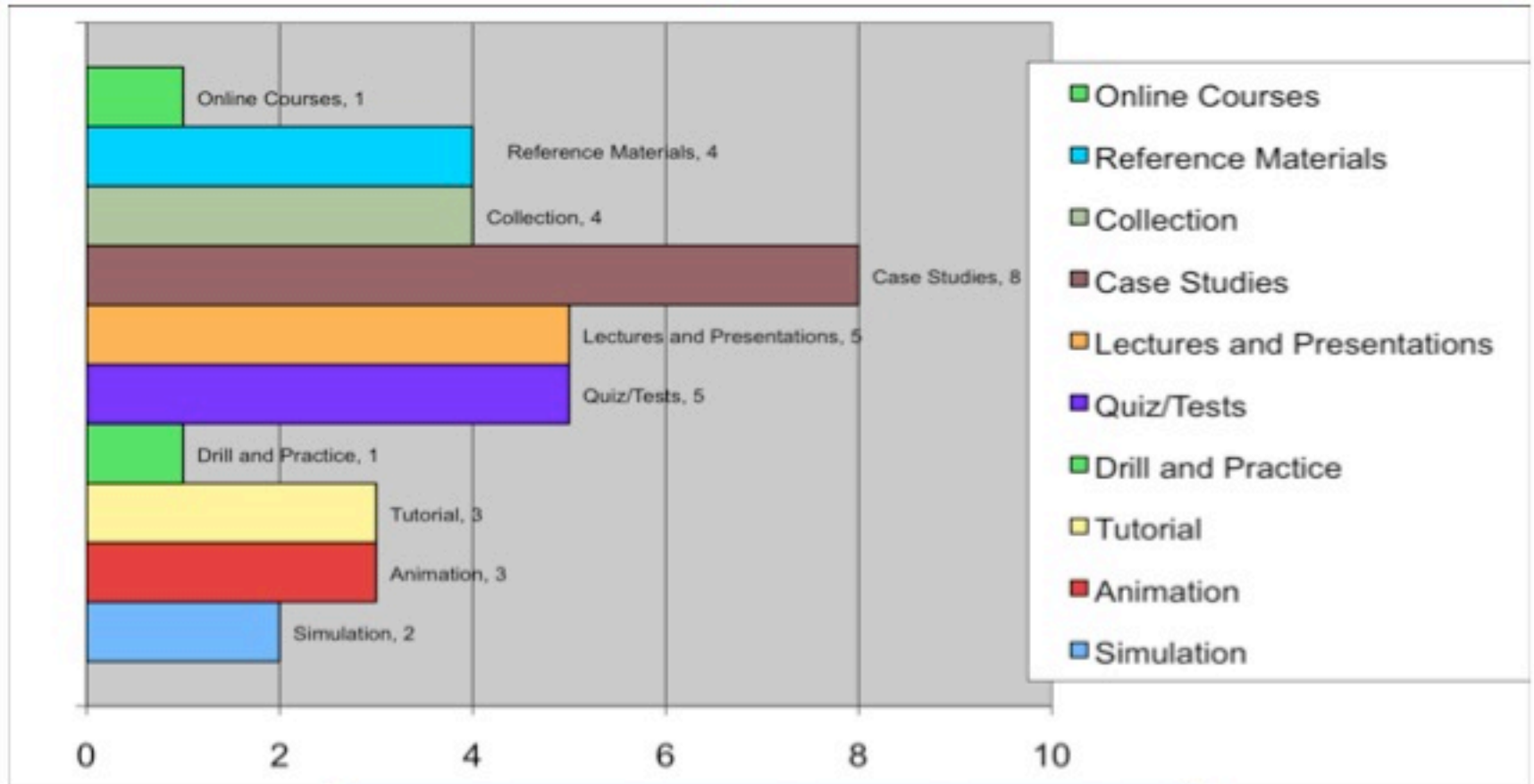


**The trainee becomes the trainer**

See “Bottom Up Faculty Development” at  
[conference.merlot.org/2009/Sat\\_Program.html](http://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



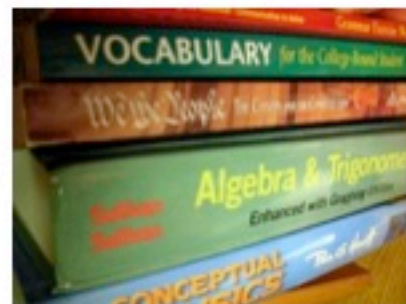
## Add Staff

- 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

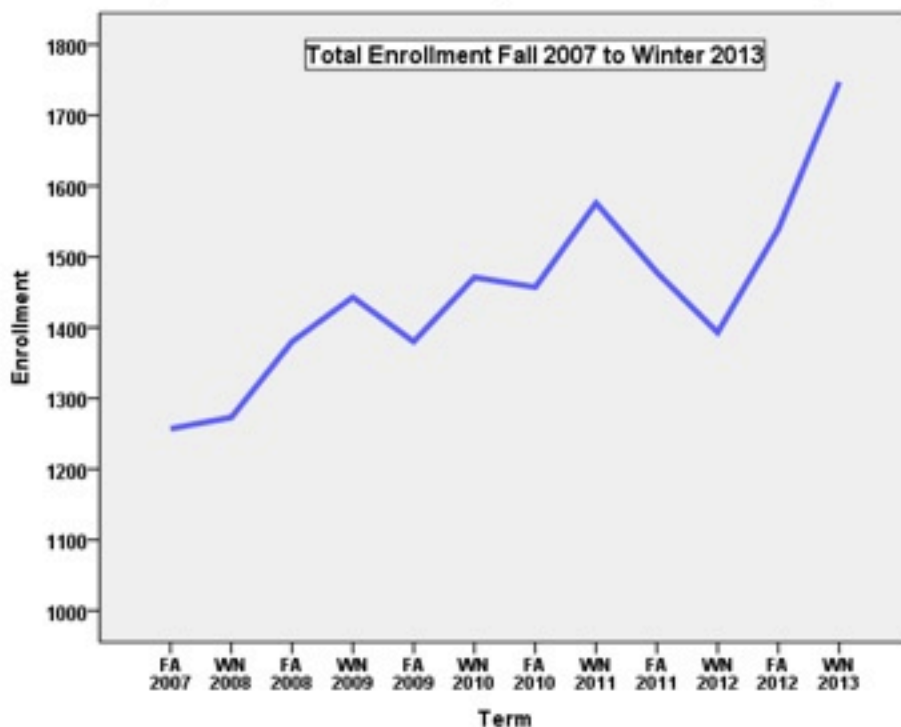
to using technology in teaching or learning



*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

method:

Proportions

Wald

$\theta$ : 0.5

n: 100

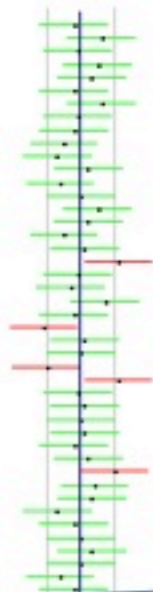
Intervals: 50

Sample

conf level: 95 %

Recalculate

Intervals containing  $\theta$   
45/50=90.0%



- What will this help me understand?
- How do I use it?
- What is the Wald method?
- What is  $\theta$ ?

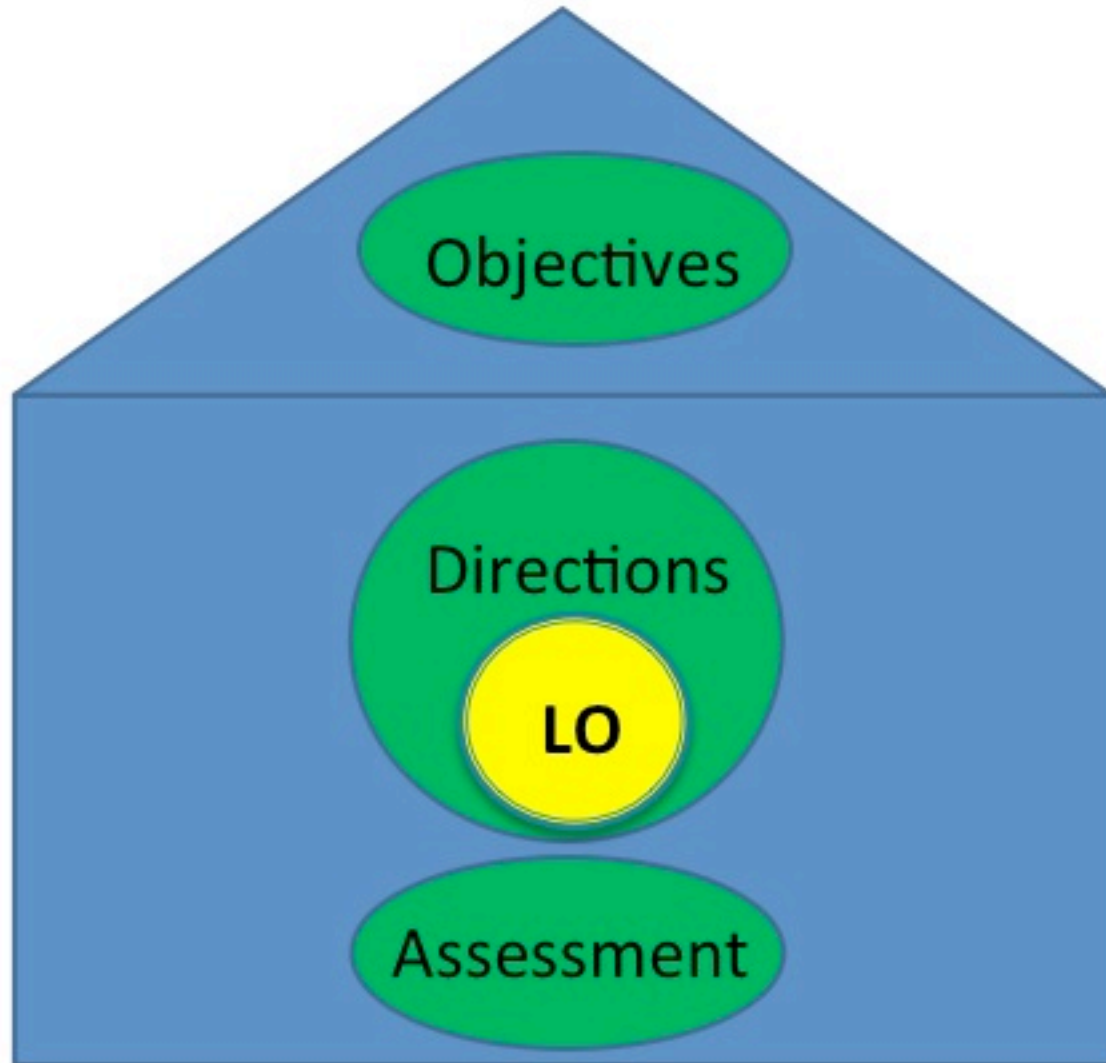
**Solution:** Create a video wrapper demonstrating features of a learning object (with Jing)

**Instead of:**





# Students will see:



# 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](#).

### Short Assignment

## 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%, 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).

# Stats 250 PreLab Summary

- **GSI** loved them!

Students came more prepared for upcoming discussion topic.

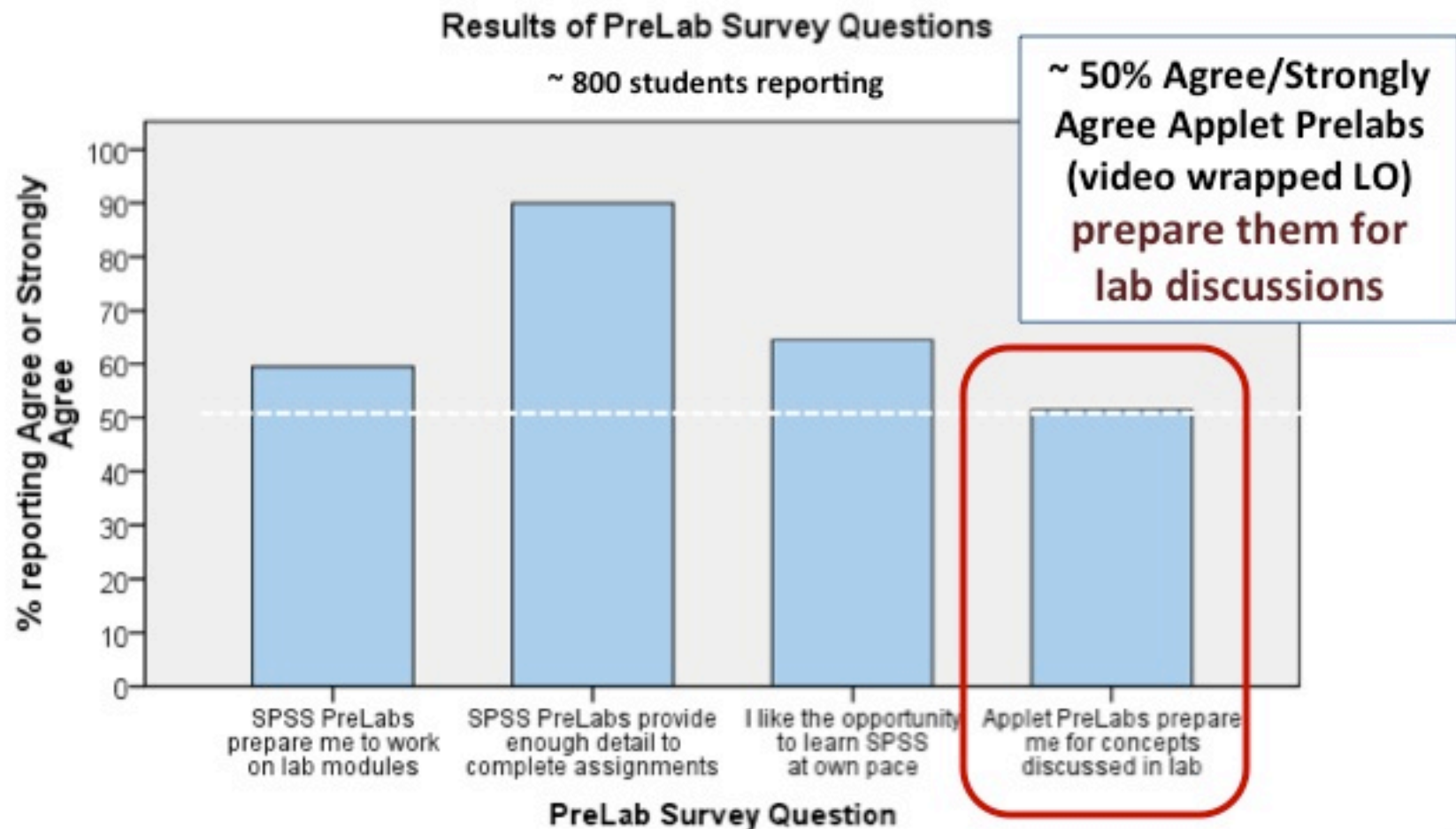
- **GSI comment:** *“My students came to lab with questions. They were curious as to why they observed the results they did in the prelab, and wanted to ask questions and better understand. Making them think before lab about discussion topics was **very beneficial for class interaction**.”*

**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.**”*

# Stats 250 PreLab Summary

## Survey Results



# More Stats 250 Video-Wrapped LOs

Course Site

workspace ▾ STATS 250 W13 ▾ Stat 250 GSIs ▾ Stat 250 Instructors ▾ Stats 250 Materials ▾ **STATS 250 F12** ▾ More Sites ▾

Home 🏠

**STATS 250 F12: Extra Review**

Options

UNIVERSITY OF MICHIGAN

**Stats 250 Review**

Home Binomial Confidence Interval/Level Normal Probabilities Video Solutions F12 Exam 1 Video

Home

**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.

Home 🏠

Schedule 📅

Announcements 📢

Resources 📁

Test Center 📝

Gradebook 📖

**Extra Review** 🌐

Name That Scenario 🎮

Site Info 📄

BlueReview 📄

More video-wrapped LOs available for students  
Link through Ctools --> can track usage

# 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                      |
| _____ 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? | B. Paired t-test  |
| _____ 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?                                     | C. 2-sample t-test for the comparison of two population means |
|   | D. 1-sample Z-test for a population proportion                |

on the correct track. After a correct choice, the relevant section of the formula sheet appears so the user can link the scenario with the correct calculations.

#### Statistics at UM

Scenario: As part of a biology project, some high school students compare heart rates before and after running a mile for 40 of their classmates. They want to see if the after heart rate of students in their age group is better than the before heart rate, on average.

- CI for a mean
- CI for a mean
- CI for the difference between two means (dependent)
- CI for the difference between two means (independent)
- CI for a paired difference
- CI for a paired difference

[View Scenario](#)

[Back To Home](#)

Did not find  
a Learning Object  
that did this well!

Scenario: As part of a biology project, some high school students compare heart rates before and after running a mile for 40 of their classmates. They want to see if the after heart rate of students in their age group is better than the before heart rate, on average.

- CI for a mean
- CI for a mean
- CI for the difference between two means (dependent)
- CI for the difference between two means (independent)
- CI for a paired difference
- CI for a paired difference

You are correct. Here is the relevant section of your yellow card.

Formula

$$\frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \sim t_{df}$$

[View Scenario](#)

[Back To Home](#)

# 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



# Name That Scenario

## Authored LO (Statistics)

### Name That Scenario

#### Question 2

score: 1

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.

RETURN TO START

NEXT QUESTION

One Proportion

ANOVA

Two Proportions

Regression

One Mean

Chi-sq Goodness of Fit

Paired

Chi-sq Homogeneity

Independent T-test

Chi-sq Independence

# Name That Scenario

## Authored LO (Statistics)

### Name That Scenario

#### Question 2

score: 1

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.

RETURN TO START

NEXT QUESTION

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.

# Student Survey

Spring  
2011

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?

[Create Chart](#) [Download](#)

Easy  
to Use

Helpful

Fun

High  
Quality

Just  
Right

Level

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

# Student Survey

Spring  
2011

Gained  
Confidence  
in skill

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?

[Create Chart](#) [Download](#)

	Not at all Confident	Somewhat not Confident	Somewhat Confident	Very Confident	Rating Average	Response Count
Before using Name That Scenario	10.8% (4)	40.5% (15)	43.2% (16)	5.4% (2)	2.43	37
After using Name That Scenario	5.6% (2)	2.8% (1)	58.3% (21)	33.3% (12)	3.19	36
answered question						37
skipped question						1

Plan to  
use again

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

[Create Chart](#) [Download](#)

	Response Percent	Response Count
No	0.0%	0
Probably not	5.4%	2
Maybe	16.2%	6
Probably	18.9%	7
Yes	59.5%	22
answered question		37
skipped question		1

# 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**

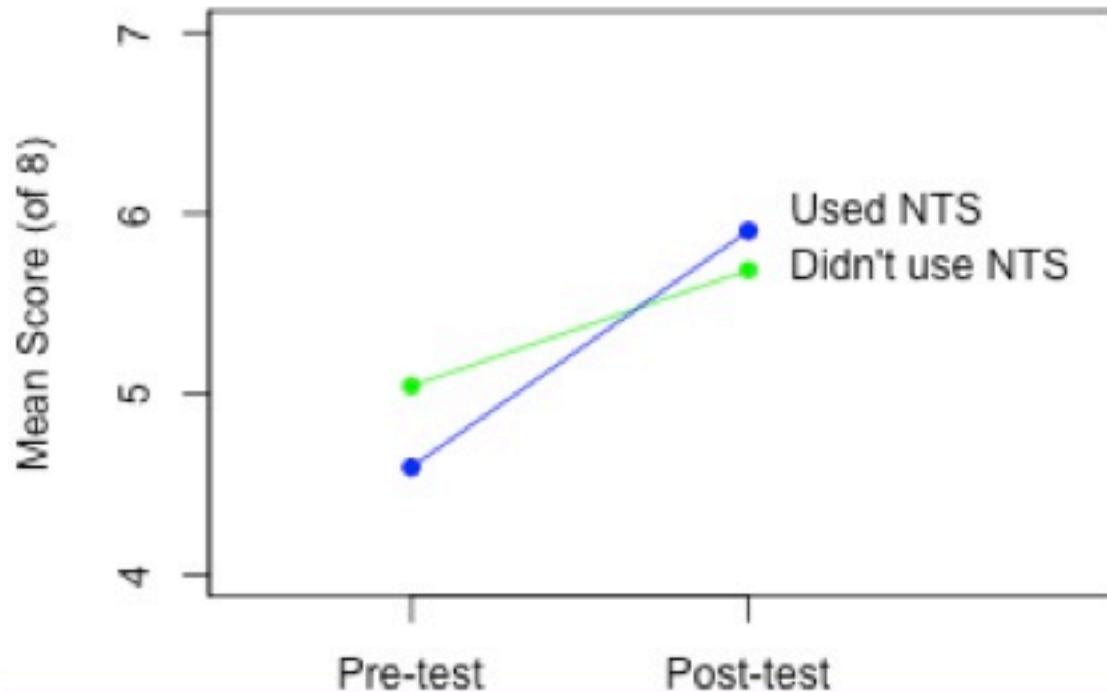
**~ 70% of students used it**

**Lab 2:**                      **NTS Post Quiz (8 points)**

# Assessing Impact:

## Pre to Post Quiz Scores (NTS user vs non-user)

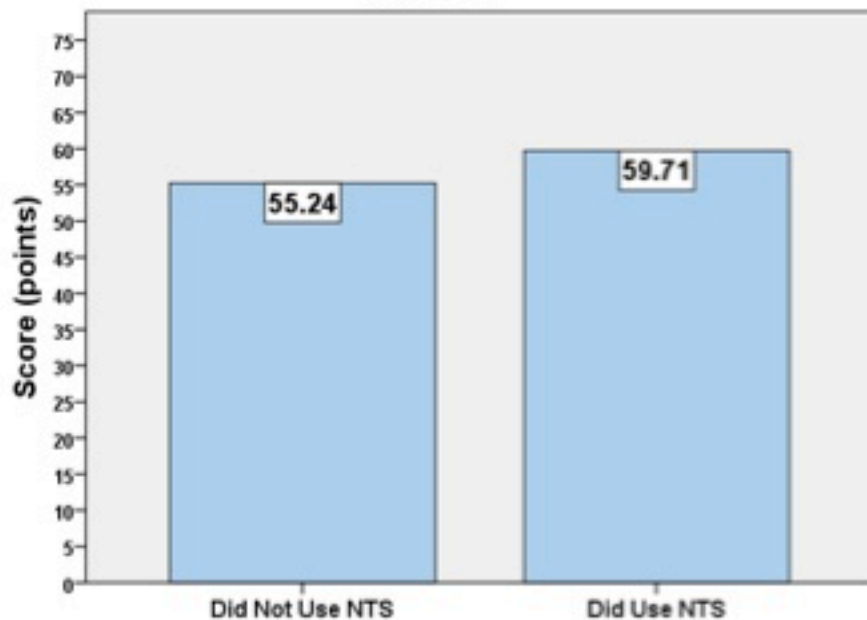
Change in Quiz Scores, Fall 2012



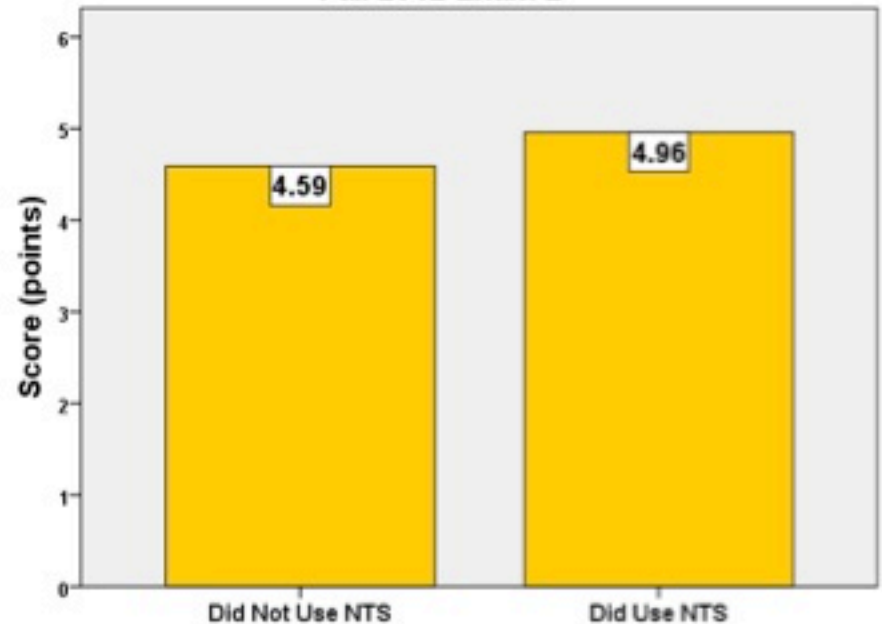
**Used NTS: 70%, mean improvement 1.30 pts**  
**Didn't use NTS: 30%, mean improvement 0.65 pts**  
*(p-value < 0.001)*

# Assessing Impact: Exam 2 Total and Specific NTS Question

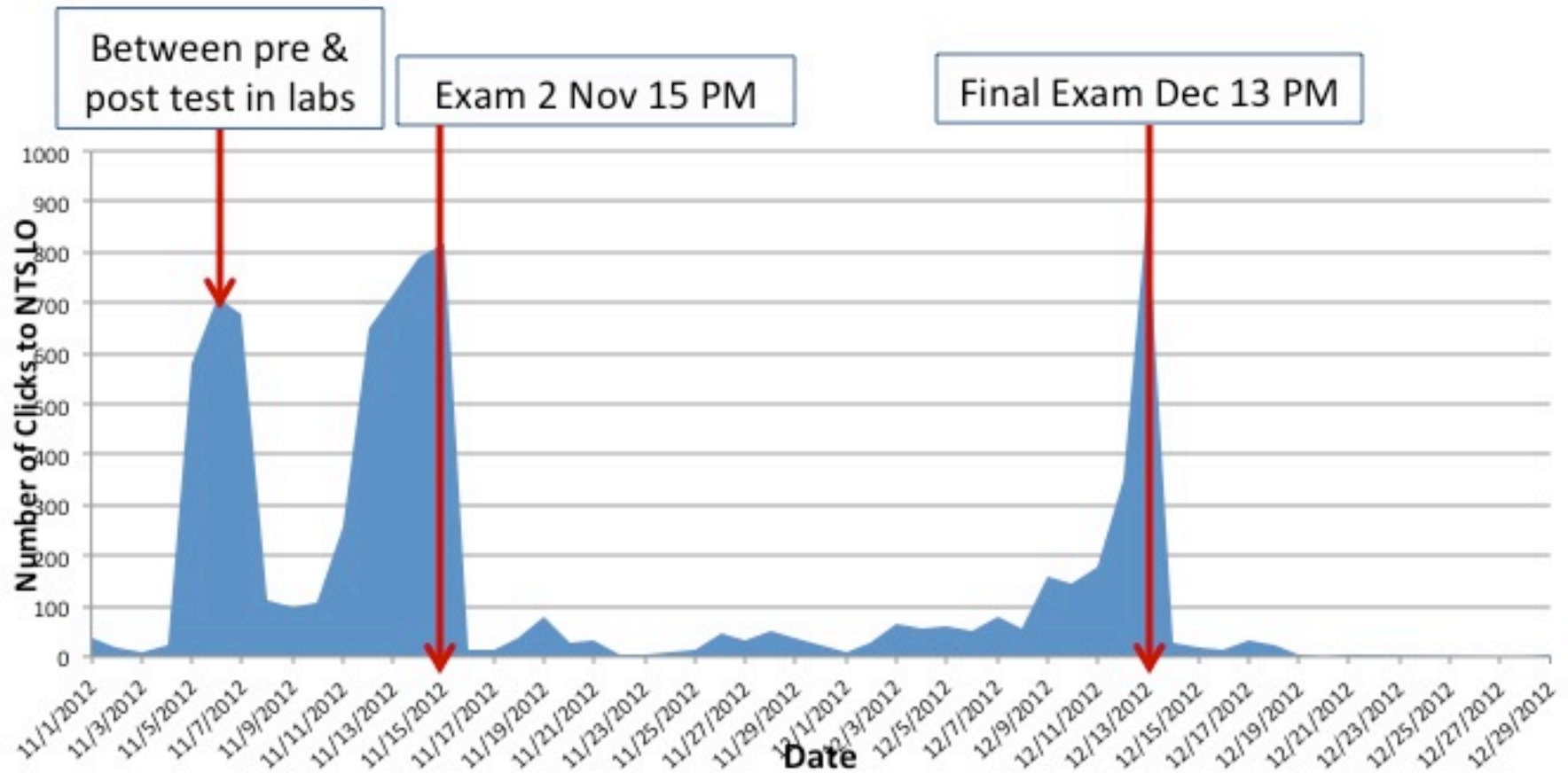
Mean Score on Exam 2 (out of 75 points)  
Fall 2012



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



# Assessing Impact: NTS LO Usage





# Chemistry 125/126

- A large (~ 2000 students per academic year) introductory chemistry course with:

- Laboratory ( 2 or 3 hours)
- Discussion ( 0 or 1 hour)



- Pre-lab lecture ( 1 hour)

GOAL – To provide the necessary background knowledge and skills needed for lab and discussion components

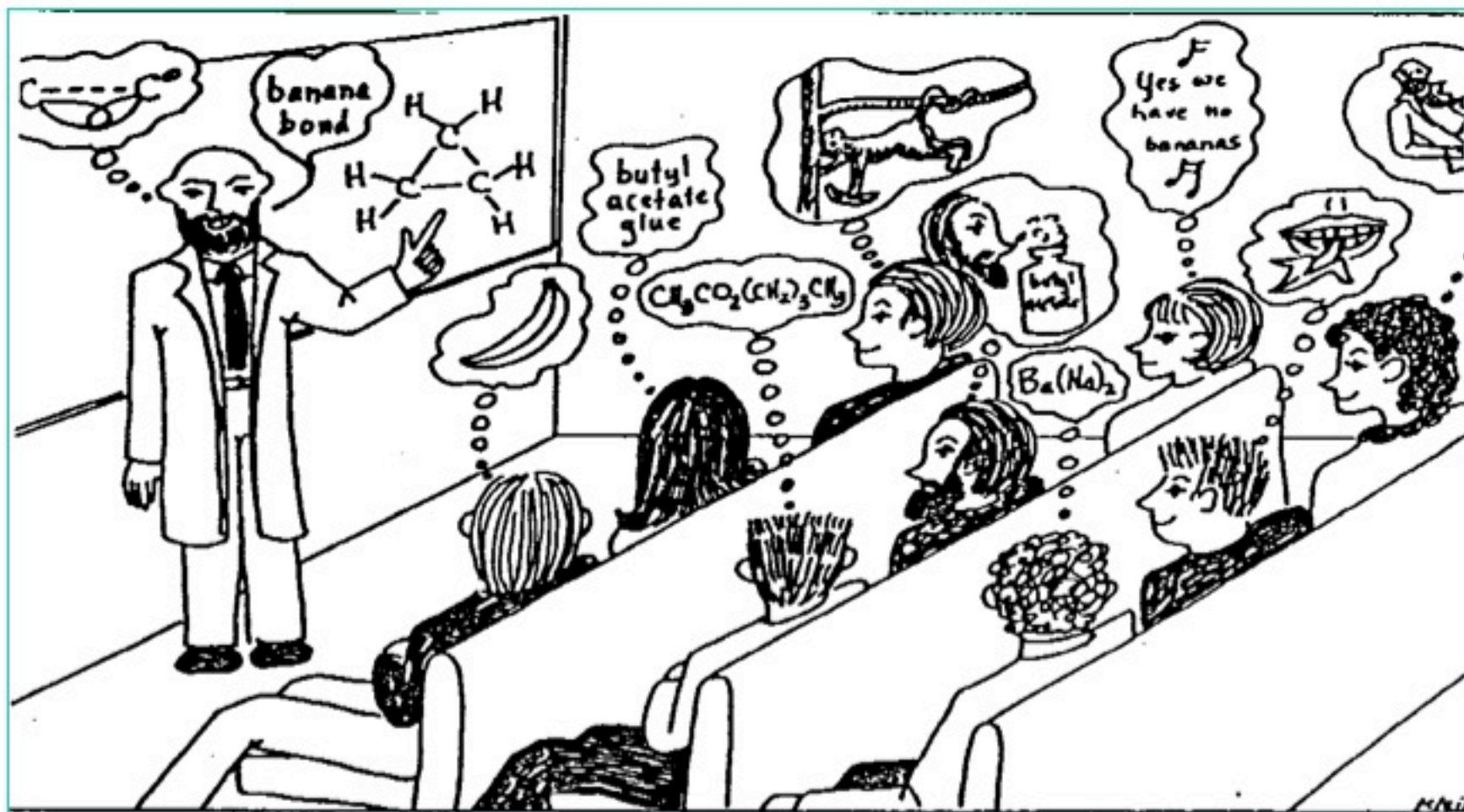
# Transforming Lecture

## Why?



- The large (450 seat) lecture and lecture hall is NOT conducive to **personalized** active learning

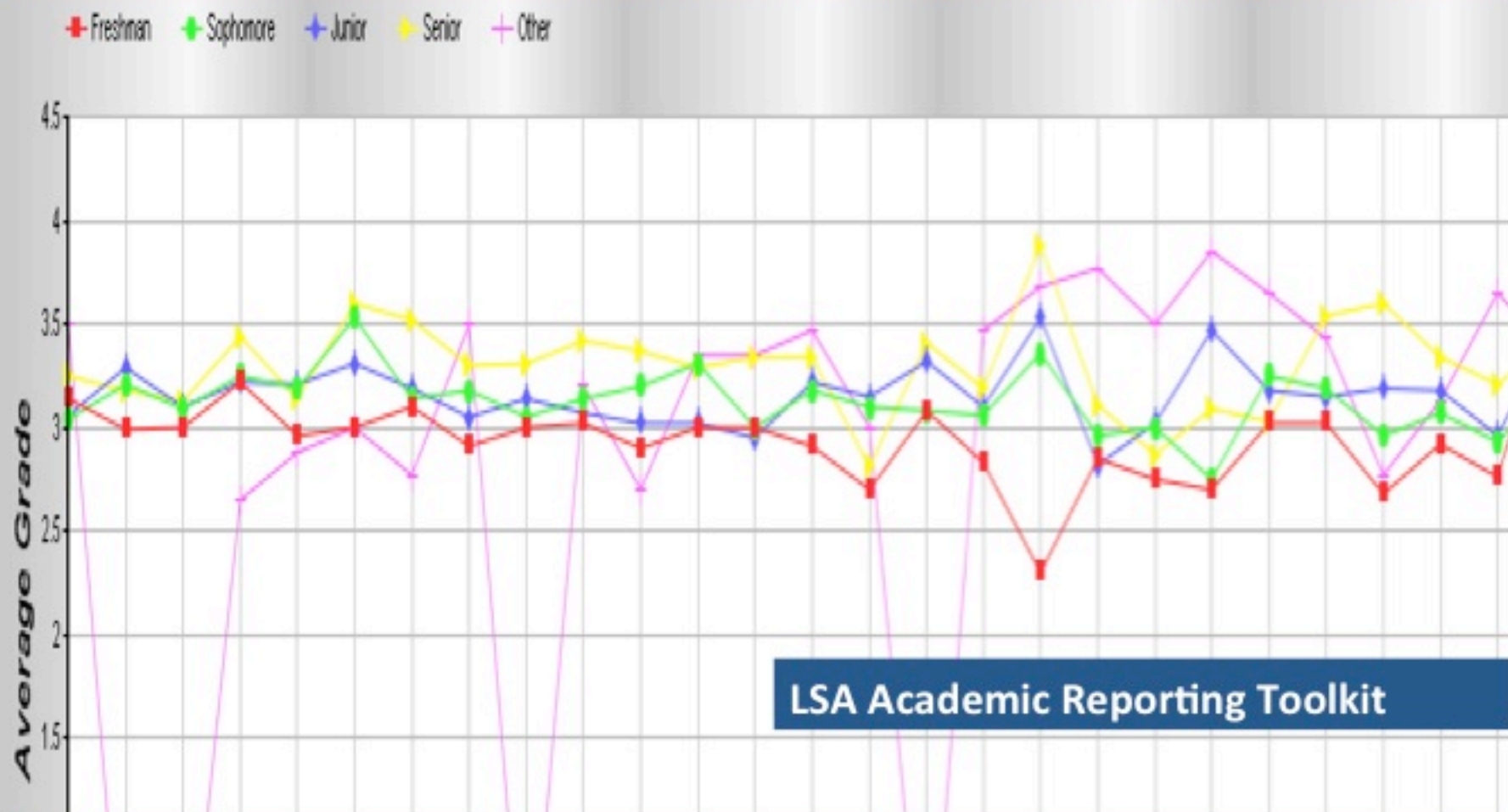
# Transforming Lecture



- Students are heterogeneous with respect to learning styles

*Kleinman, Griffin, and Kerner; J. Chem. Educ., 1987, 64 (9)*

# Average Chem.125/126 Grade by Term, Academic Level 2001 - 2008



- The higher the students' academic level the higher the course grade!
- Enrolled chem.125/126 students are primarily freshman!

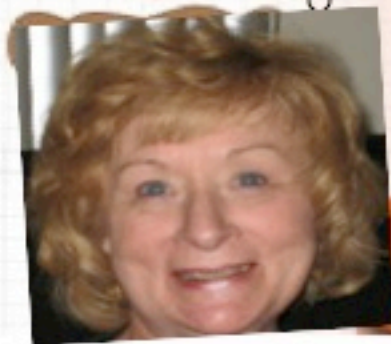
# Transforming Lecture

## 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?*



Implementation

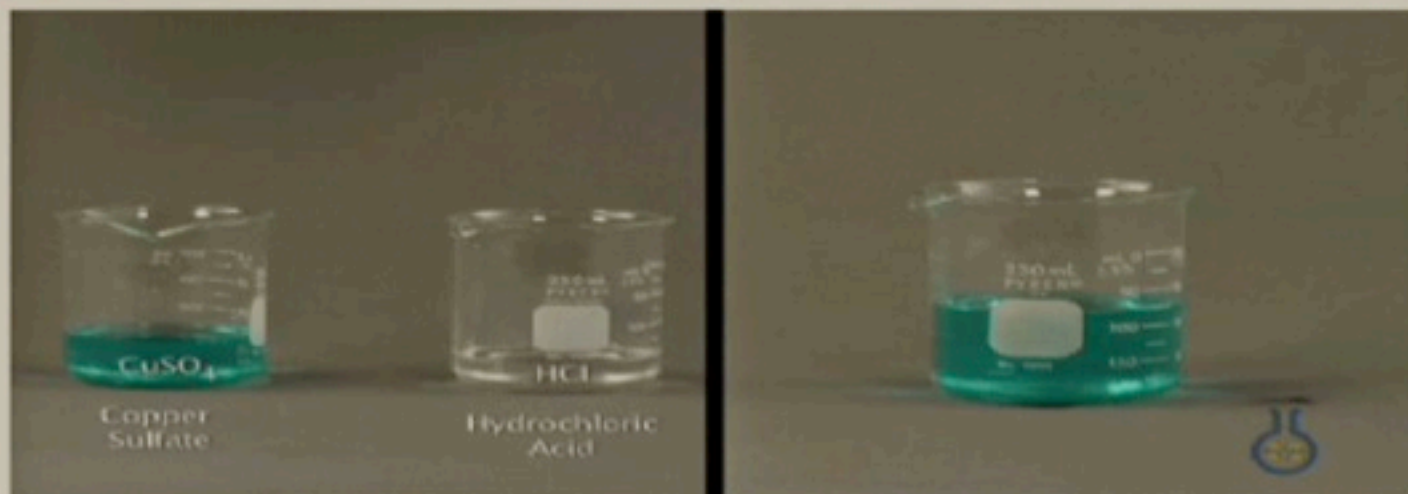
# Transforming Lecture

## Stepping Stones to Pedagogical Innovation

- ▶ Video capture of demonstrations (Summers 08-09)



## Analysis of Reactions



Rxn:  $\text{CuSO}_4 + \text{HCl}_{(\text{con})}$

Test:  $\text{CuSO}_4 + \text{HNO}_3_{(\text{con})}$

<http://bit.ly/CuSO4split>

### 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

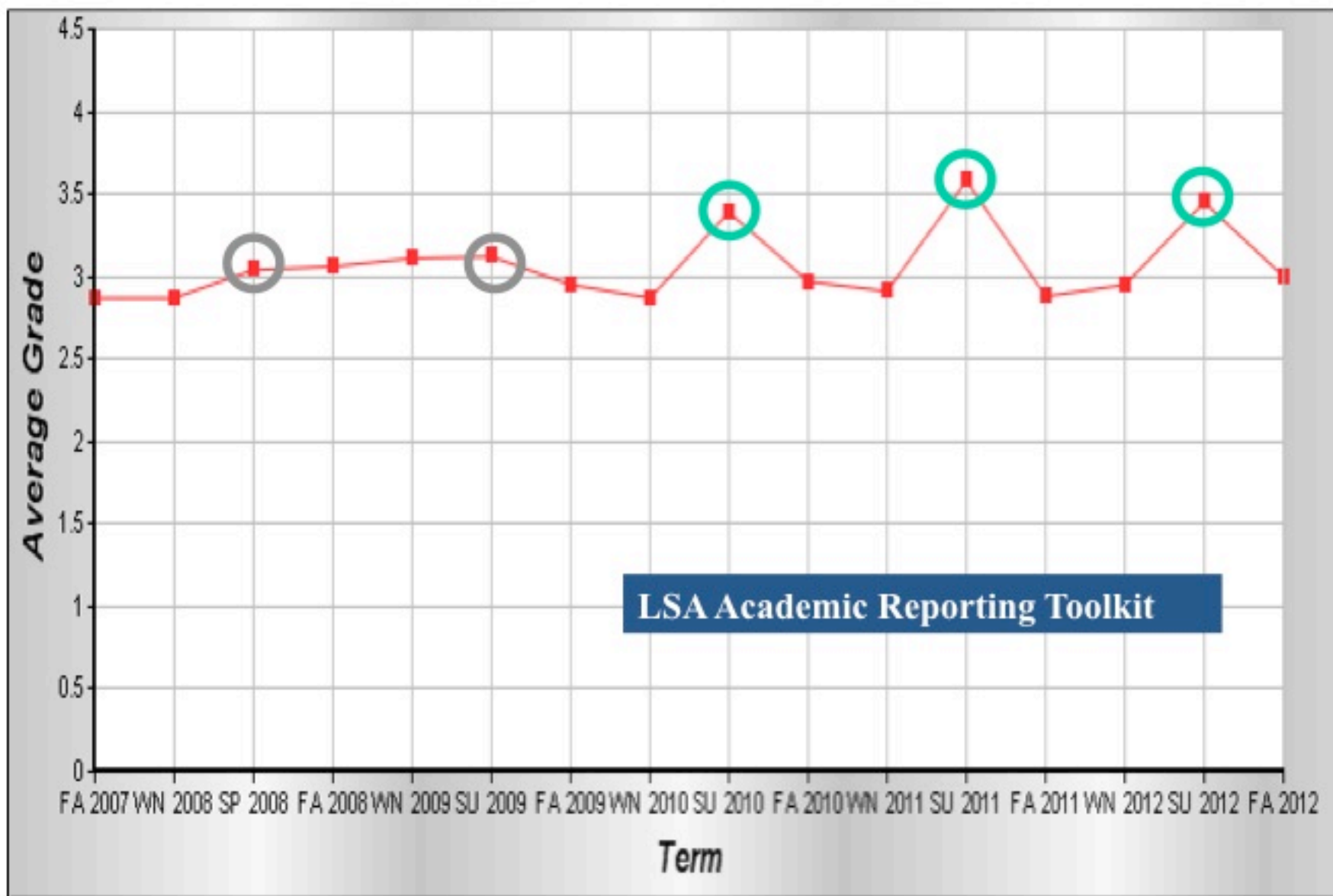
- Summer 2010 students could view **podcasts before** (and after) **the “live” lecture**
- Identical term exams given summer 2009 and 2010
- Student composition similar to prior summer term

Summer 2009 Exam Results

	A+	A	A-	B+	B	B-	C+	C	C-	D+	E
#	9	2	4	2	6	3	5	2	1	1	7
%	20.5	4.5	9.0	4.5	13.6	6.8	10.6	4.2	2.1	2.1	14.9
Total%	25.1%		24.9%			14.8%			2.1%	14.9%	

Summer 2010 Exam Results

	A+	A	A-	B+	B	B-	C+	C	C-	D+	E
#	16	5	4	3	1	0	1	5	1	3	7
%	34.0	12.8	8.5	6.4	2.1	0	2.1	10.6	2.1	6.4	14.8
Total%	46.9%		8.5%			14.8%			6.4%	14.8%	



LSA Academic Reporting Toolkit

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***

- CRLT Summer 2010 Survey
- 53% of class viewed podcasts multiple times

# Transforming Lecture

## Stepping Stones to Pedagogical Innovation

 UNIVERSITY OF MICHIGAN

### Chem 125 Learning Object Hunt!

[Home](#)

[MERLOT](#)

[Learning Object Hunt  
Information](#)

[Learning Object Submission  
Form](#)

[General Resource Links](#)

[Submitted Websites](#)

SUBMIT COMPLETED FORMS TO: [chem125hunt@gmail.com](mailto: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 web based digital resource that can be used regularly to enhance learning and support teaching of a given subject matter. There is a link to the MERLOT website which has an ever increasing collection of links to submitted learning objects dealing with material on nearly every subject. Presently we are looking to involve students in 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 you 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](mailto: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

More than 100 LOs submitted!  
Students become co-teachers!

# Online LO Resources (C-Tools)

<input type="checkbox"/>	<u>Title</u>
	<a href="#">Online Learning Resources</a>
<input type="checkbox"/>	<a href="#">Cross-discipline LOs.pdf</a>
<input type="checkbox"/>	<a href="#">OnlinePeriodicTableResources.pdf</a>
<input type="checkbox"/>	<a href="#">Experiment1LOs.pdf</a>
<input type="checkbox"/>	<a href="#">Experiment2LOs.pdf</a>
<input type="checkbox"/>	<a href="#">Experiment3LOs.pdf</a>
<input type="checkbox"/>	<a href="#">Experiment4LOs.pdf</a>
<input type="checkbox"/>	<a href="#">Experiment5LOs.pdf</a>



# Transforming Lecture

## Multimedia Online Materials

- ▶ Interactive website with personalized learning path



- ▶ [http://www.umich.edu/~chem125/softchalk/exp1\\_final/](http://www.umich.edu/~chem125/softchalk/exp1_final/)

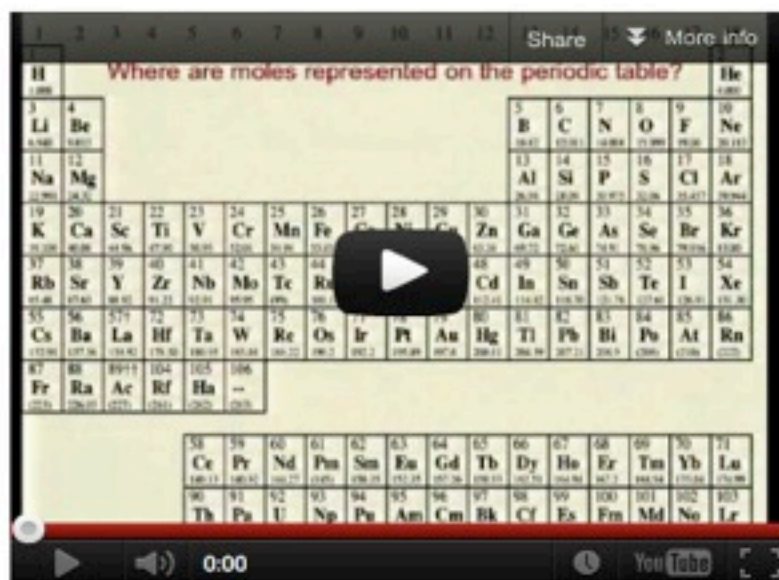
# Preparing a solution of known concentration

## 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.

Where are moles represented on the periodic table?



1	2	3	4	5	6	7	8	9	10	11	12	Share	More info				
H 1.008	Where are moles represented on the periodic table?										He 4.003						
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 52.00	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc 98.906	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.757	52 Te 127.60	53 I 126.905	54 Xe 131.29
55 Cs 132.905	56 Ba 137.327	57 La 138.905	58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm 144.913	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.054	71 Lu 174.967	
87 Fr 223.018	88 Ra 226.025	89-103 Ac 227.037	104 Rf 261.101	105 Db 262.109	106 Sg 263.109												
		58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm 144.913	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.054	71 Lu 174.967		
		90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu 244.064	95 Am 243.061	96 Cm 247.070	97 Bk 247.070	98 Cf 251.080	99 Es 252.083	100 Fm 257.095	101 Md 258.10	102 No 259.10	103 Lr 260.10		

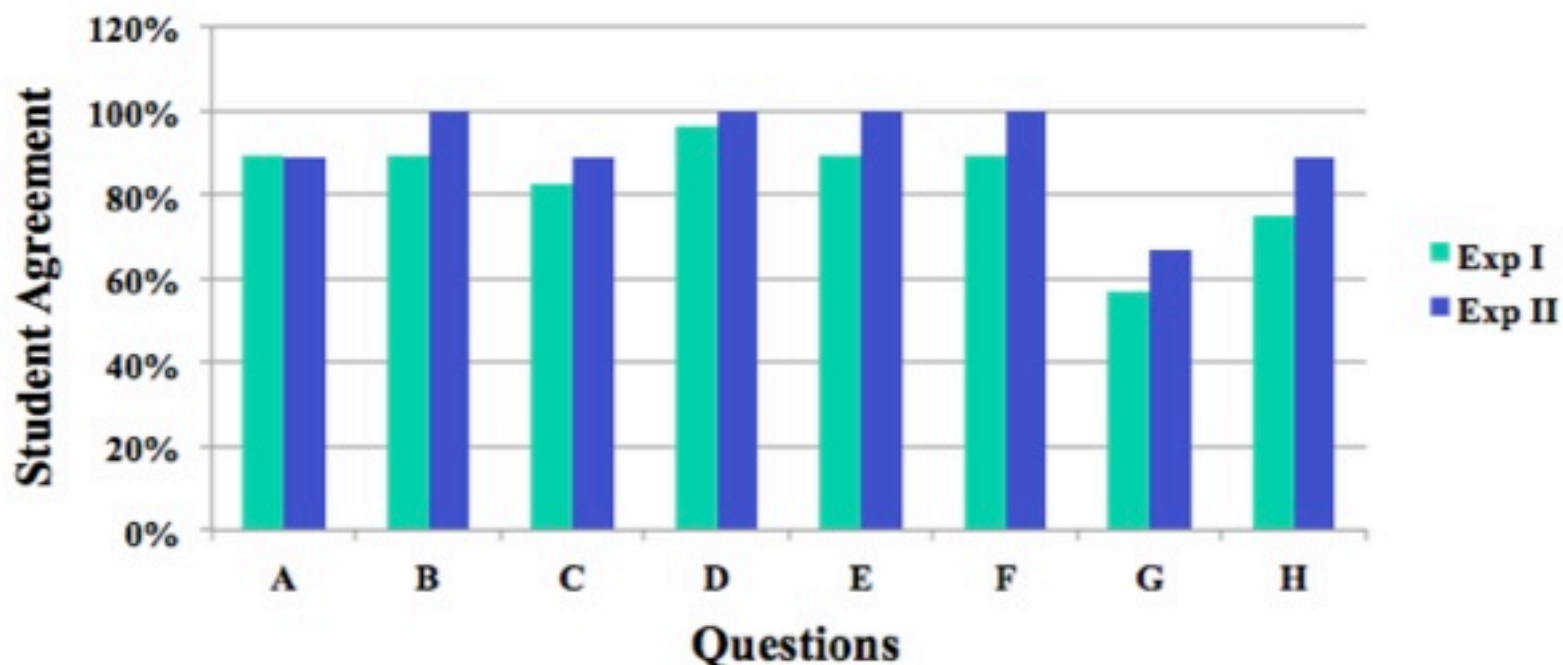
## Chem125 Soft Chalk E2Draft Survey Winter 2011

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**.*



## Chem125 SoftChalk Survey: Winter 2012



- 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

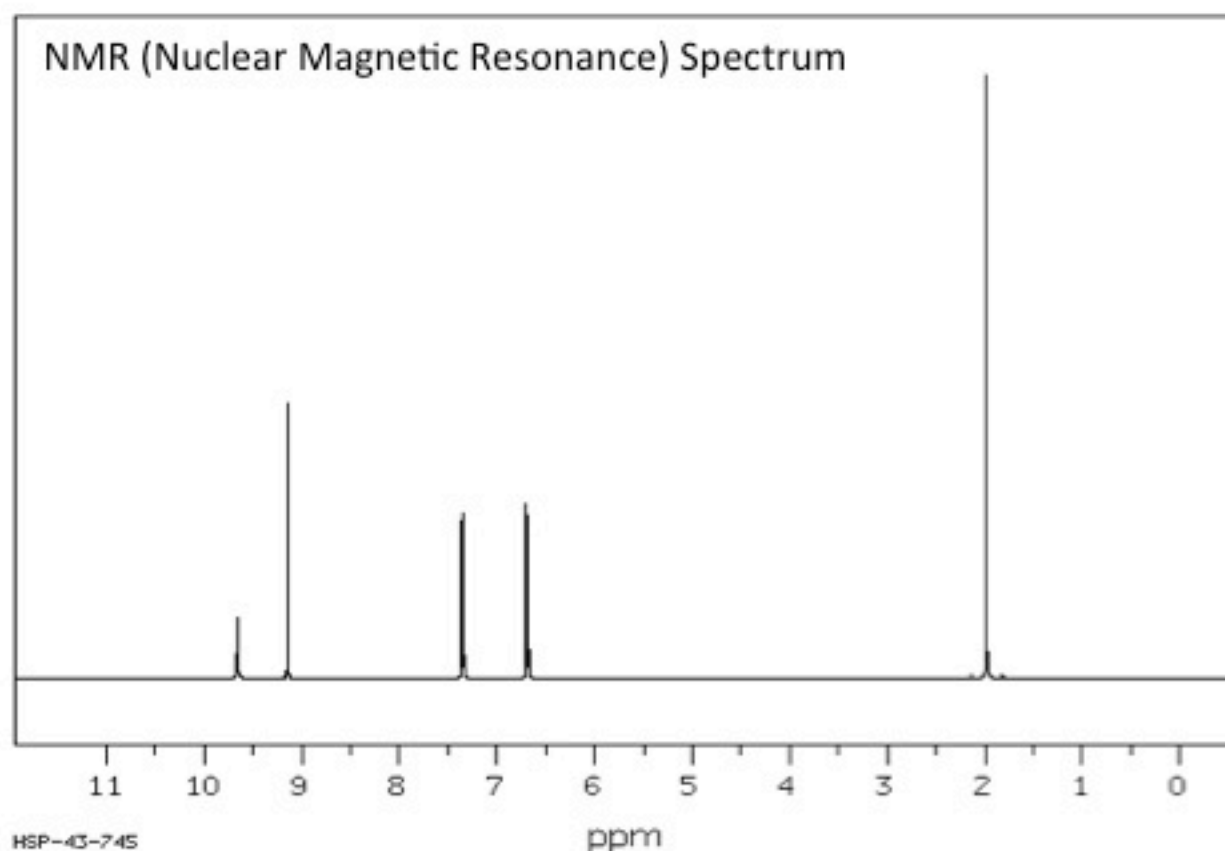
# Chemistry 216: Synthesis and Characterization of Organic Compounds (or Second Term Organic Chemistry Lab)

850 students  
50 sections  
30 GSIs  
1 instructor  
2 credits

1 hour lecture

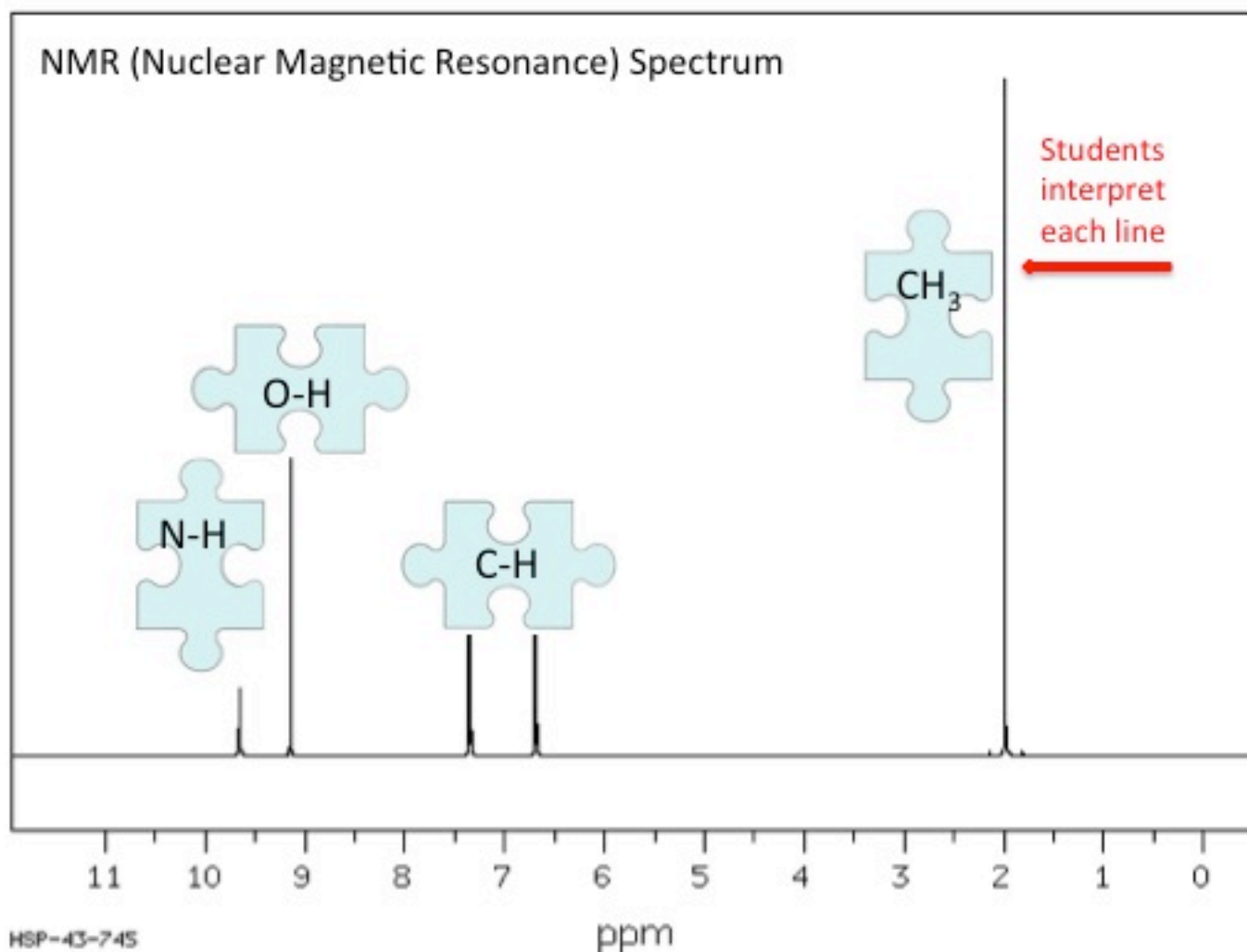
4 hour lab session

# Most Challenging CHEM 216 Content: Spectroscopy



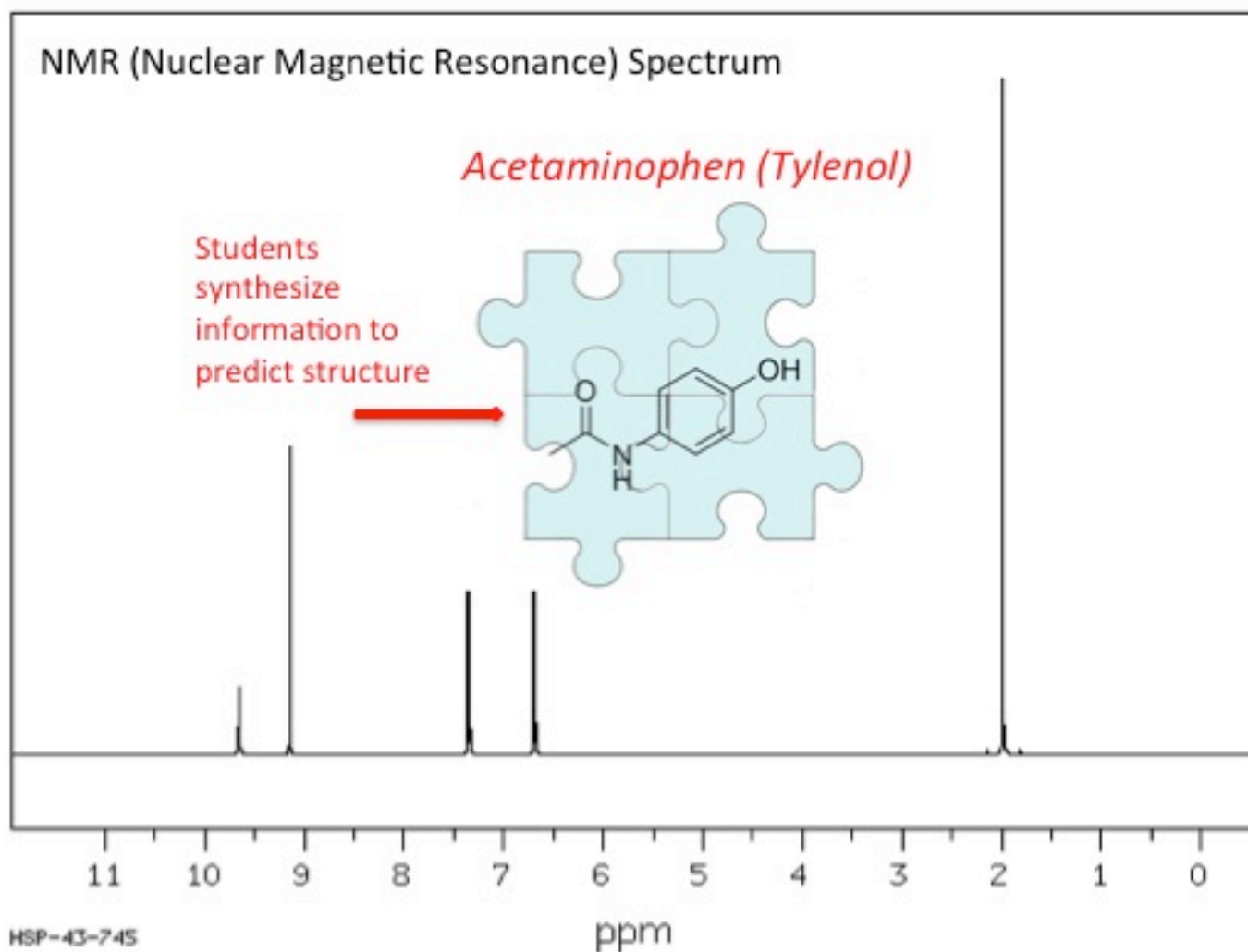
- Notoriously difficult to teach and learn
- Major point loss on CH 216 exams is attributed to spectroscopy questions

# Most Challenging CHEM 216 Content: Spectroscopy



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

# Most Challenging CHEM 216 Content: Spectroscopy



One answer – multiple solutions!

# Online resources exist for Spectroscopy, but must be adapted for Chemistry 216

The image shows two overlapping screenshots of online resources. The background screenshot is the MERLOT Learning Materials website, displaying a search for 'spectroscopy' with various filters and search results. The foreground screenshot is a Google search for 'spectroscopy for organic chemistry students', showing search results for 'IR spectroscopy - Organic Chemistry at CU Boulder' and 'spectroscopy - Organic Chemistry Review'.

- 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.**

# Pedagogical Design for Learning Object Adaptation

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?**

# Screencast Tutorials

Talk less, say more

Jing®

Screencasts & captures at the speed of conversation

TechSmith

Captured with Jing - [free download](#) >

Syllabus - ...	mail.umic...	Inbox (23...	Universit...	Solvent - ...	CTools t...	https://ct...
HIT-NO=960	SCORE= ( )	SDBS-NO=319	IR-NIDA-63533 : LIQUID FILM			
ACETONE						
<chem>C3H6O</chem>						

4000 3000 2000 1000 500

WAVENUMBER (cm⁻¹)

How does an expert solve this?

<http://screencast.com/t/DGjsrbM9>



# Online Discussion Board: Voicethread

Discussion 2; Final Week (3/3)

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, chose another. If they are all taken, look at the other analyses your peers have provided and determine whether you agree or disagree.

CCOC1=CC=C(C=C1)C=O A

CC(C)(C)C(=O)C(C)(C)C B

CC1=CC=C(C=C1)C#N C

CC1=C(C)C=C(C)C1C D

CC1(C)OCCO1 E

comment

How do my peers solve this?

<https://voicethread.com/?#u1910045.b2924514.i15443680>

## Small Scale Implementation: Fall 2011

**Fall enrollment:**

23 lab sections, 359 students  
12.5 GSIs

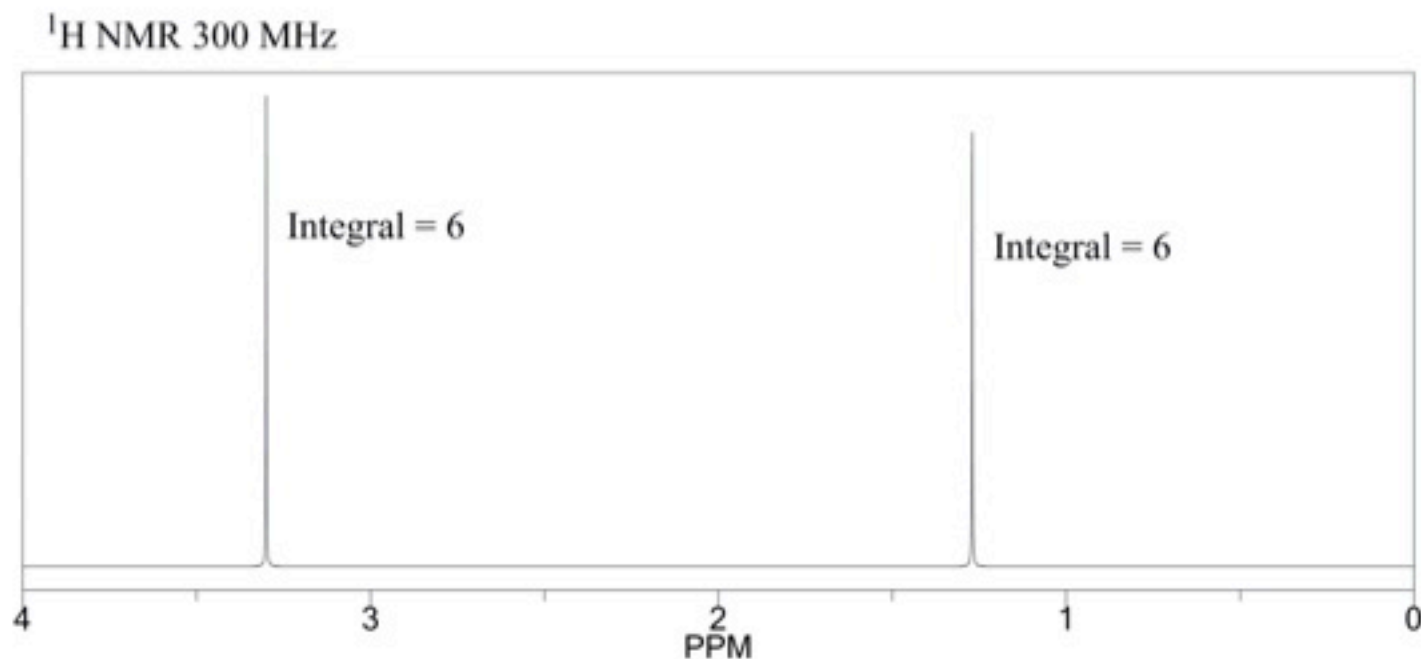
**Treatment group:**

3 lab sections, 47 students,  
3 GSIs

- **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.

## Pre/Post Term Spectroscopy Assessment

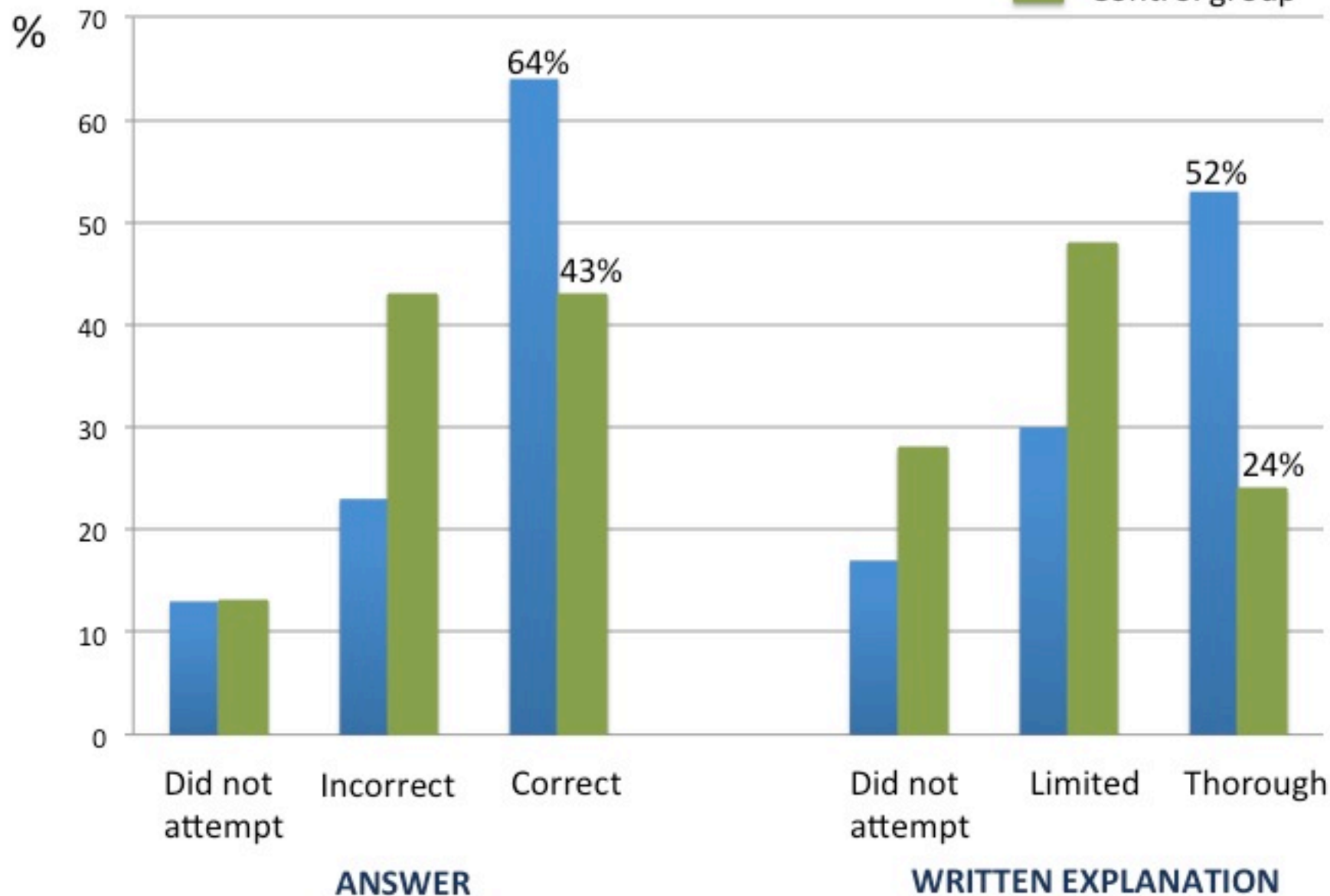
1. Draw the structure of a molecule with the formula  $C_5H_{12}O_2$  that corresponds to the following NMR spectrum.



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

# Spectroscopy Assessment Outcome

Treatment group  
Control group



## Analysis of Written Explanation - Coding

“I guessed...”

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

### Limited Explanation

30% Treatment

48 % Control

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

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

### Thorough Explanations

52% Treatment

24% Control

## Student Comments

“I thought the VoiceThread and learning objects were **incredibly useful, and helped prepare me for the exam**. The feed back 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

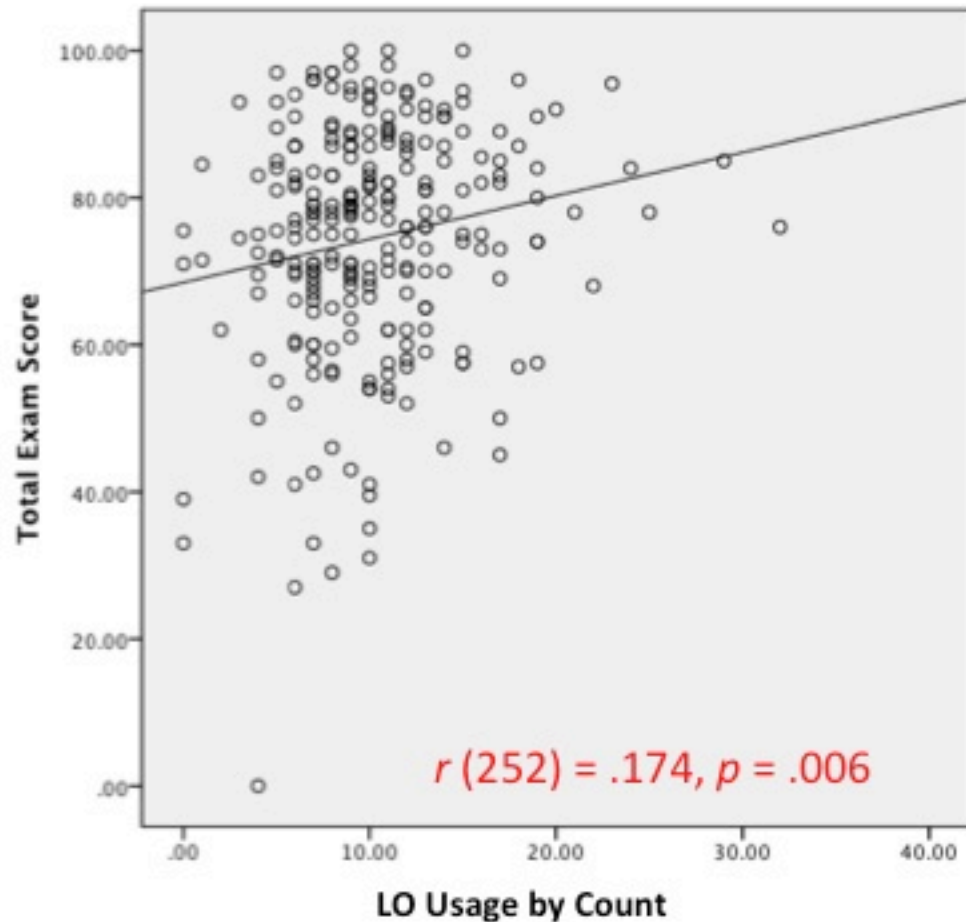
## **Treatment group:**

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

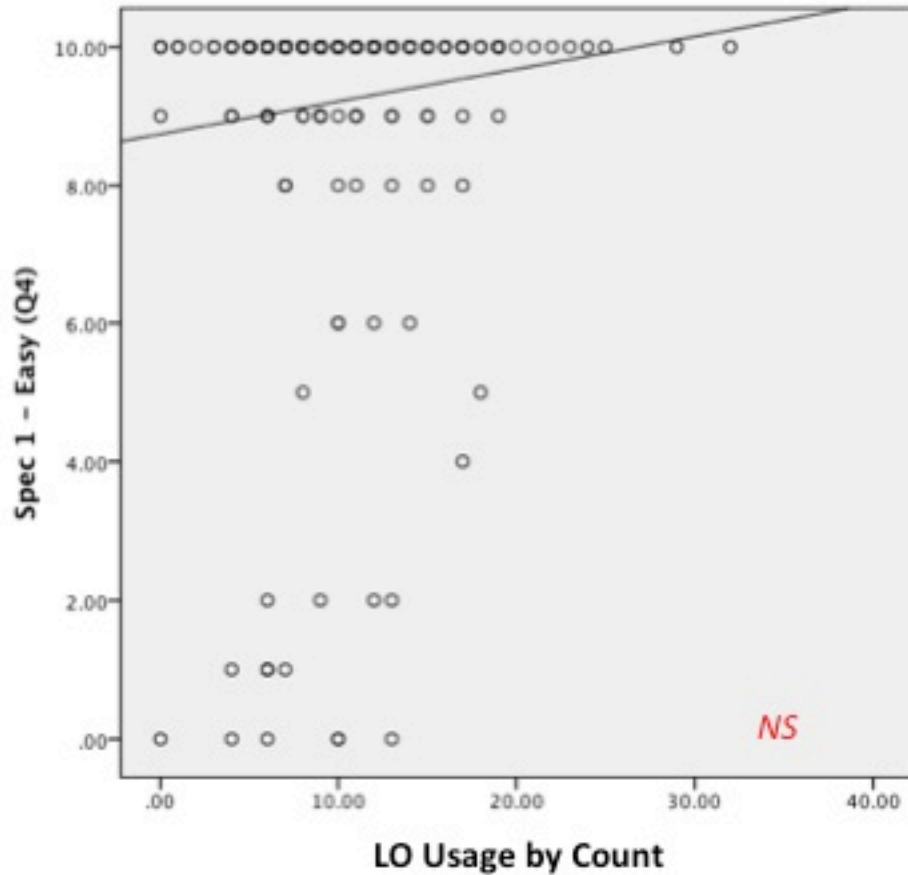


- LO usage positively impacted exam performance
- Exam included other content in addition to spectroscopy

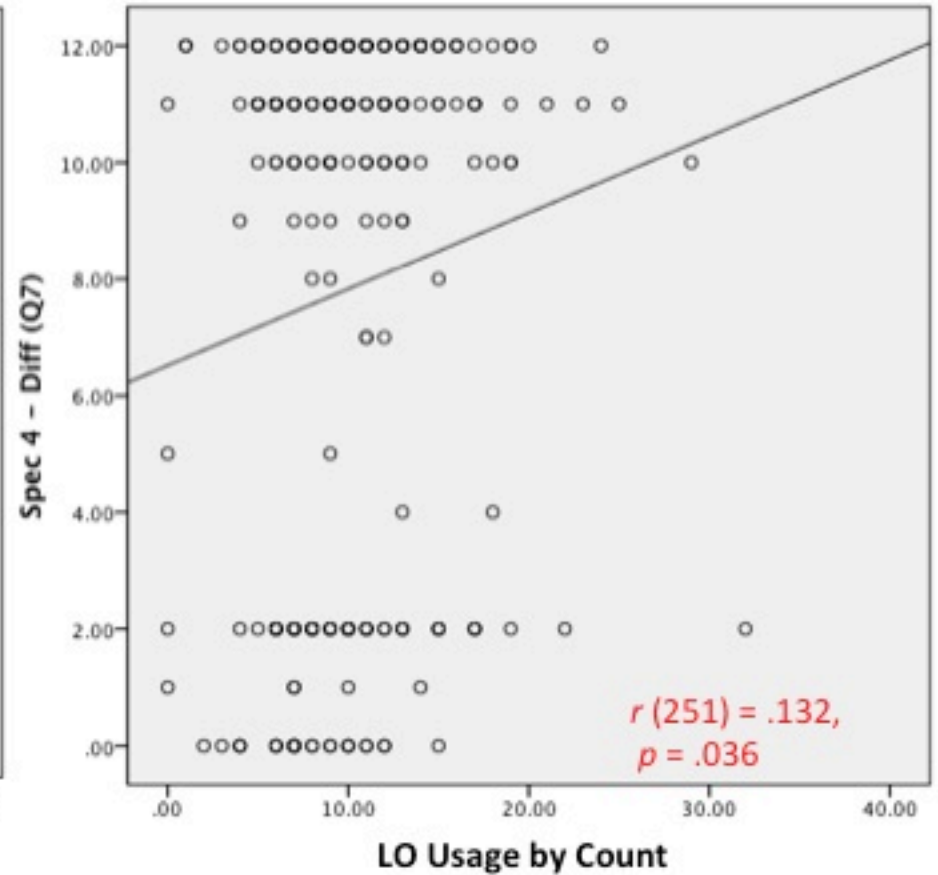


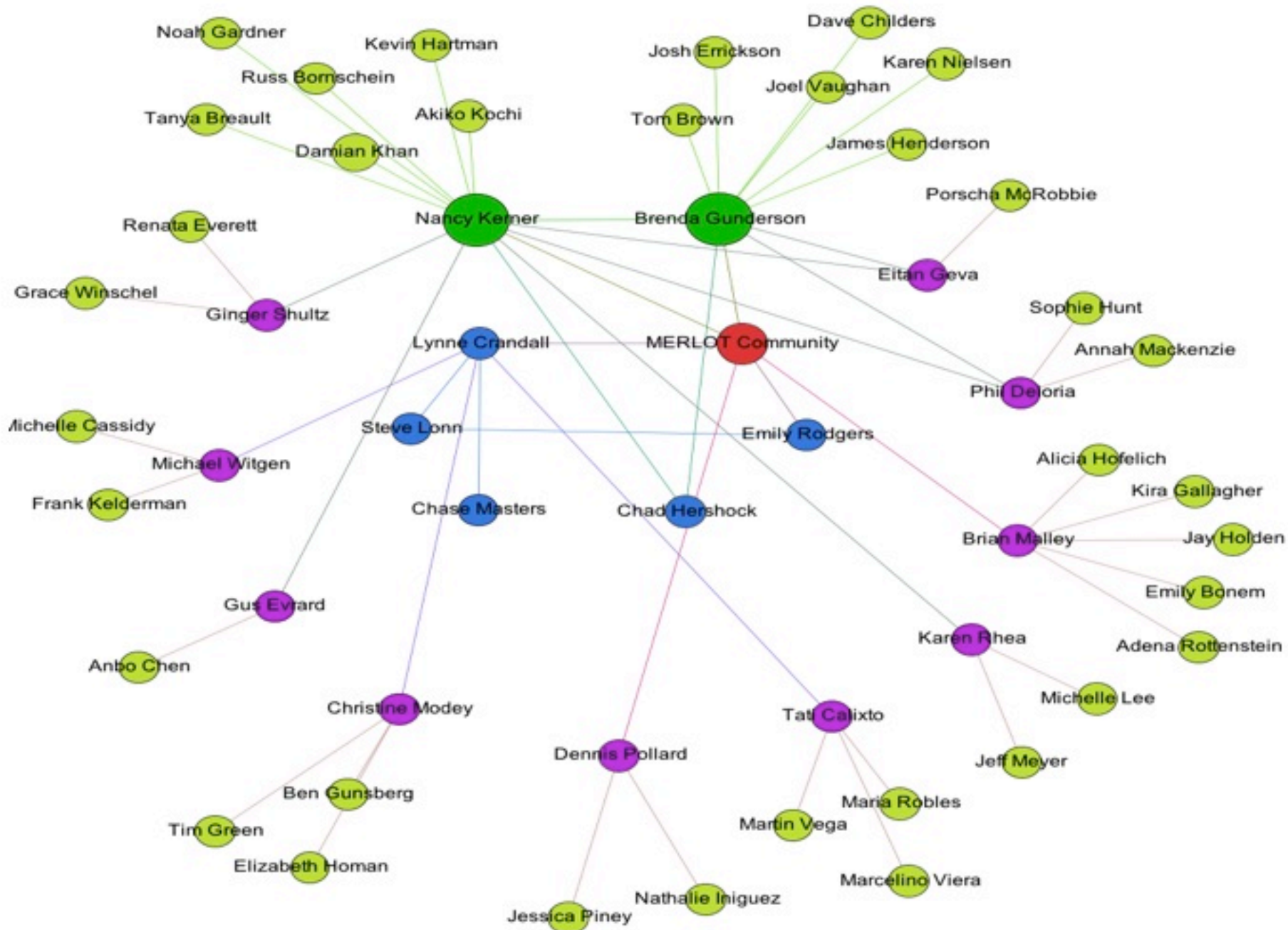
Evaluation of individual spectroscopy questions indicated the effect of Learning Object usage was *most significant on difficult questions*

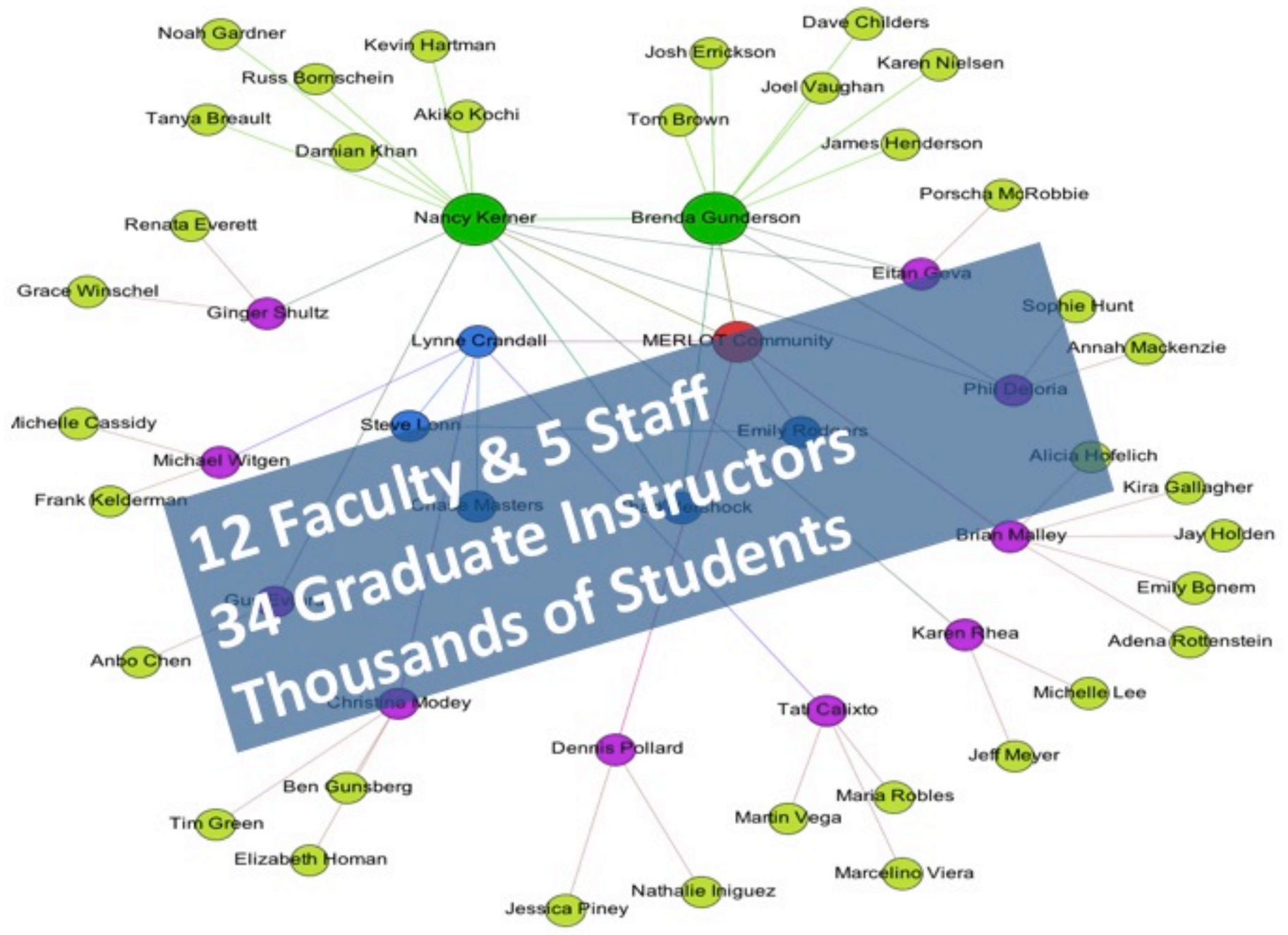
Easy Spectroscopy Question



Difficult Spectroscopy Question









THANK  
YOU!

**Contact information**

[bkg@umich.edu](mailto:bkg@umich.edu)

[nkerner@umich.edu](mailto:nkerner@umich.edu)

[gshultz@umich.edu](mailto:gshultz@umich.edu)

<http://melo3d.wordpress.com/>