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

STUDENT LEARNING AND ANALYTICS AT MICHIGAN

www.crlt.umich.edu/slam

SLAM MICHIGAN

STUDENT LEARNING AND ANALYTICS AT MICHIGAN

Online Learning Resources in Chemistry and Statistics

MERLOT

Multimedia Educational Resource for Learning and Online Teaching

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

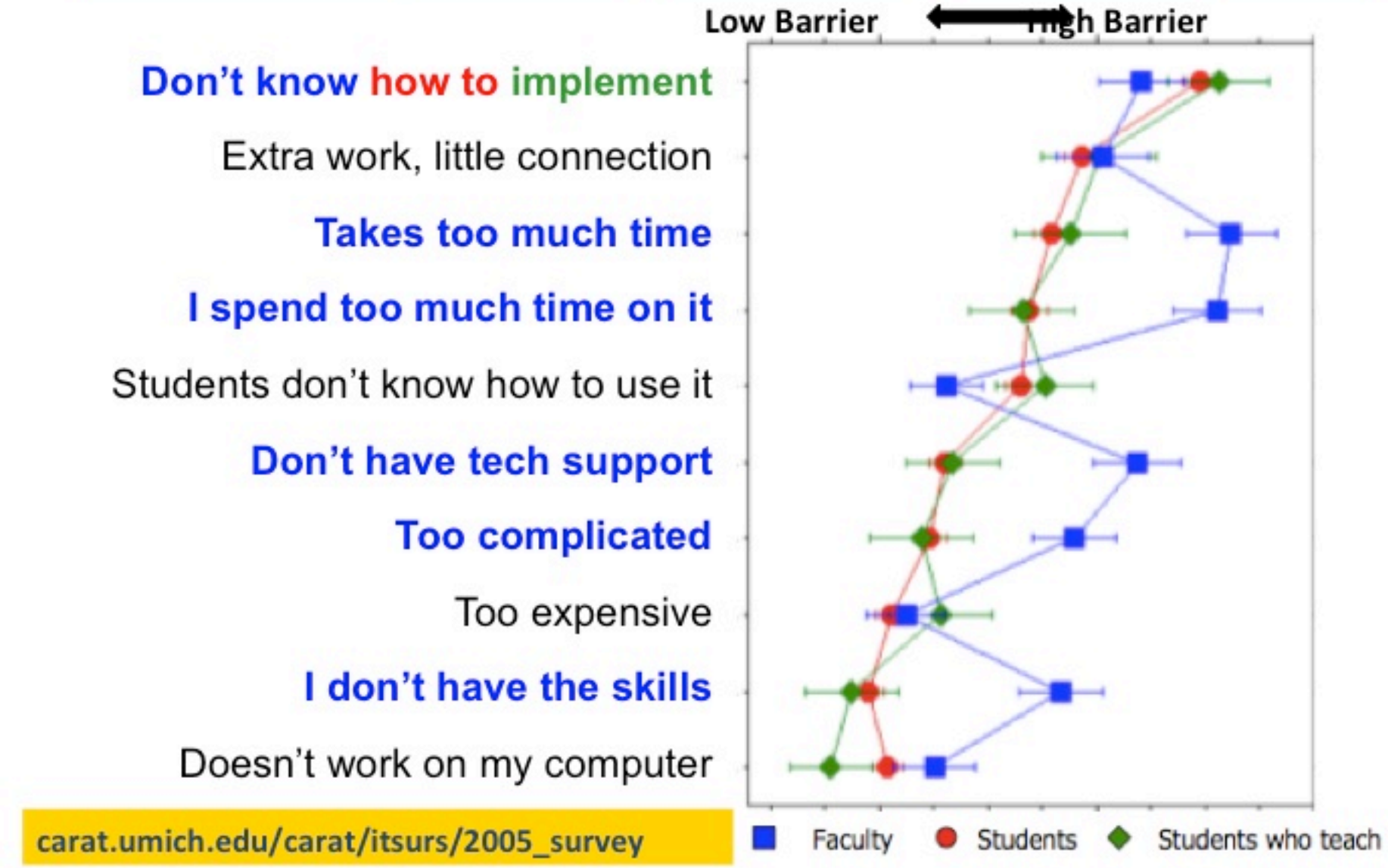
Project Goal

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



carat.umich.edu/carat/itsurs/2005_survey

The Proposed Solution
Train (Graduate) Students

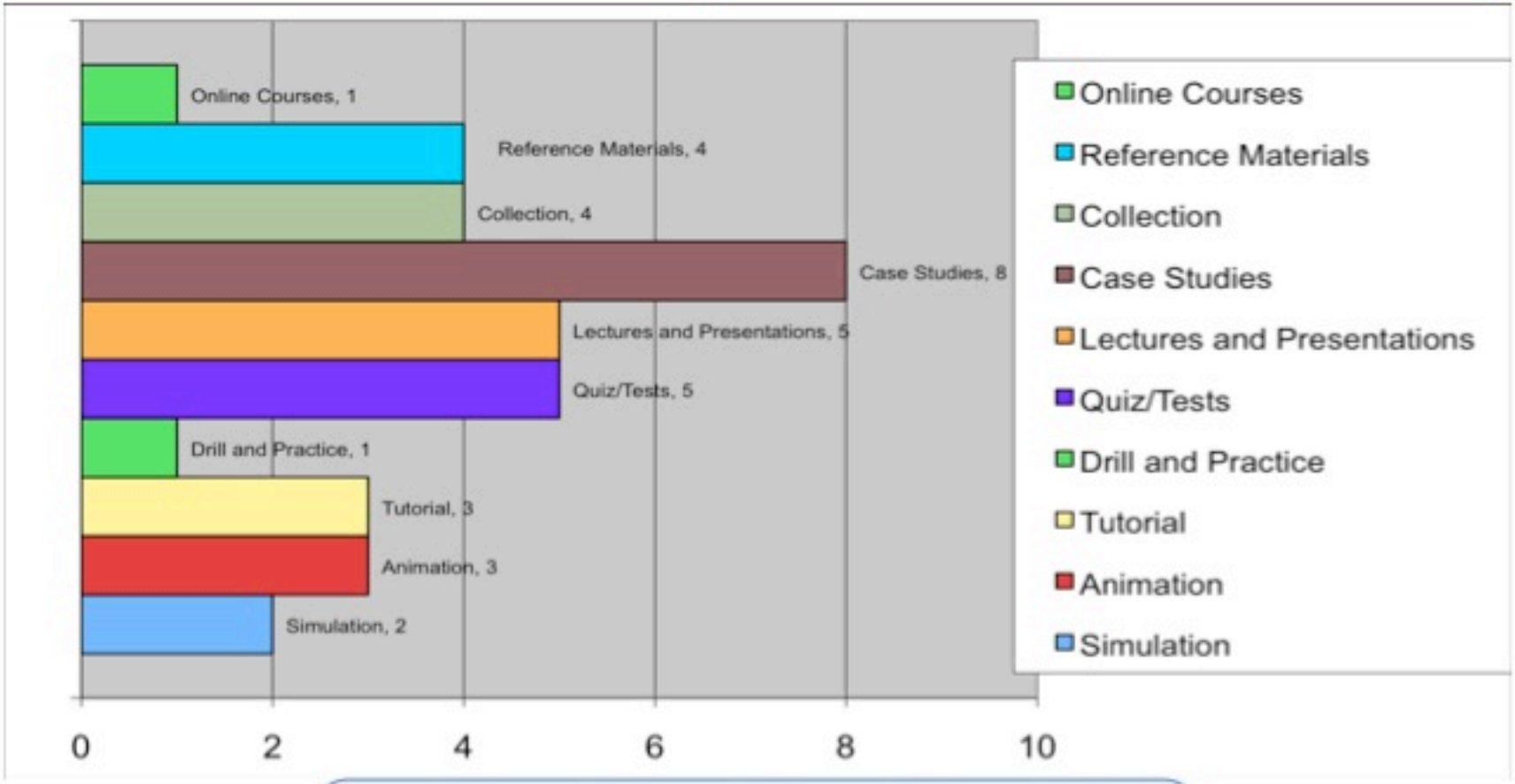
- **Educate (graduate) students** across disciplines to access, evaluate, design LOs; and to create quality course-specific and cross-discipline LO collections.
- (**Graduate**) **students disseminate LOs** to relevant faculty for integration into undergraduate courses

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

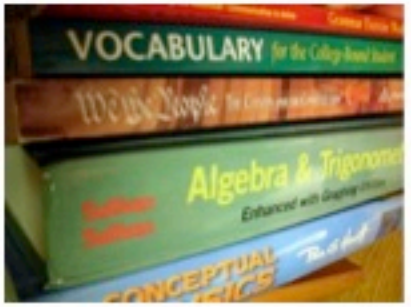
Add Staff

- Provide basic grant support
- Some technology support
- OER support
- Assessment/ Analytics

Initial Outcomes

MERLOT
Multimedia Educational Resource for Learning and Online Teaching

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



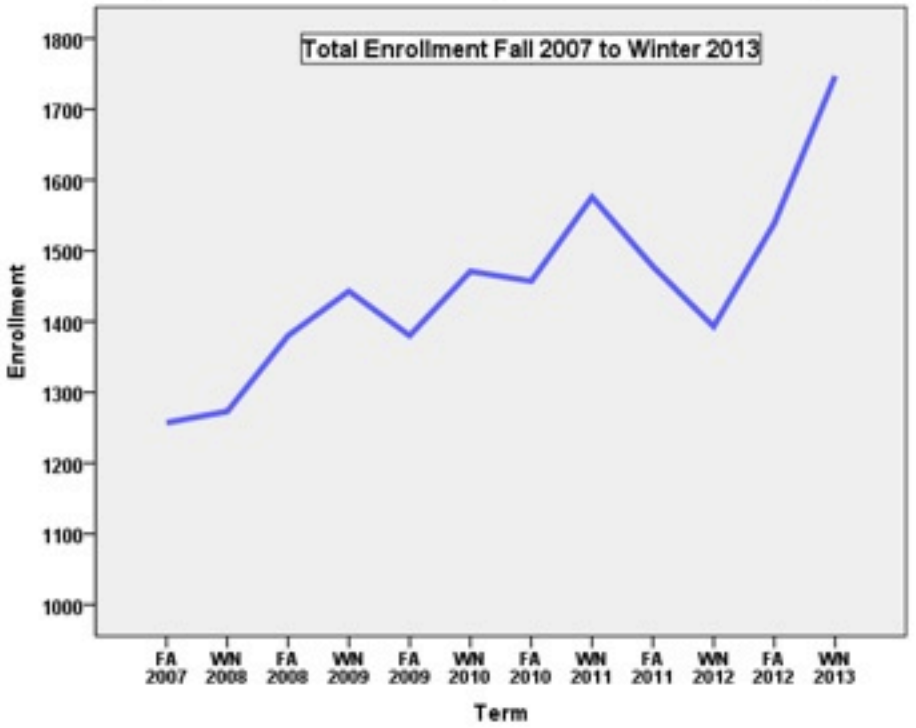
- **LOs tagged for course integration**
  - Choice based on **needs vs type** of LO
  - Choice focused on LOs that address **difficult concepts or skills**

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

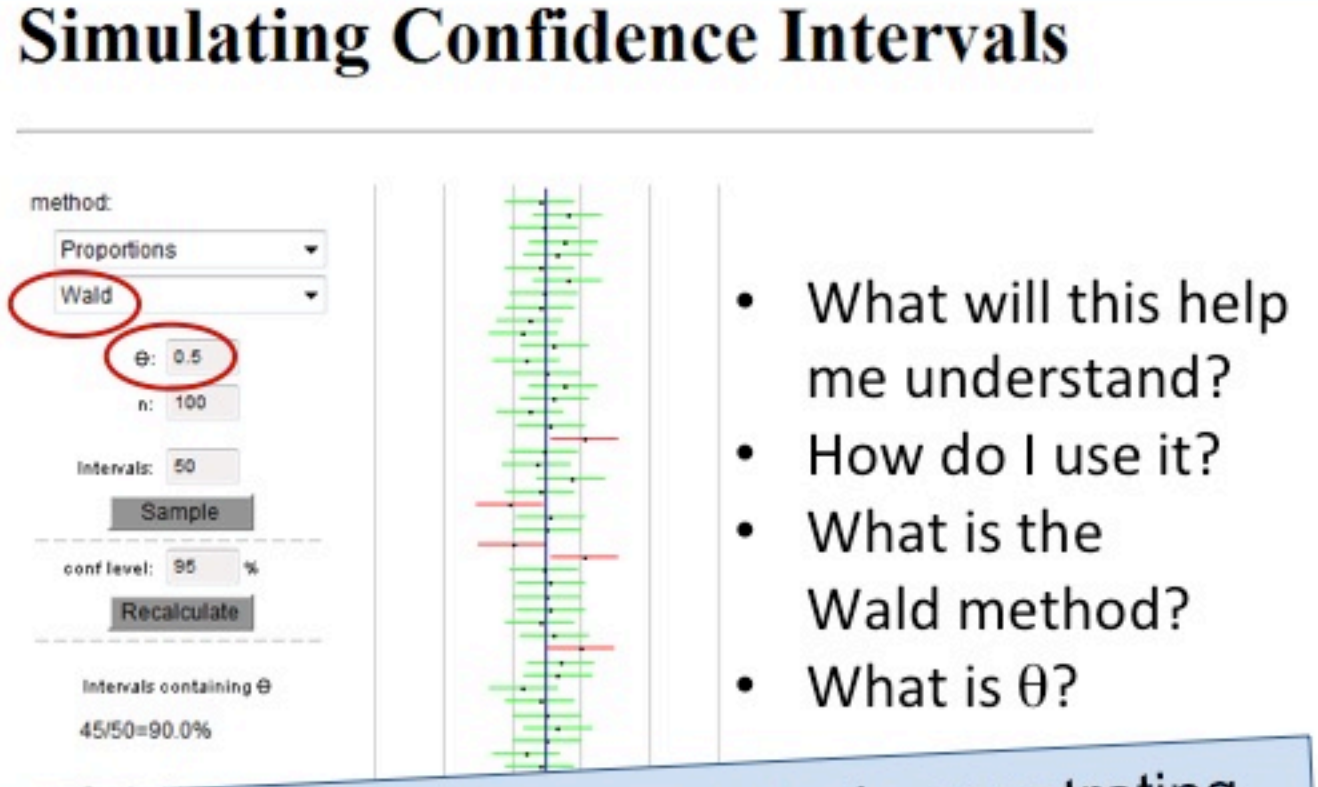
Stats 250

- **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!



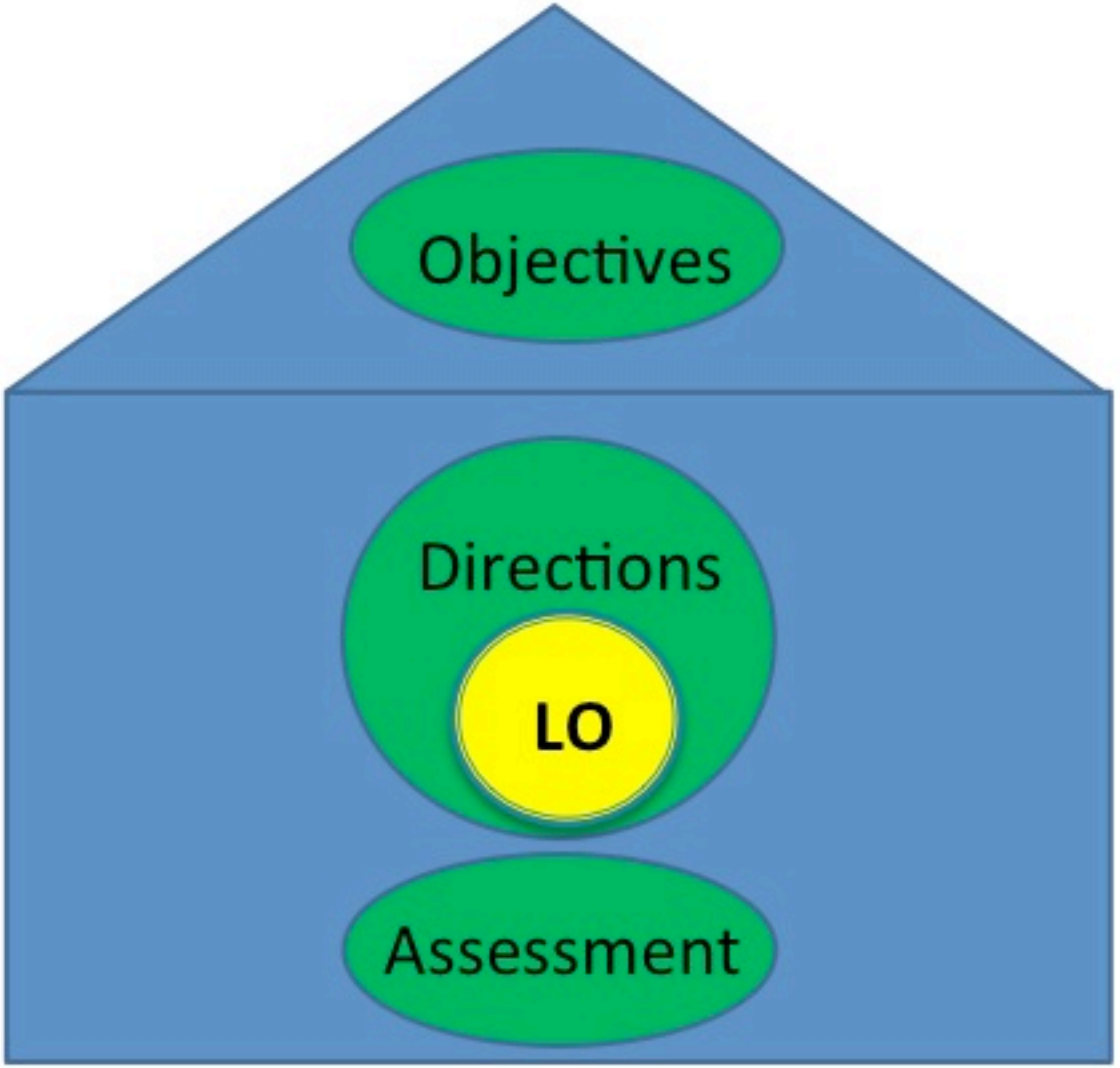
- What will this help me understand?
- How do I use it?
- What is the Wald method?
- What is θ?

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

http://www.rossmanchance.com/applets/Confsim/Confsim.html

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 abo[illegible] 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 submissio[illegible]ils.

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).

http://sitemaker.umich.edu/stats250.prelab/lesson_3

Stats 250 PreLab Summary

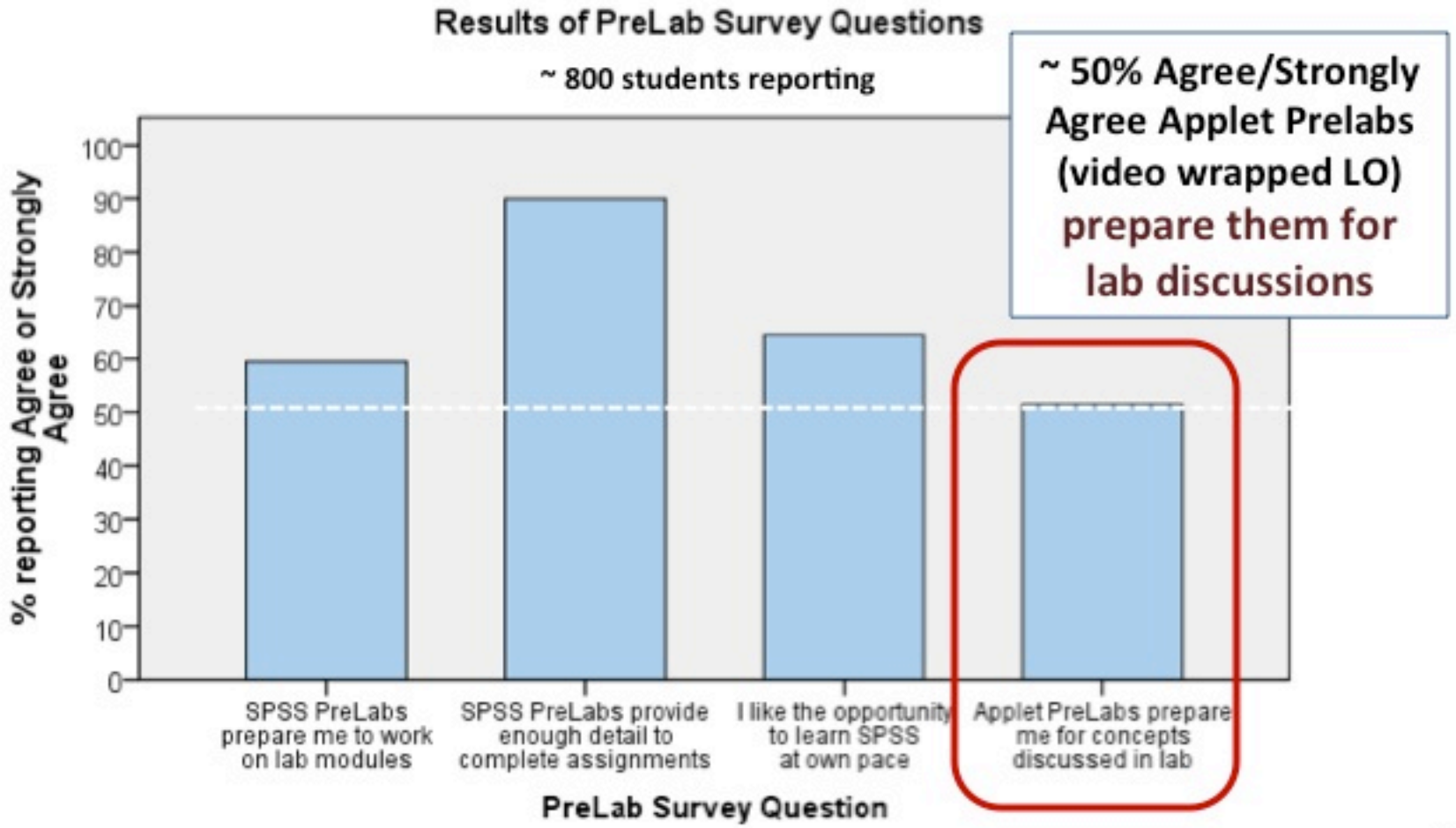
- **GSIs loved them!**
  Students came more prepared for upcoming discussion topic.
- **GSI comment:** "***My students came to lab with questions***. ***They were curious*** *as to why they observed the results they did in the prelab, and wanted to ask questions and better understand.* ***Making them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

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

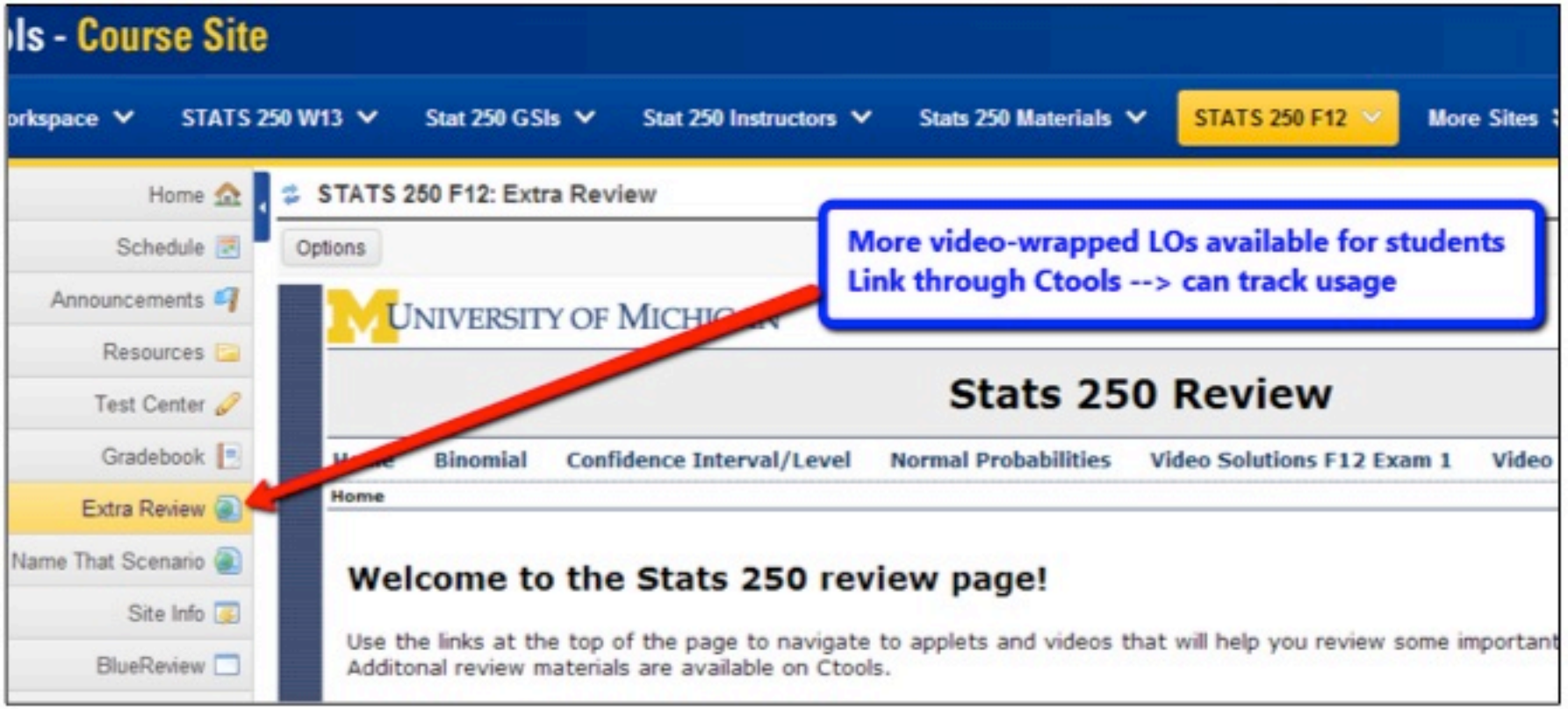
- **Students liked them!** Able to cover PreLabs at own pace, came to labs prepared to discuss and learn.
- **Student comment:** *"They are pretty useful, but the* ***applet based ones are the most useful.***"

Stats 250 PreLab Summary

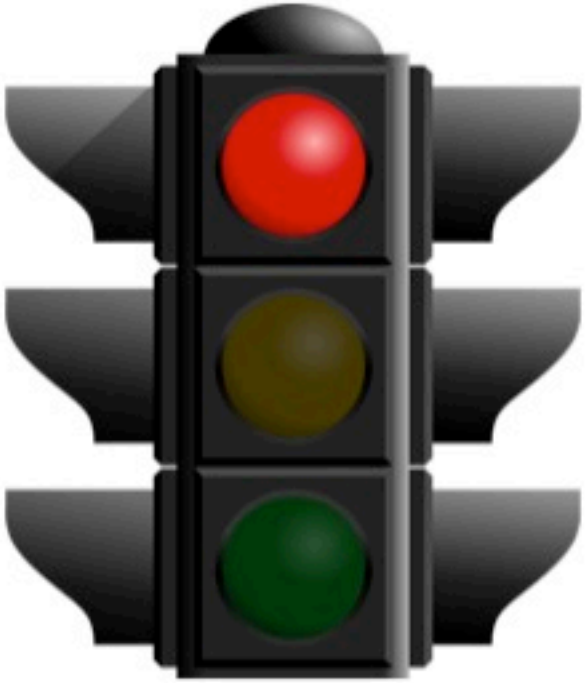
Survey Results



More Stats 250 Video-Wrapped LOs



Perceived Barriers Alter
to using technology in teaching or learning

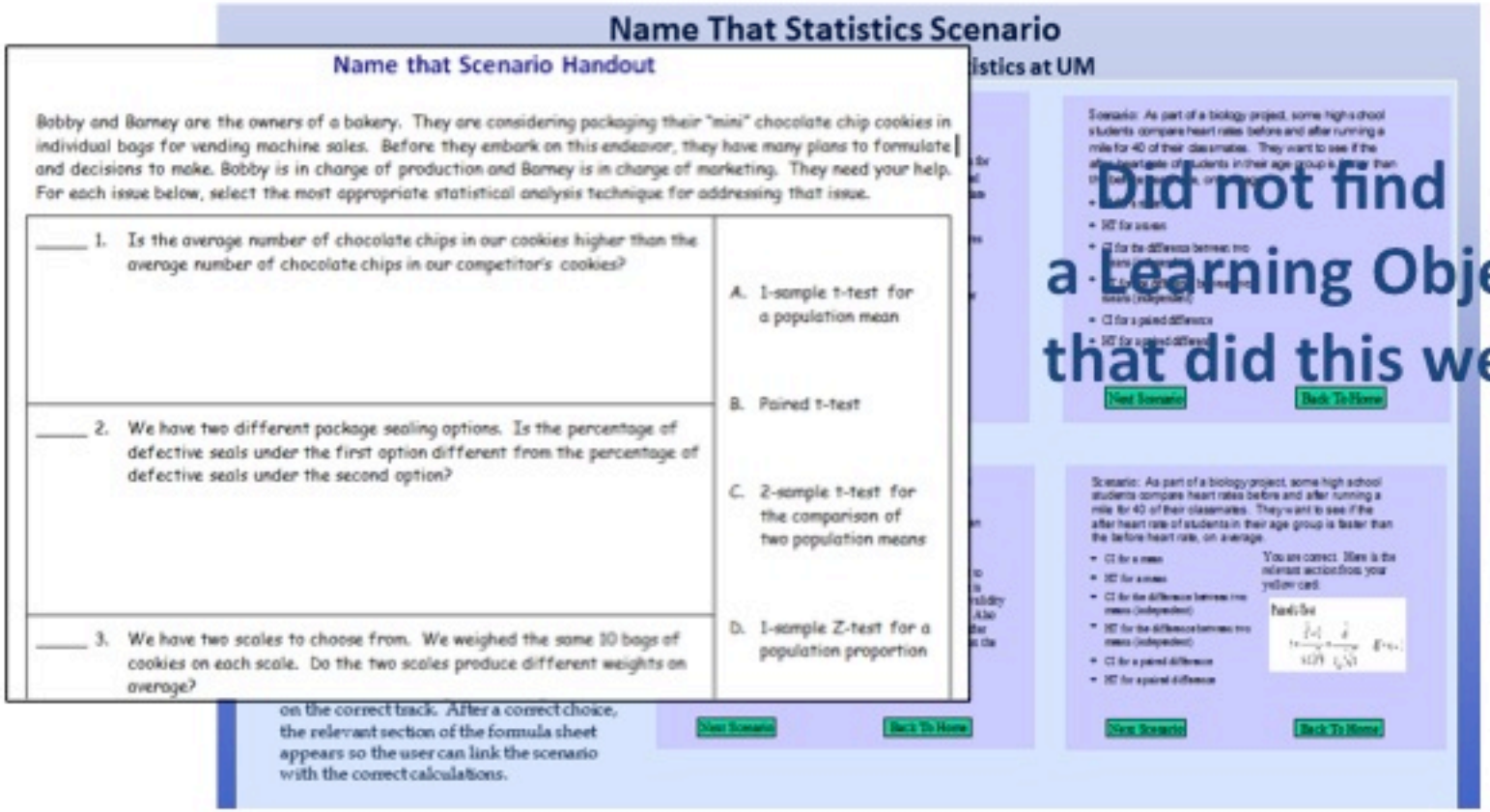


Quality online learning objects that **address key course concepts do NOT exist!**

Example Barrier

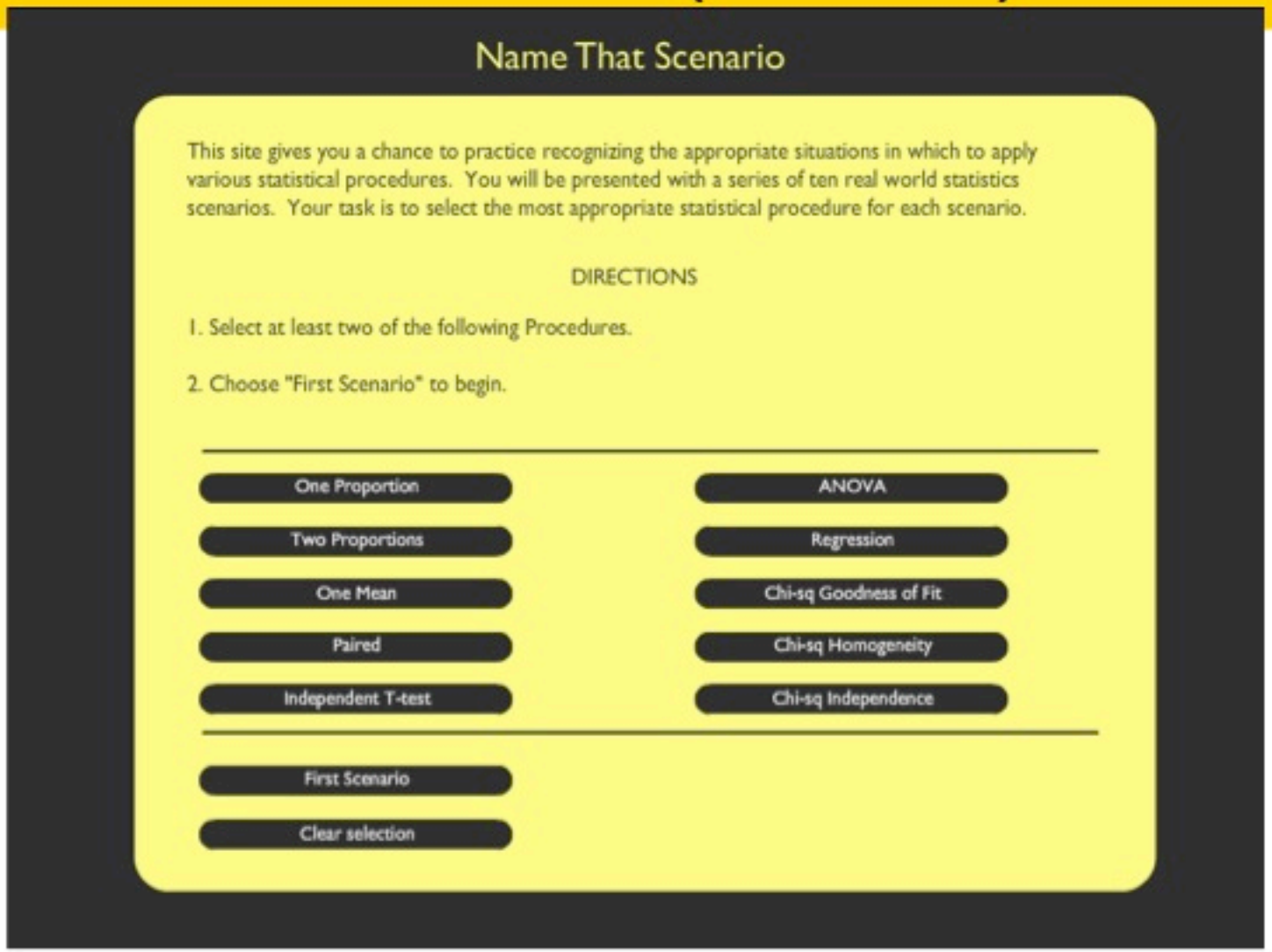
LO did not Exist!

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



Name That Scenario

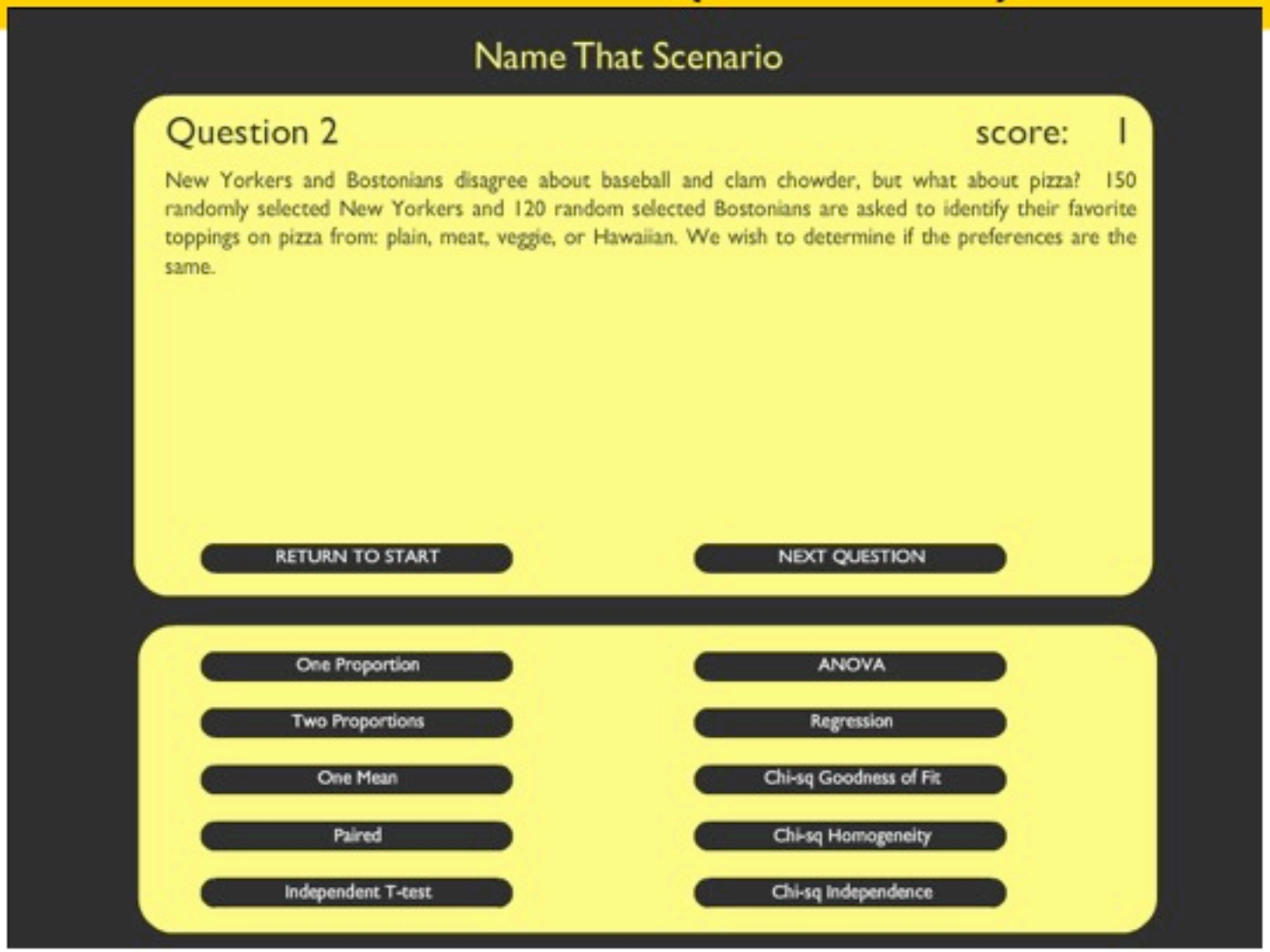
Authored LO (Statistics)



http://sitemaker.umich.edu/name.that.scenario/nts

Name That Scenario

Authored LO (Statistics)



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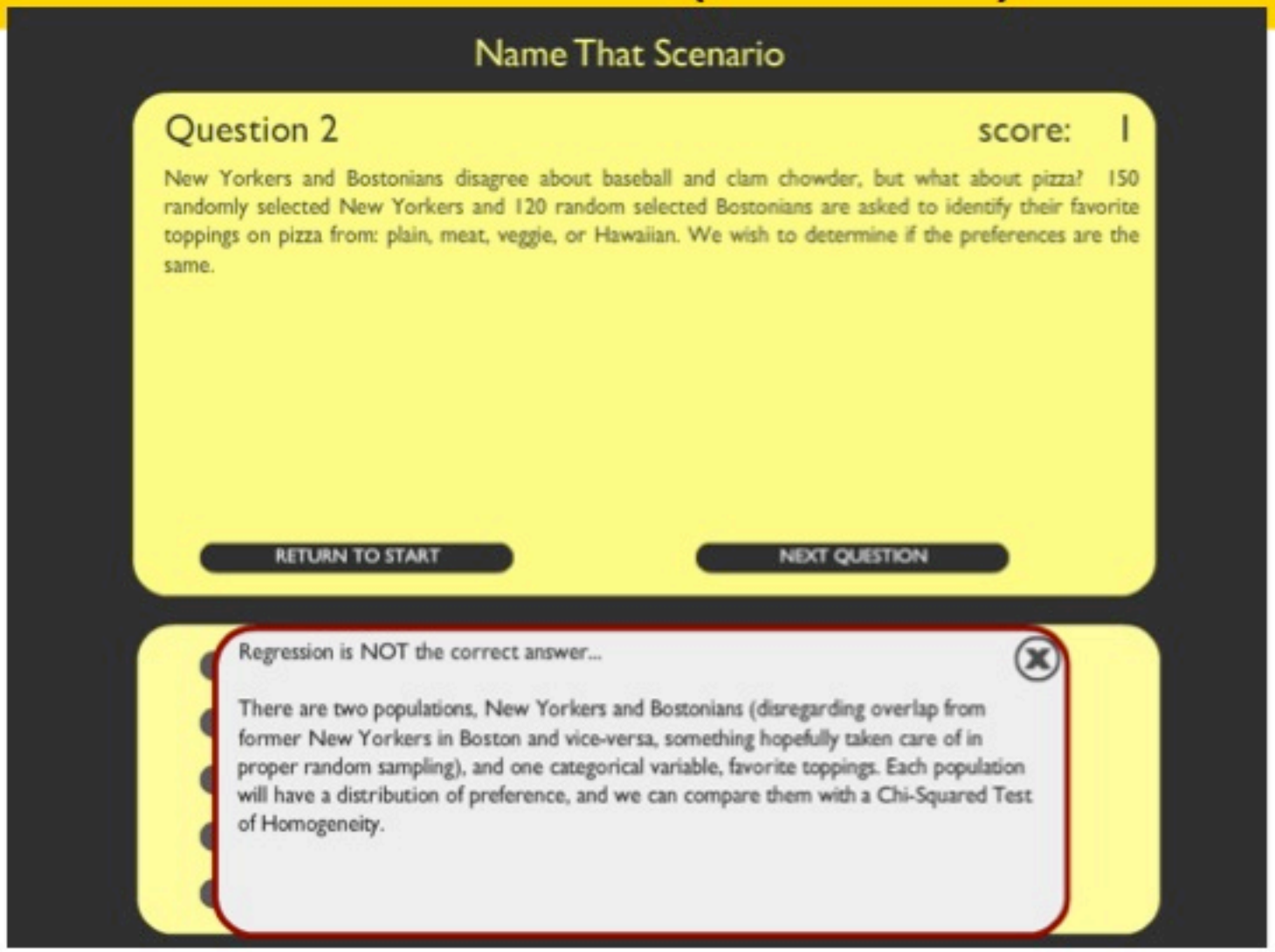


http://sitemaker.umich.edu/name.that.scenario/nts

Student Survey

Spring 2011

Easy to Use

Helpful

Fun

High Quality

Just Right Level

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

	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

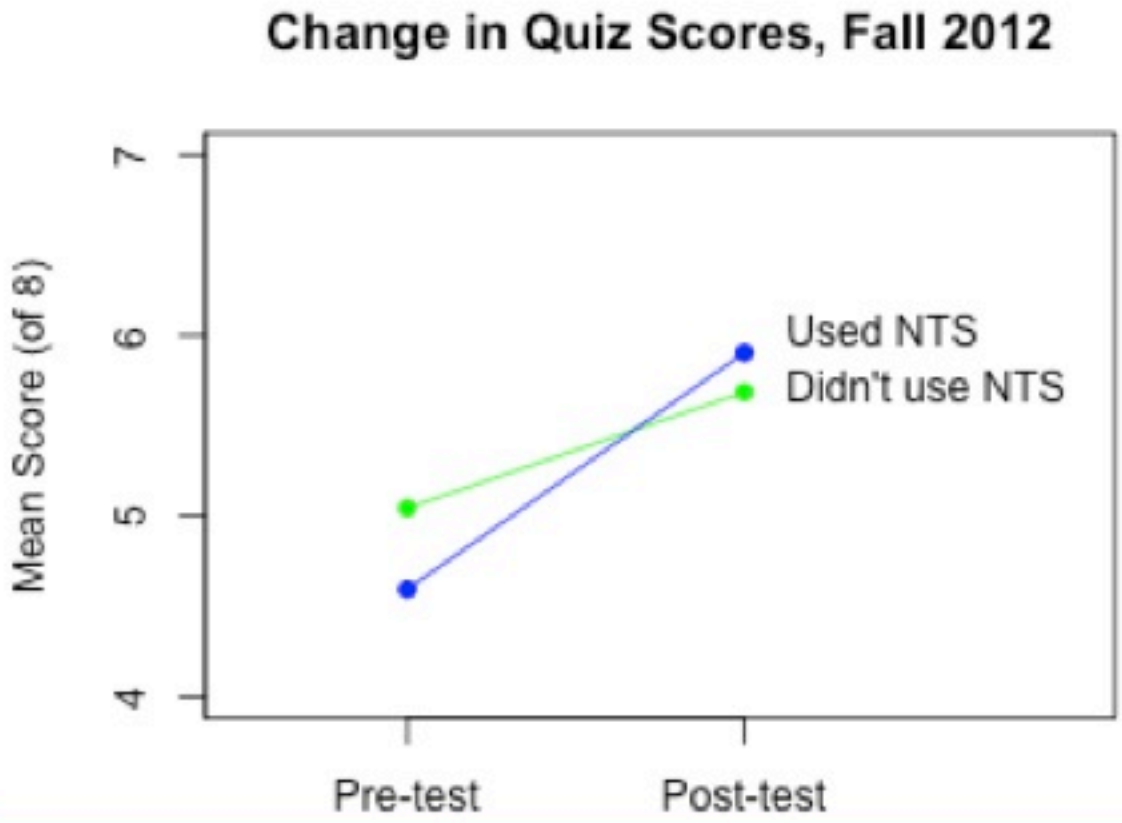
Assessing Impact:
Pre to Post Quiz Scores (NTS user vs non-user)

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

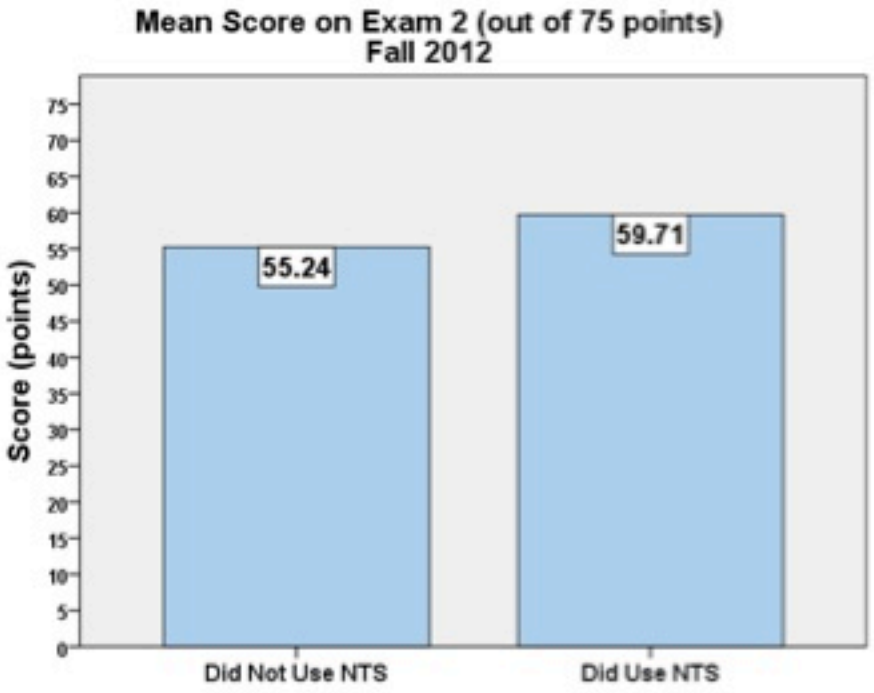
Lab 2: NTS Post Quiz (8 points)

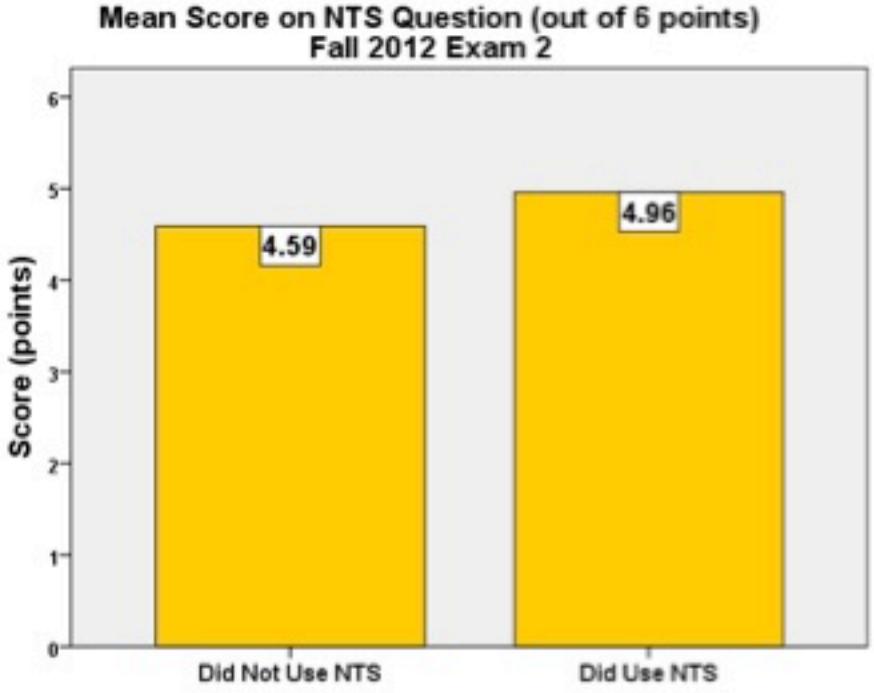
Assessing Impact:
Pre to Post Quiz Scores (NTS user vs non-user)



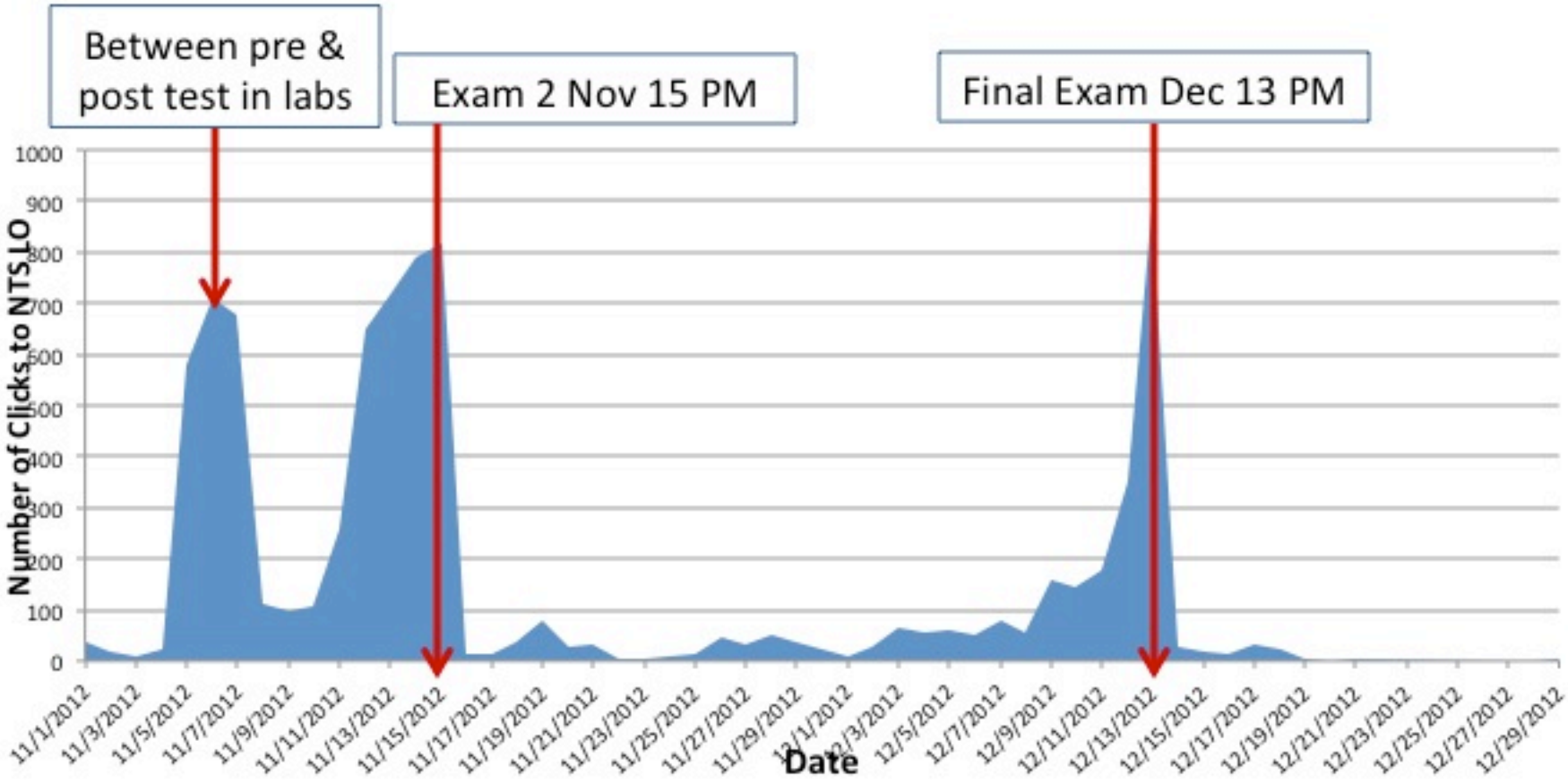
Used NTS: 70%, mean improvement 1.30 pts
Didn't use NTS: 30%, mean improvement 0.65 pts
(*p-value* < 0.001)

Assessing Impact:
Exam 2 Total and Specific NTS Question





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)

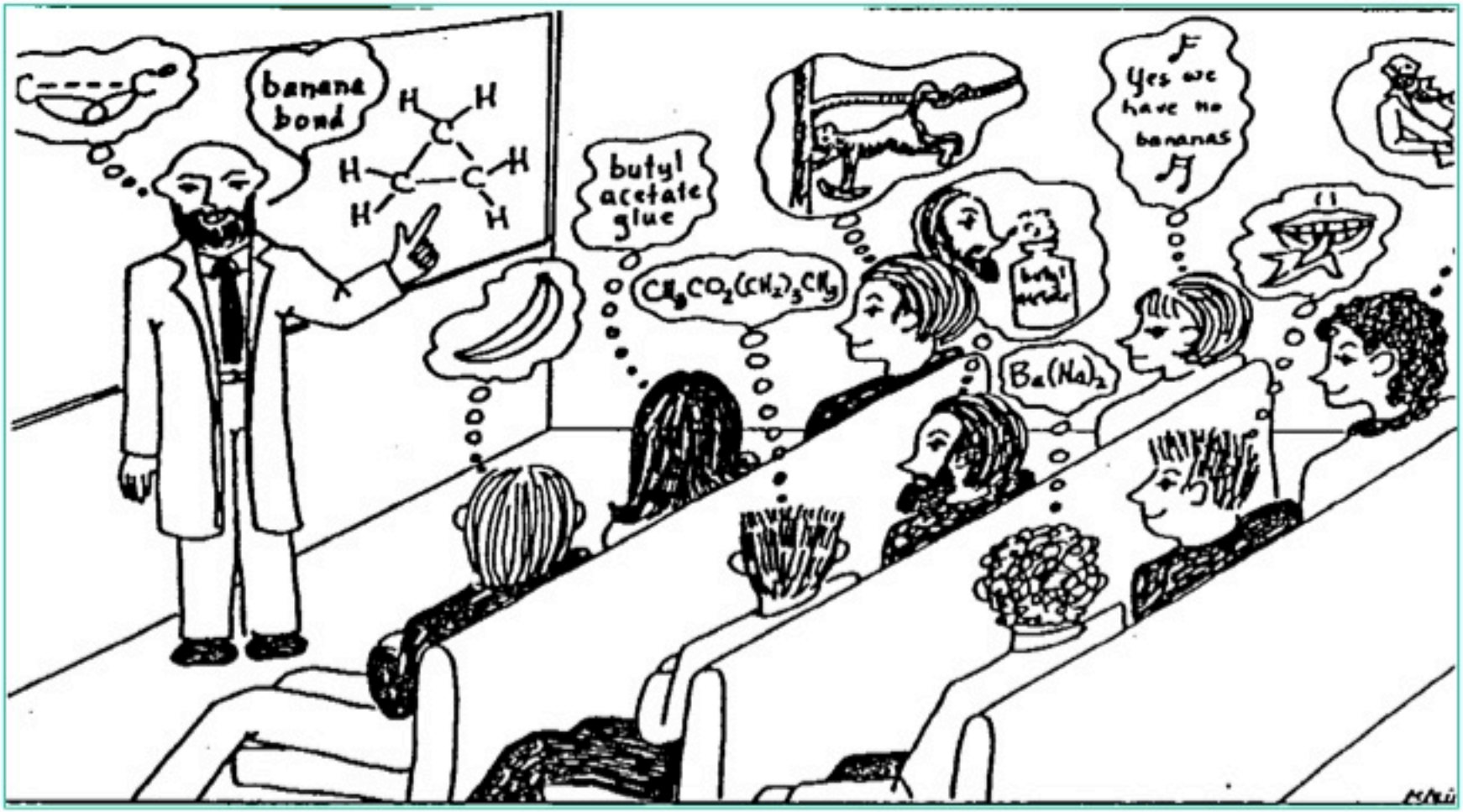
GOAL – To provide the necessary background knowledge and skills needed for lab and discussion components

Transforming Lecture

Why?

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

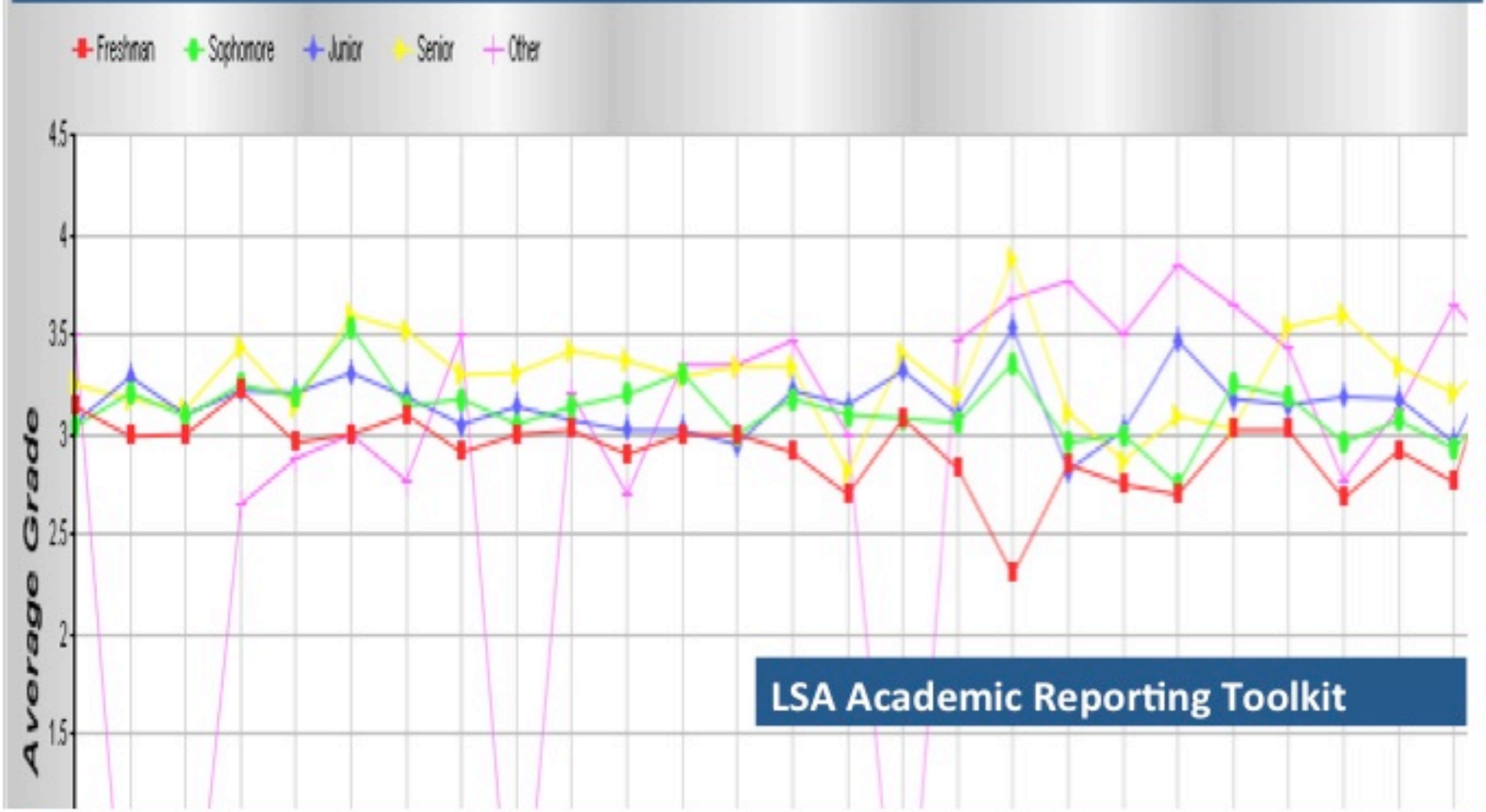
Transforming Lecture



- 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?

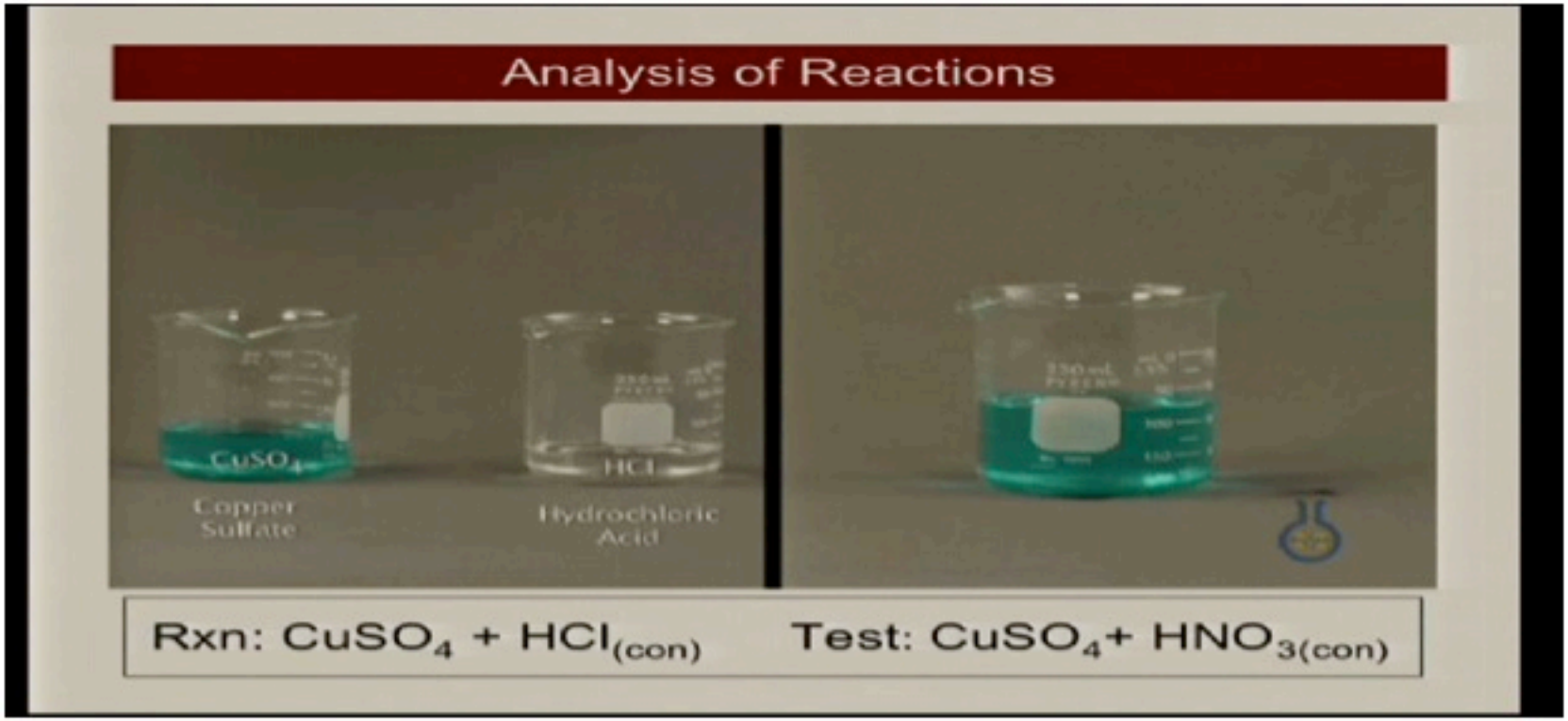
Implementation

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)



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.podcasting for learning.com

Transforming Lecture

Podcasts Yield Positive Shift in Grades

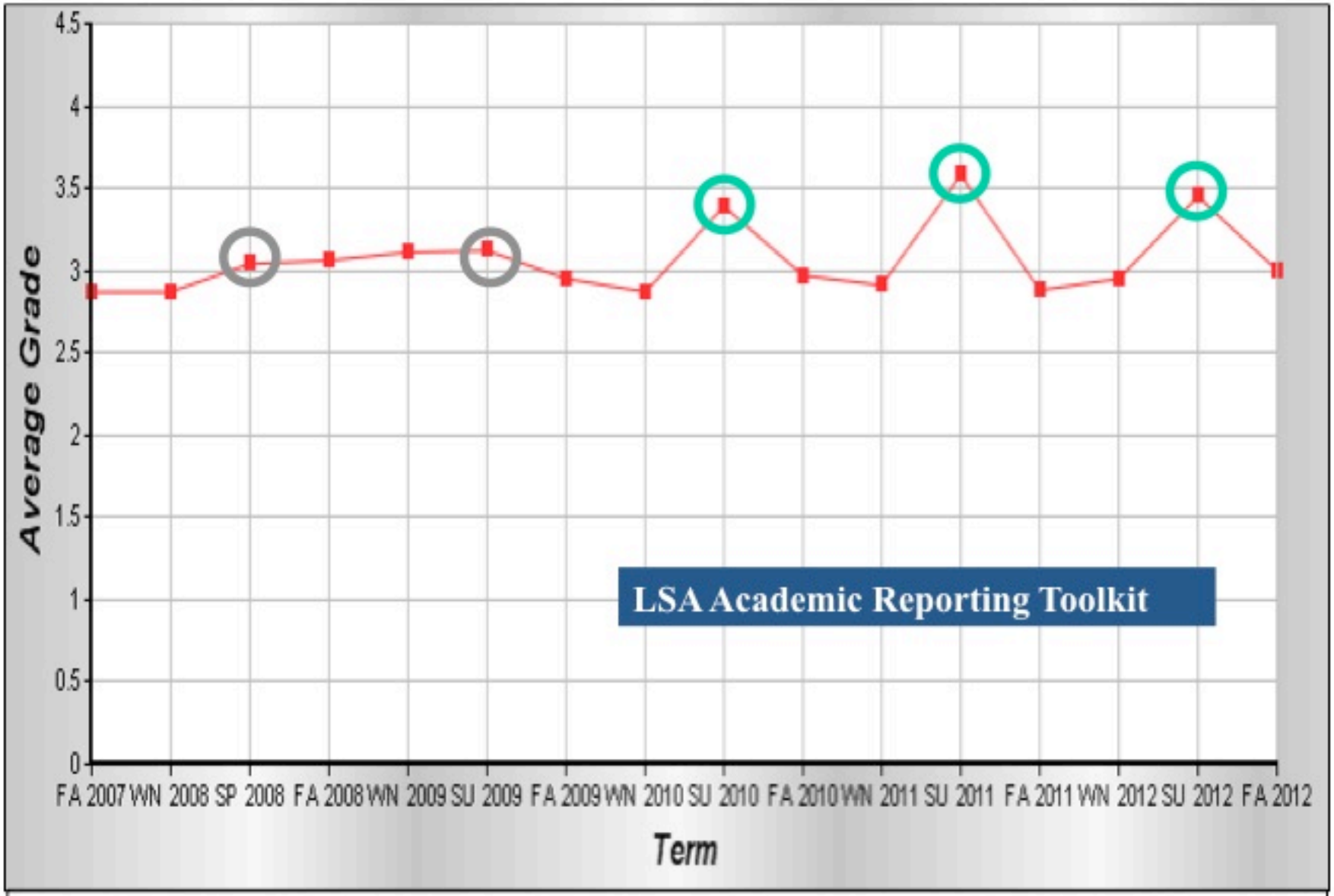
- Summer 2010 students could view **podcasts before** (and after) **the "live" lecture**
- Identical term exams given summer 2009 and 2010
- Student composition similar to prior summer term

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%



Average Grade Pre and Post 2010 Summer Interventions

Chem125 Podcast Survey*

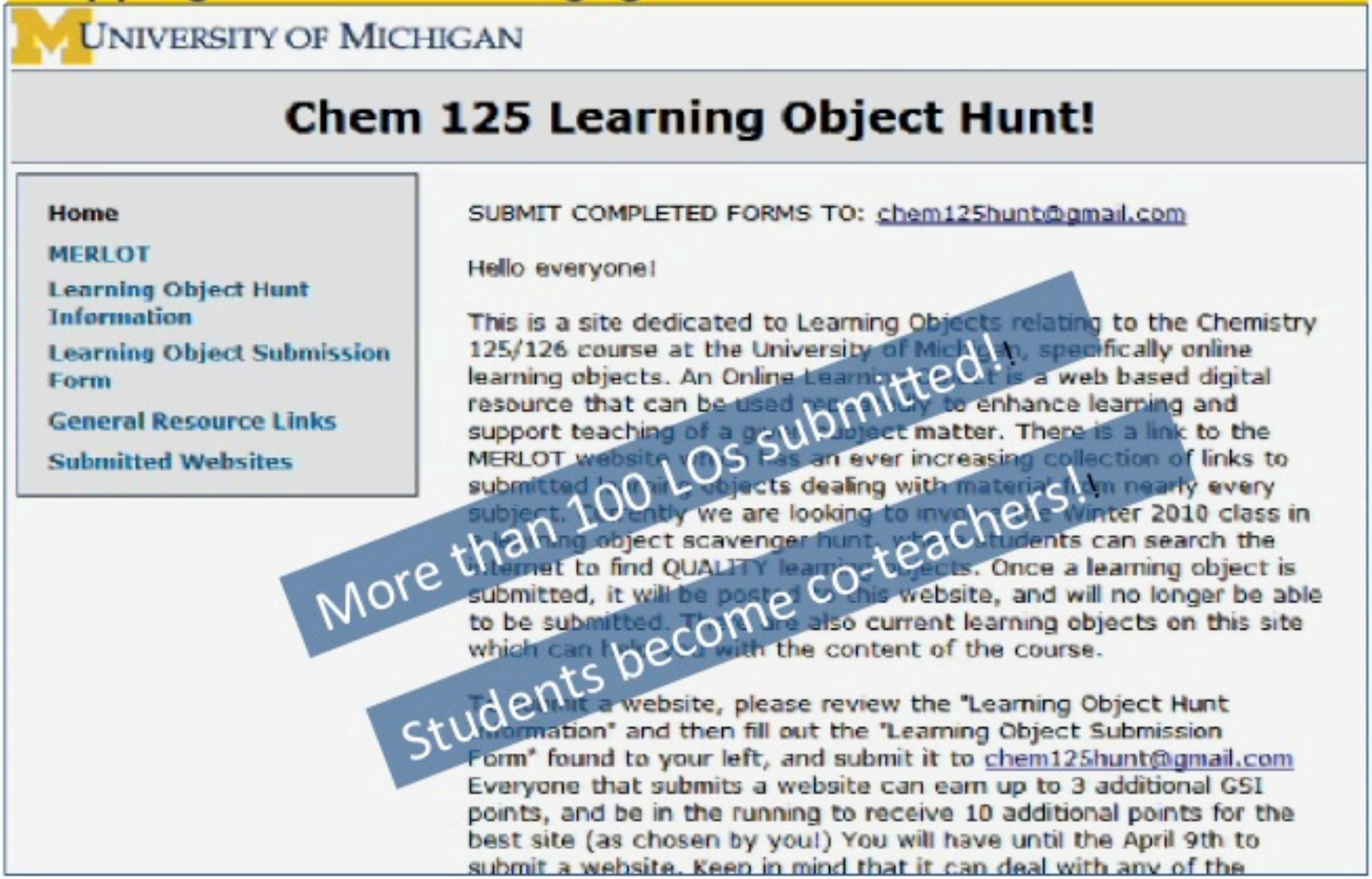
What are the **major strengths** to using podcasts? (What about the podcasts helped you learn?)*

- *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



More than 100 LOs submitted!

Students become co-teachers!

Online LO Resources (C-Tools)

Title
Online Learning Resources
Cross-discipline LOs.pdf
OnlinePeriodicTableResources.pdf
Experiment1LOs.pdf
Experiment2LOs.pdf
Experiment3LOs.pdf
Experiment4LOs.pdf
Experiment5LOs.pdf

Transforming Lecture

Multimedia Online Materials

- Interactive website with personalized learning path

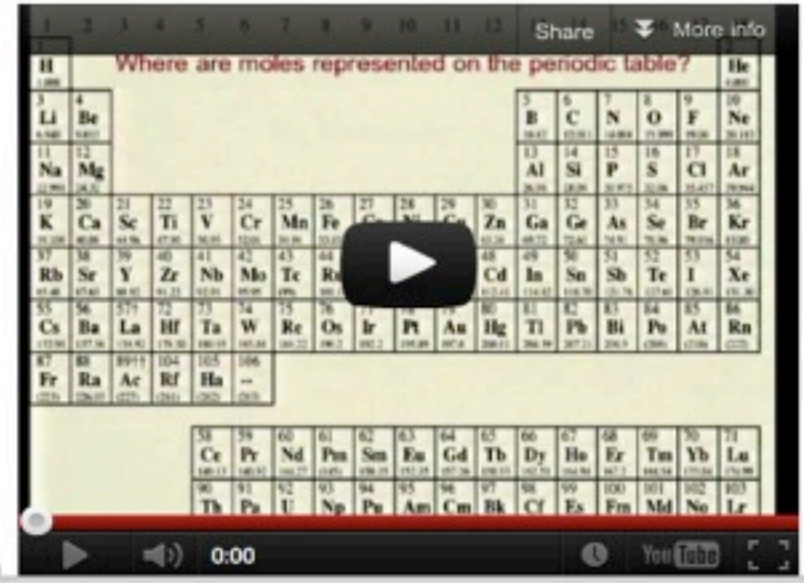
- http://www.umich.edu/~chem125/softchalk/exp1_final/

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 6.02×10^{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 6.02×10^{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 6.02×10^{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.

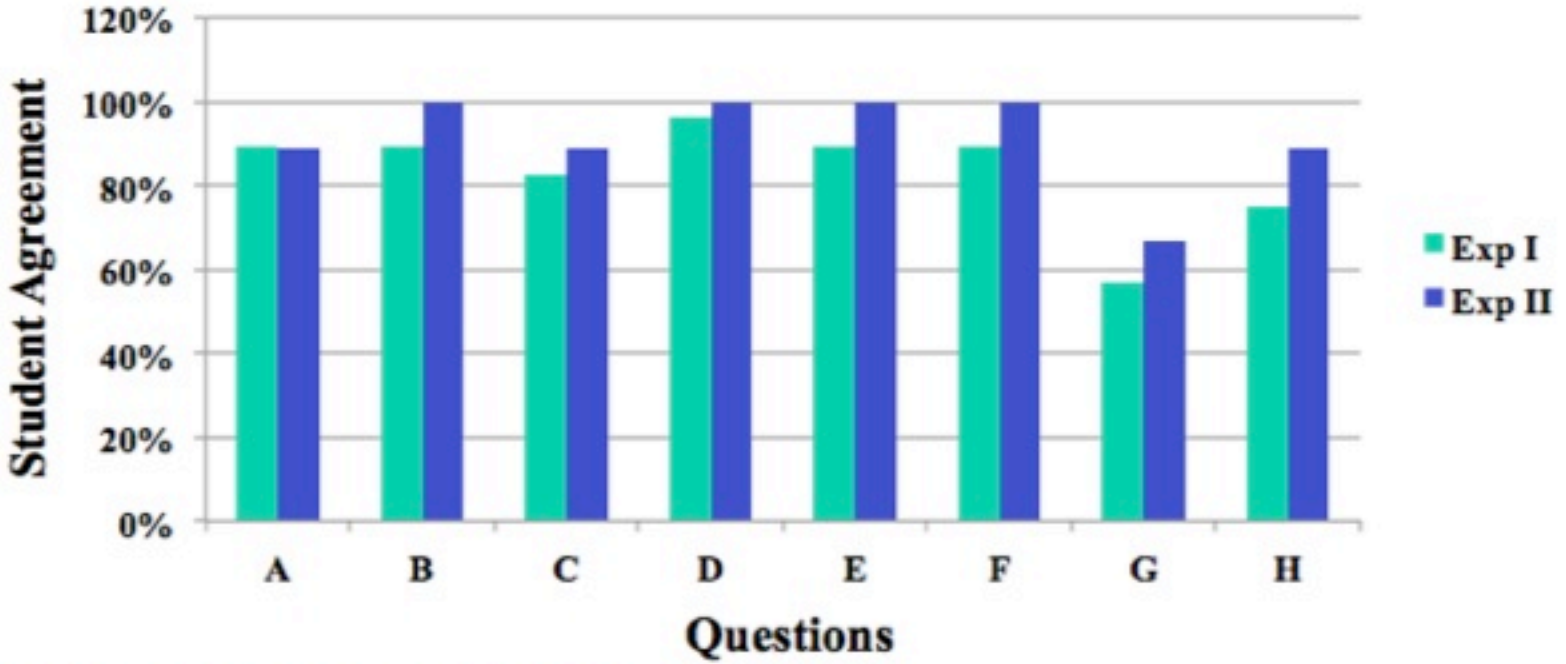


Chem125 Soft Chalk E2Draft Survey Winter 2011

Which aspects of this interactive online presentation were most helpful to your learning as you prepared for lab. Why?

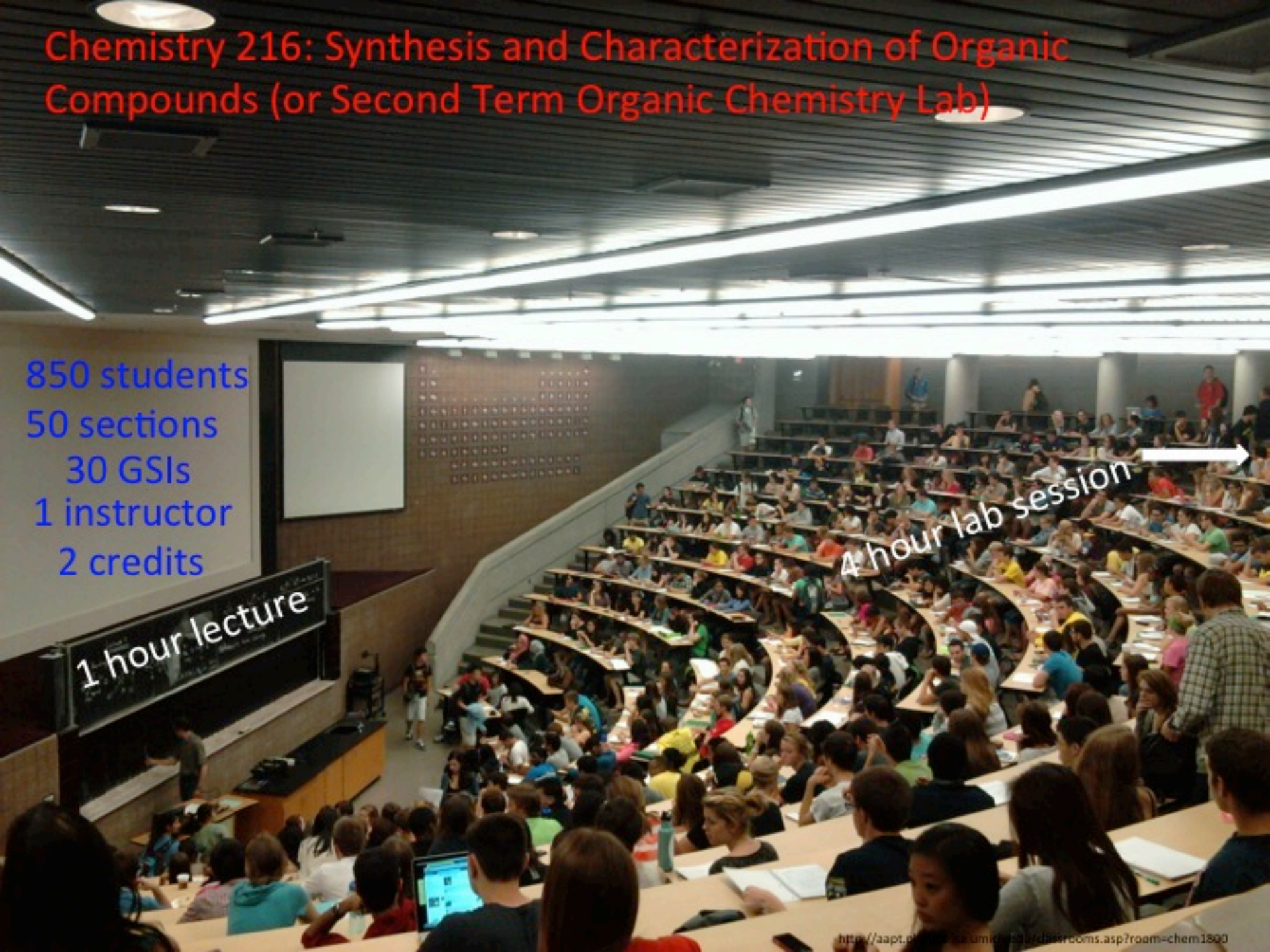
- *The **interactive visuals** because they **allowed me to see the concepts** in action **and understand** what was explained.*
- *I definitely liked **seeing the process done in demos. I am a visual learner** and trying to understand the procedure from reading the lab manual is not helpful.*
- *Liked how you could **go at your own pace**.*

Chem125 SoftChalk Survey: Winter 2012

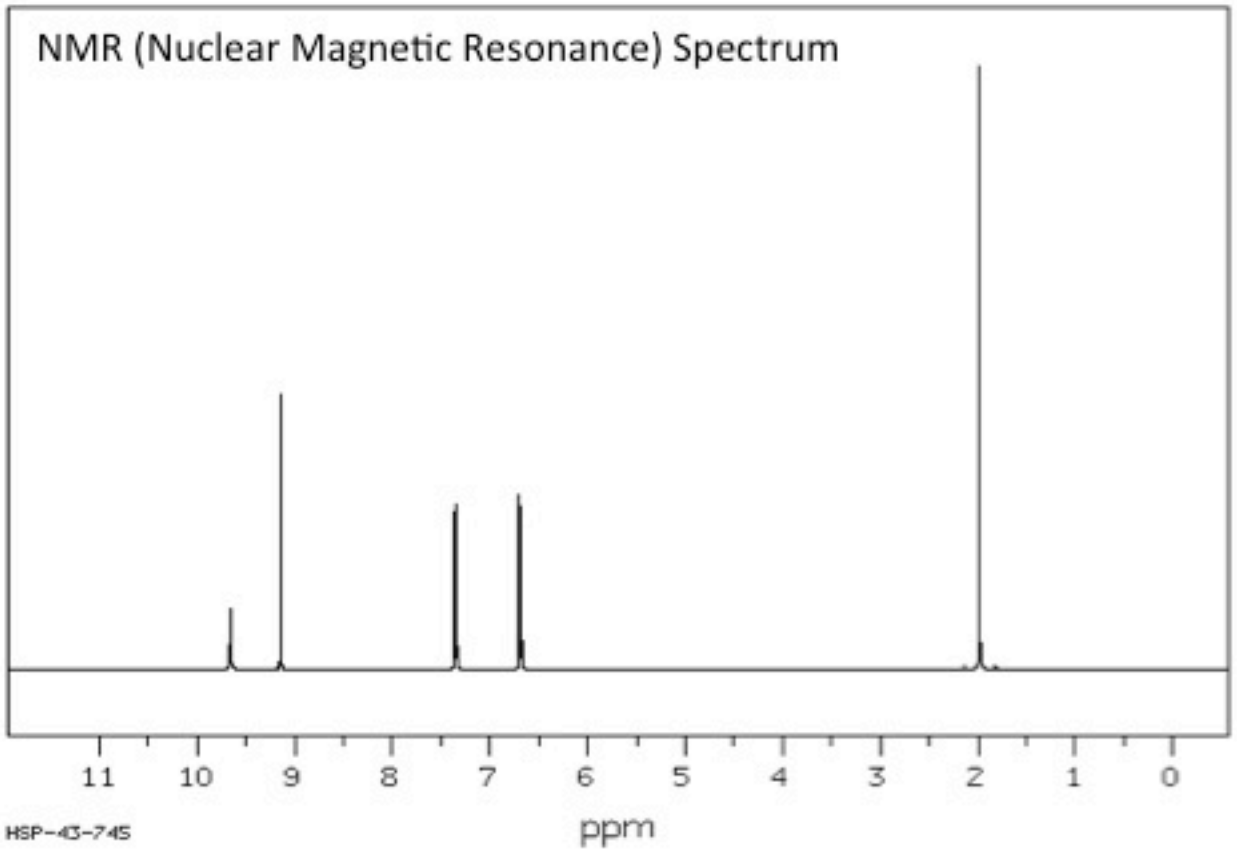


a) Valuable addition to lecture
b) Helped me to feel more prepared for the lab experiment
c) Helped me to successfully complete the lab experiment
d) Enhanced my understanding by introducing me to needed terminology
e) Enhanced my understanding by introducing me to needed skills
f) Were a valuable addition 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)



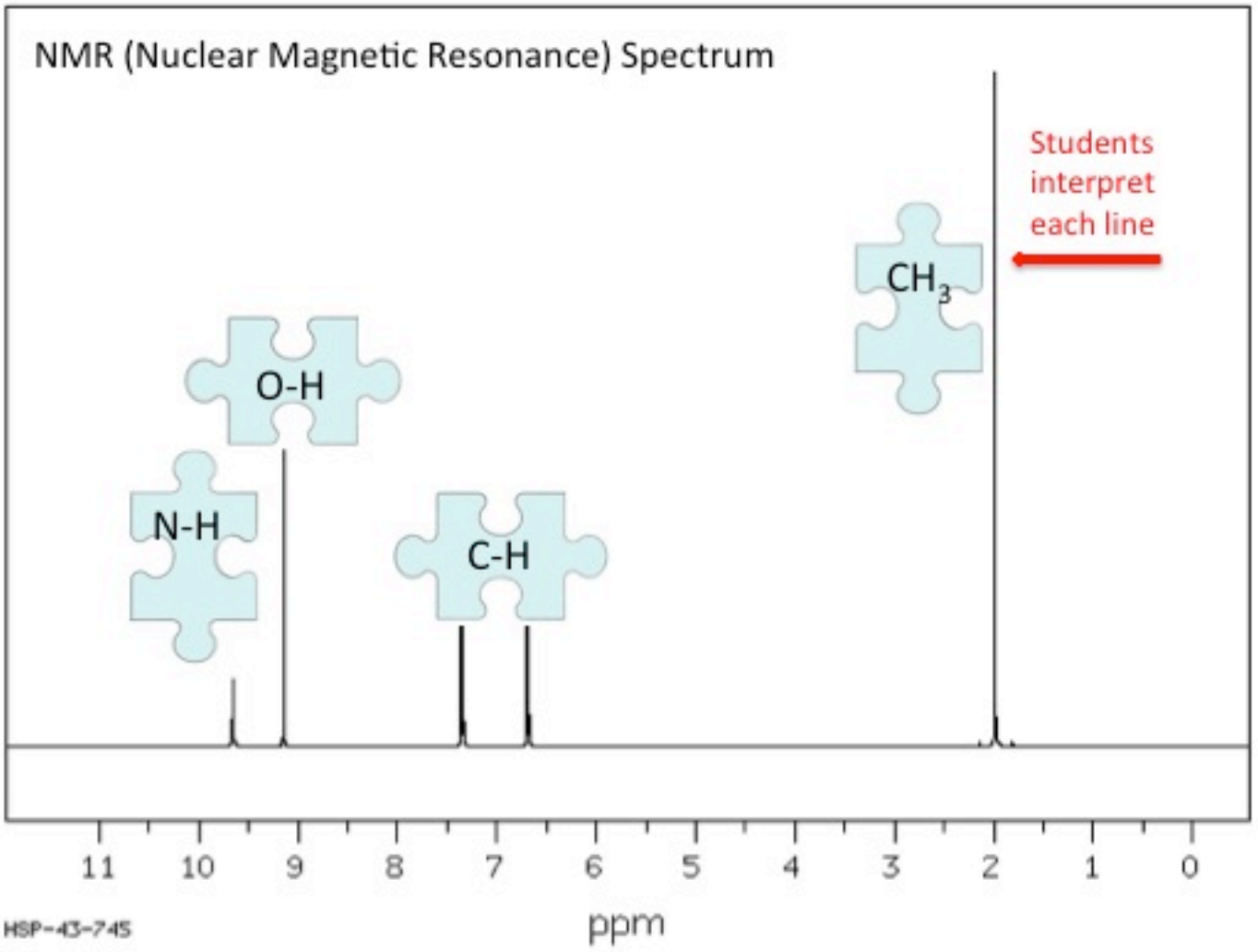
Most Challenging CHEM 216 Content: Spectroscopy



- 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/sdbs/cgi-bin/direct_frame_top.cgi

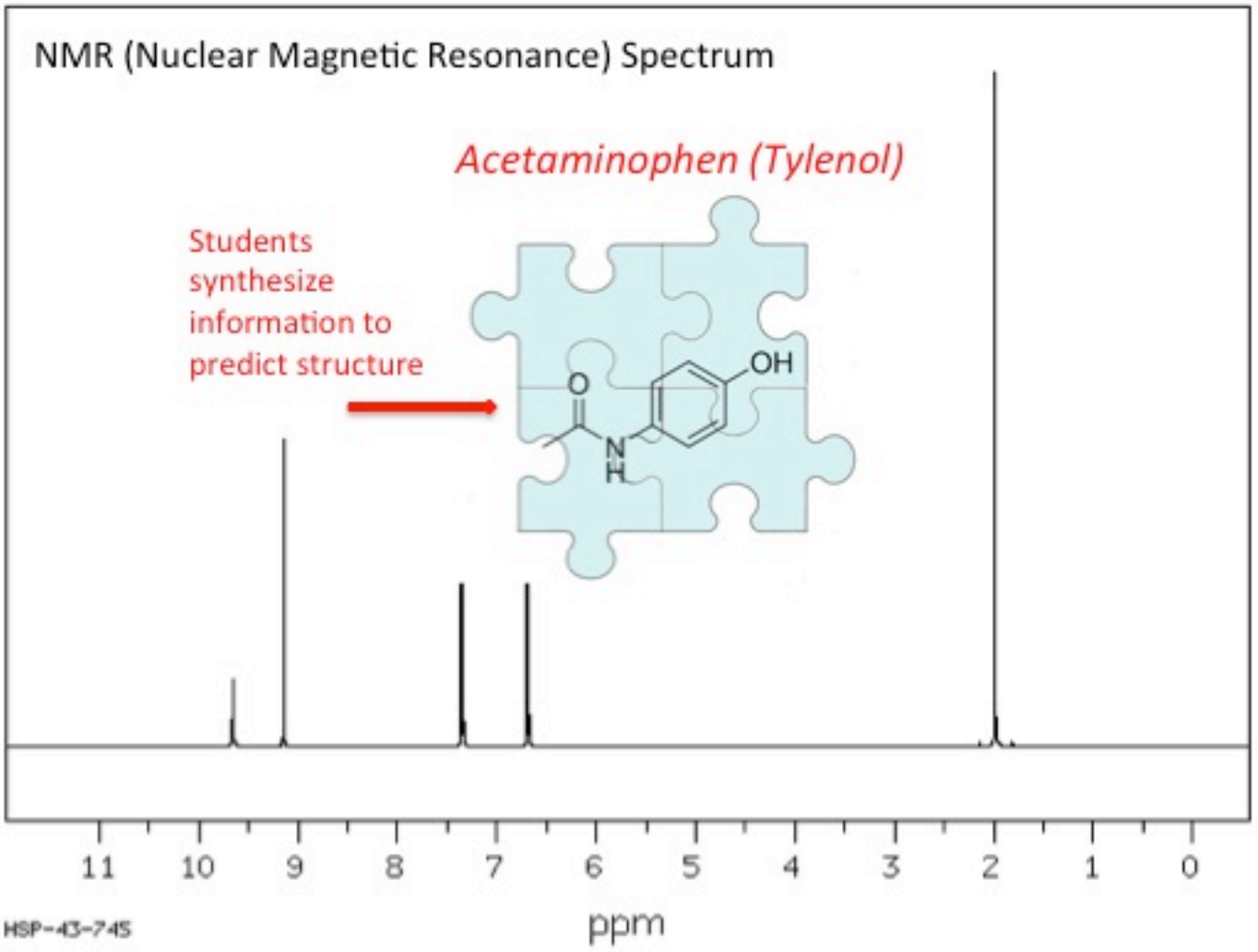
Most Challenging CHEM 216 Content: Spectroscopy



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



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 <u>practice</u> beyond what is offered in an typical organic chemistry textbook
- **Most Organic Chemistry focused Spectroscopy LOs provide an answer, <u>but not a solution</u>.**

Pedagogical Design for Learning Object Adaptation

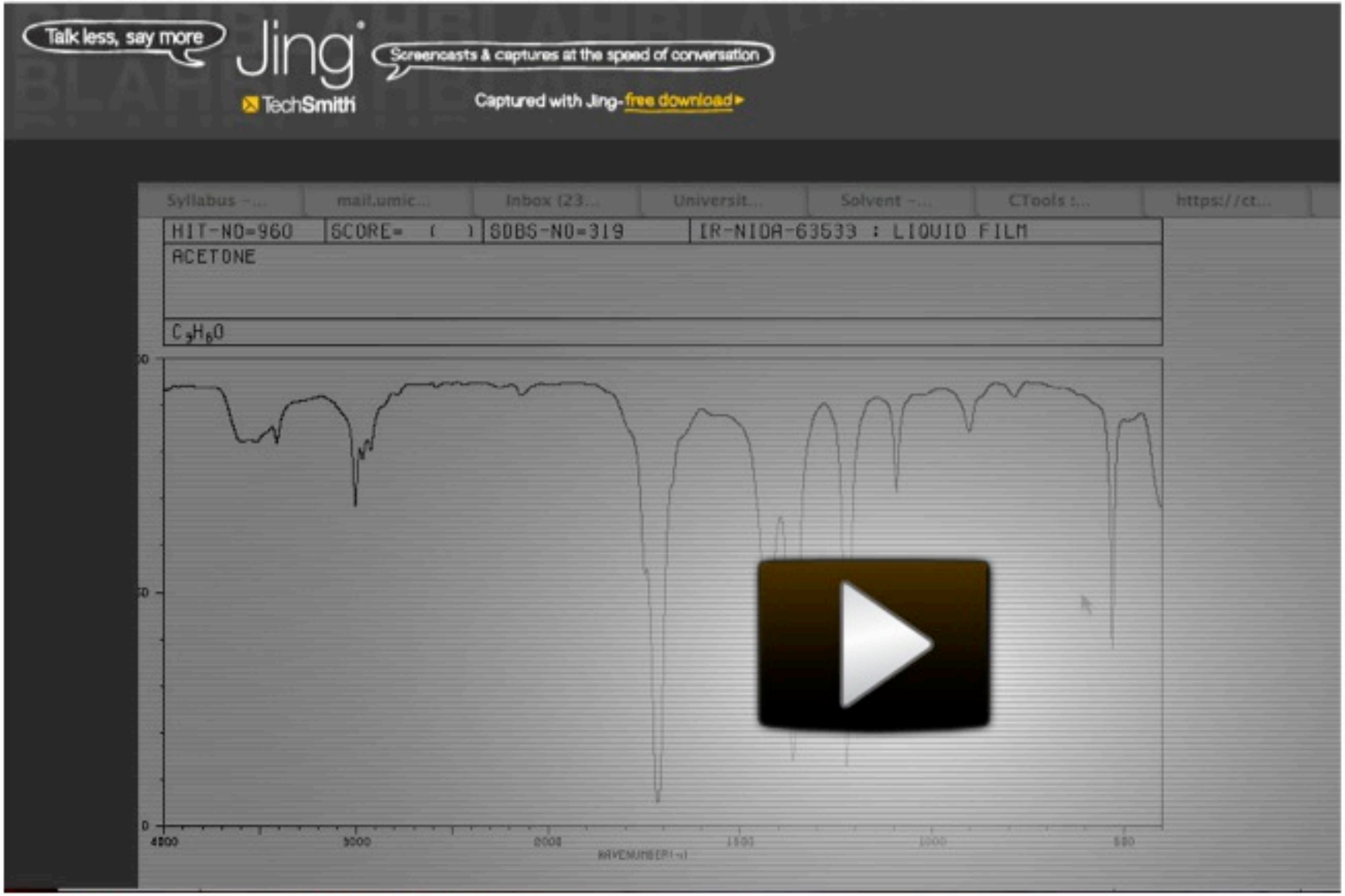
How do we elucidate the problem solving process using technology?

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?

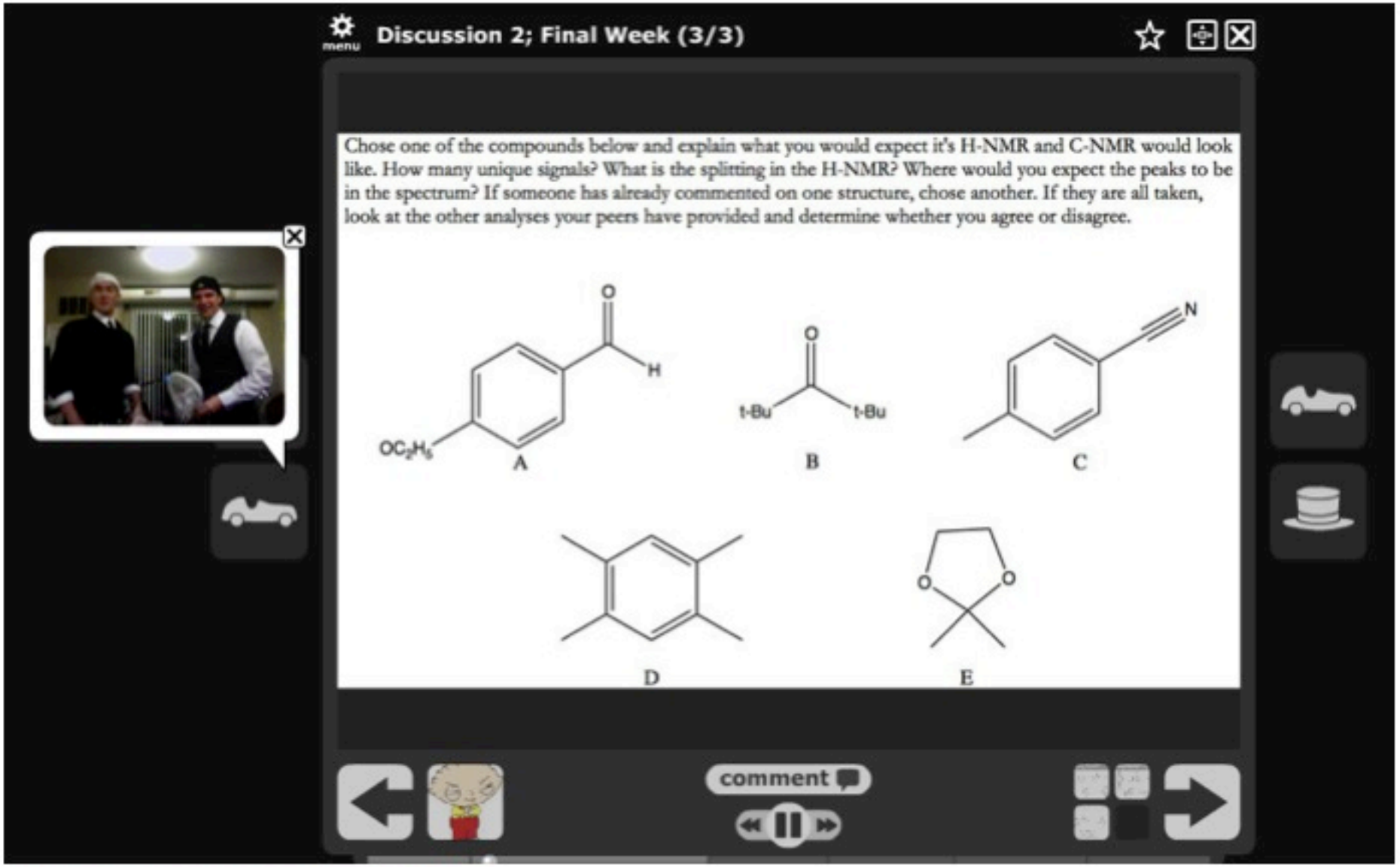
Screencast Tutorials



How does an expert solve this?

http://screencast.com/t/DGjsrbM9

Online Discussion Board: Voicethread



How do my peers solve this?

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

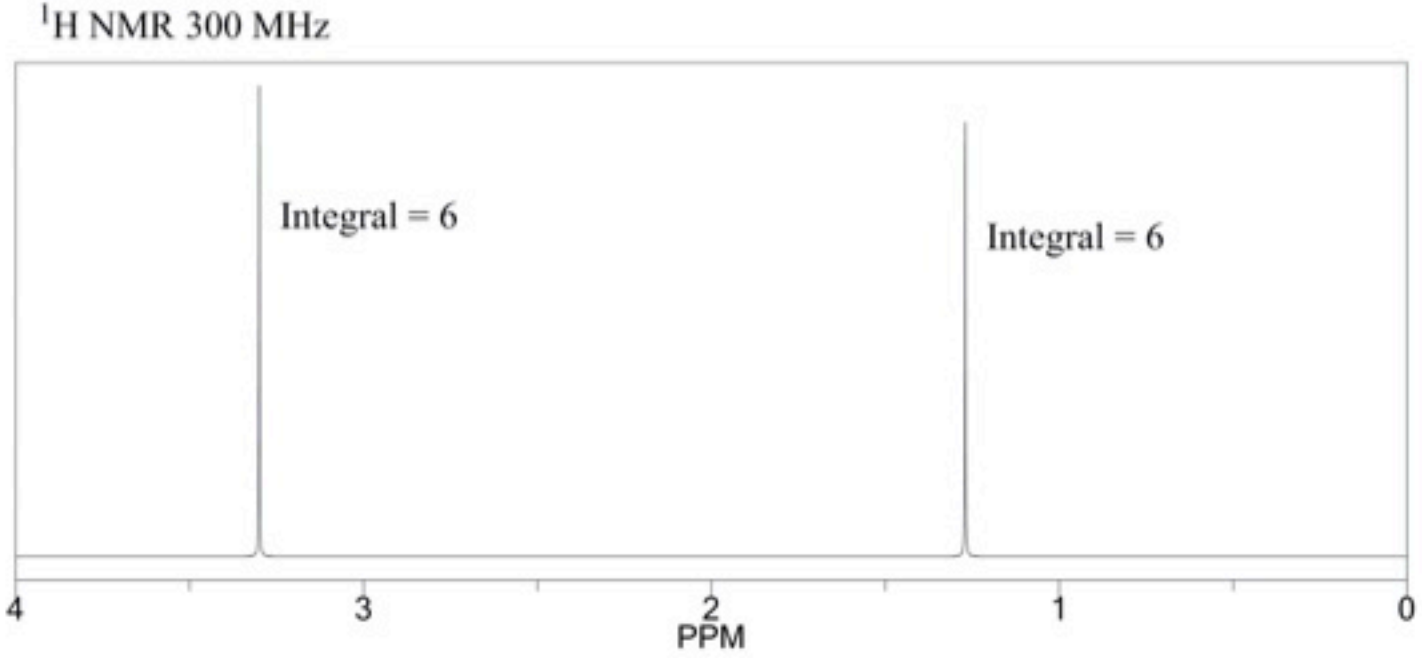
Small Scale Implementation: Fall 2011

Fall enrollment:	**Treatment group:**
23 lab sections, 359 students	3 lab sections, 47 students,
12.5 GSIs	3 GSIs

- **The treatment group** was given weekly homework and some of which included documented problem solving and is accompanied by screencast tutorials. Each students 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.

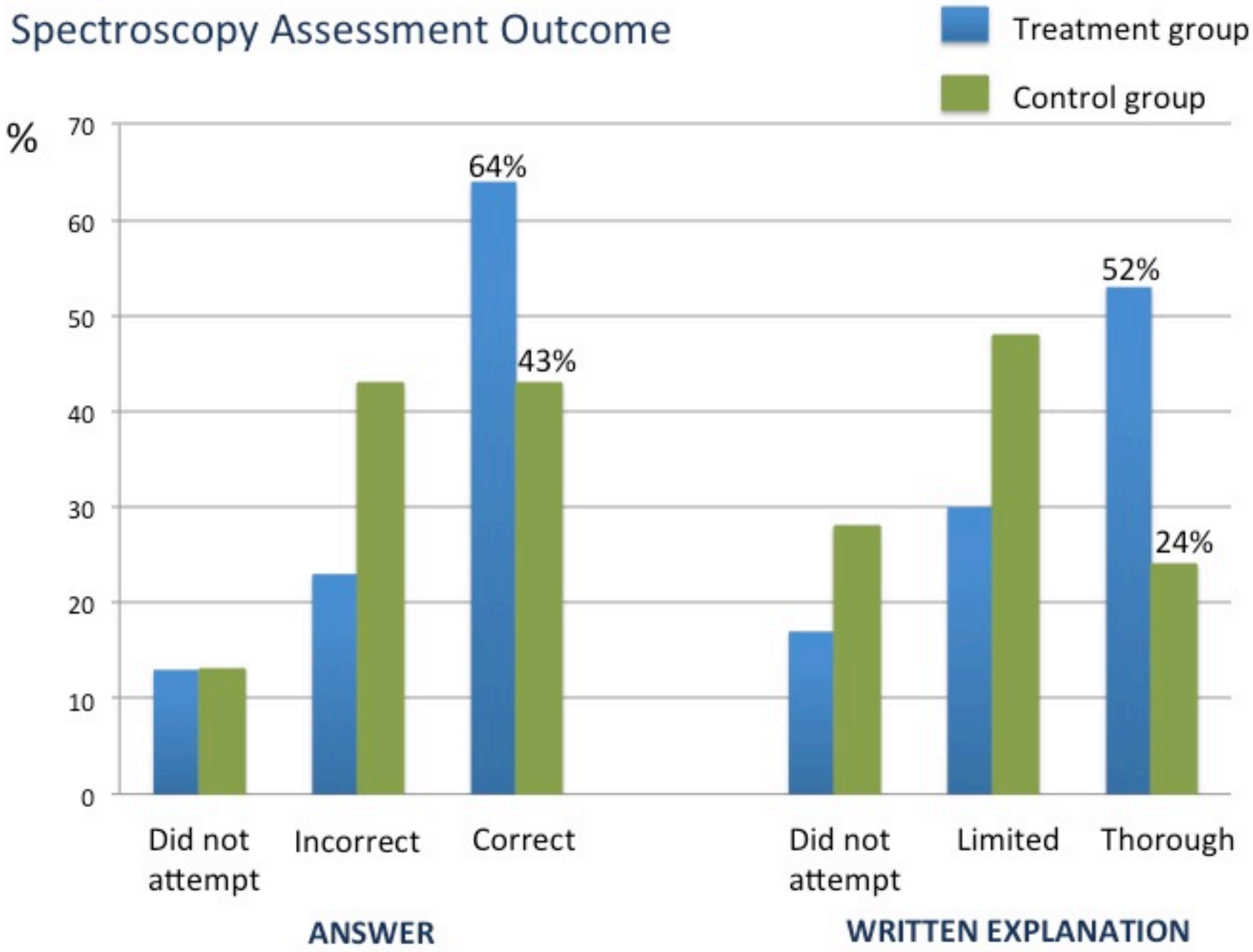
Pre/Post Term Spectroscopy Assessment

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

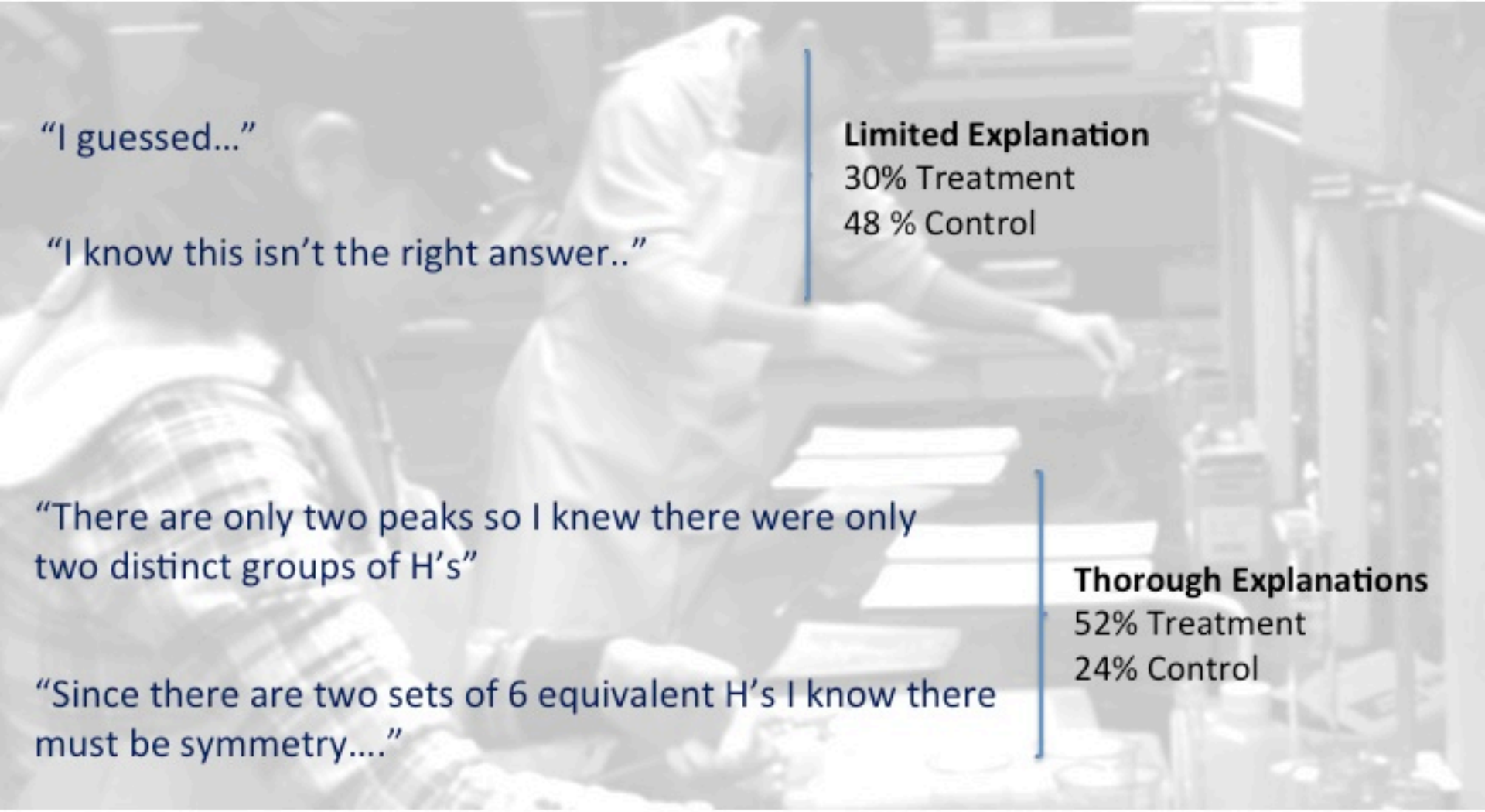


2. **Explain, in your own words, how you arrived at your answer.** Write as if you were explaining how to solve the problem to classmate. Feel free to draw on or label the spectrum above.

Spectroscopy Assessment Outcome



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

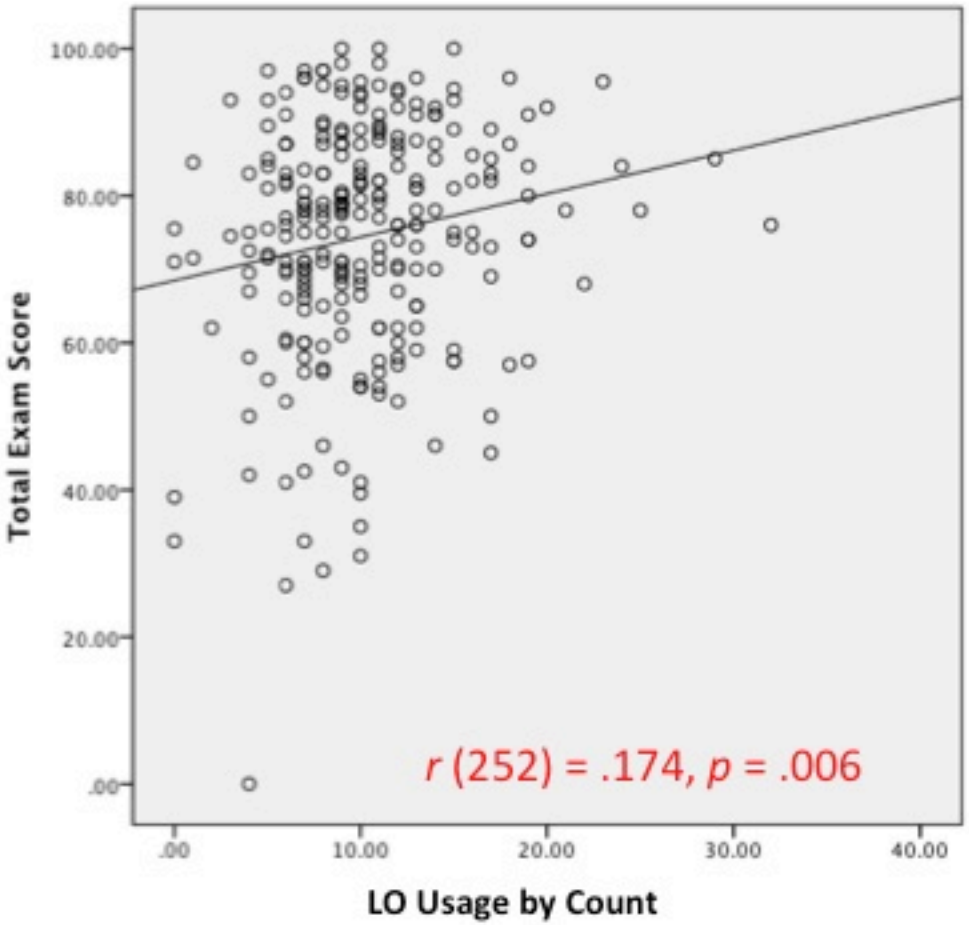
Course enrollment:
52 lab sections, 796 Students,
27 GSIs

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

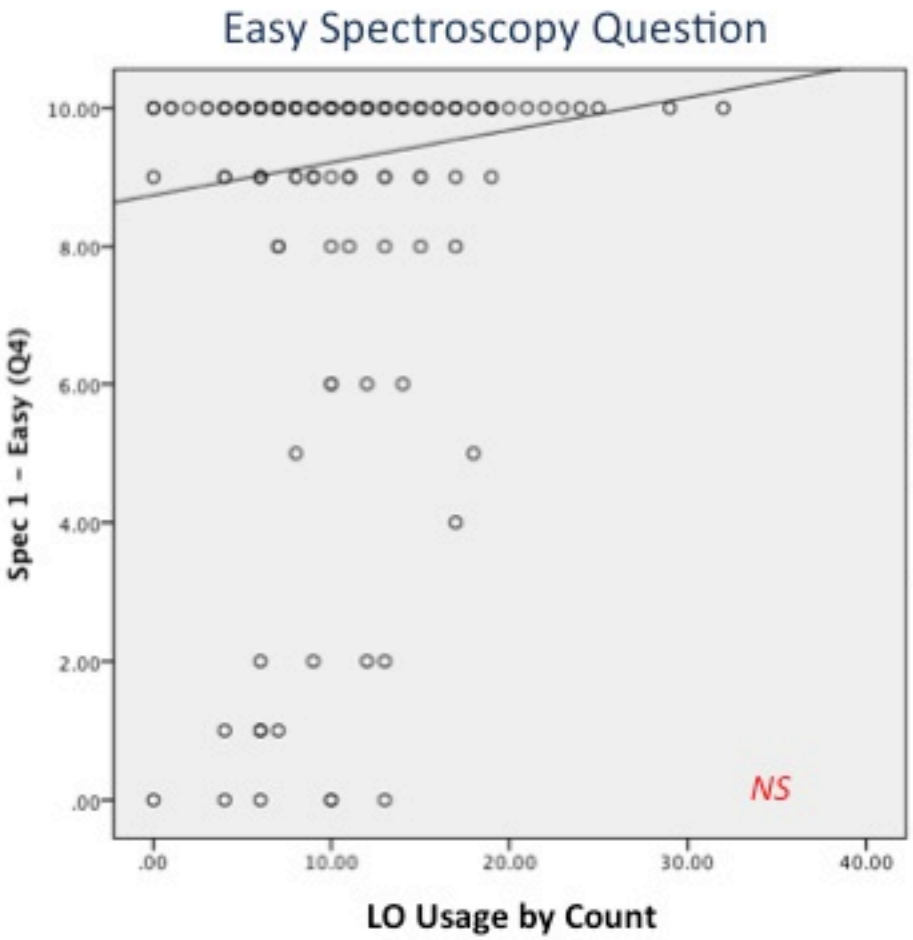
- CTools usage data was used in combination with exam data to probe learning gains

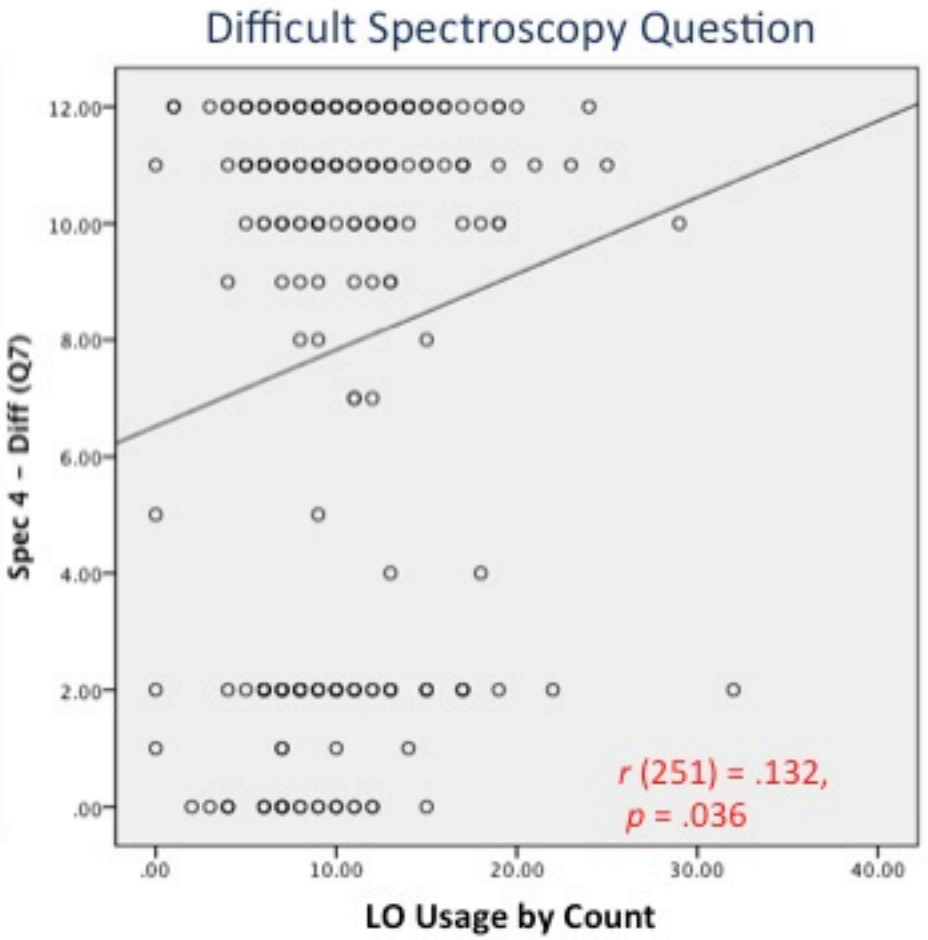
Correlation of Exam Performance to Learning Object Use

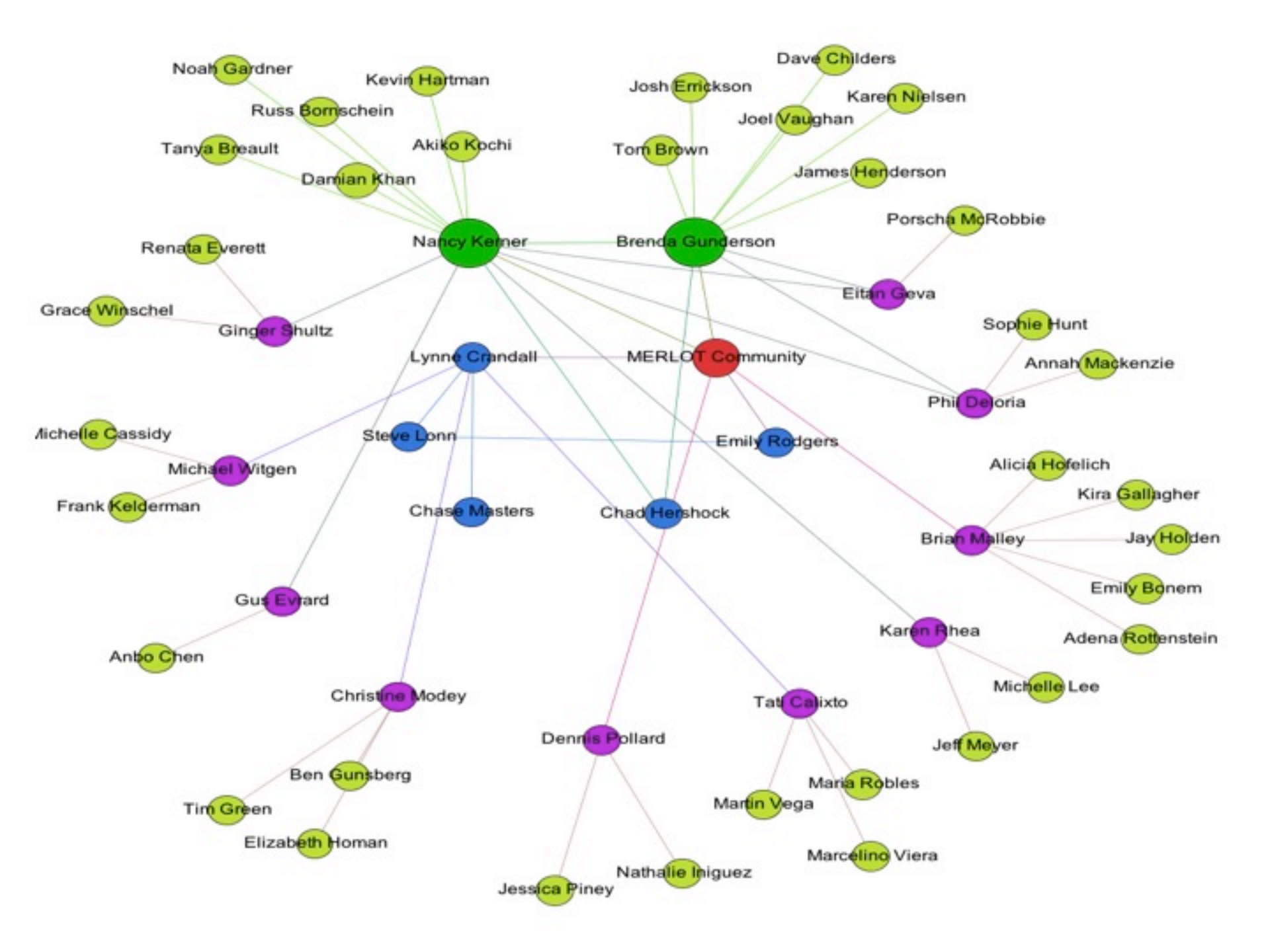


- LO usage positively impacted exam performance
- Exam included other content in addition to spectrscopy

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



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Eitan Geva
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Ginger Shultz
Sophie Hunt
Annah Mackenzie
Lynne Crandall
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Phil Deloria
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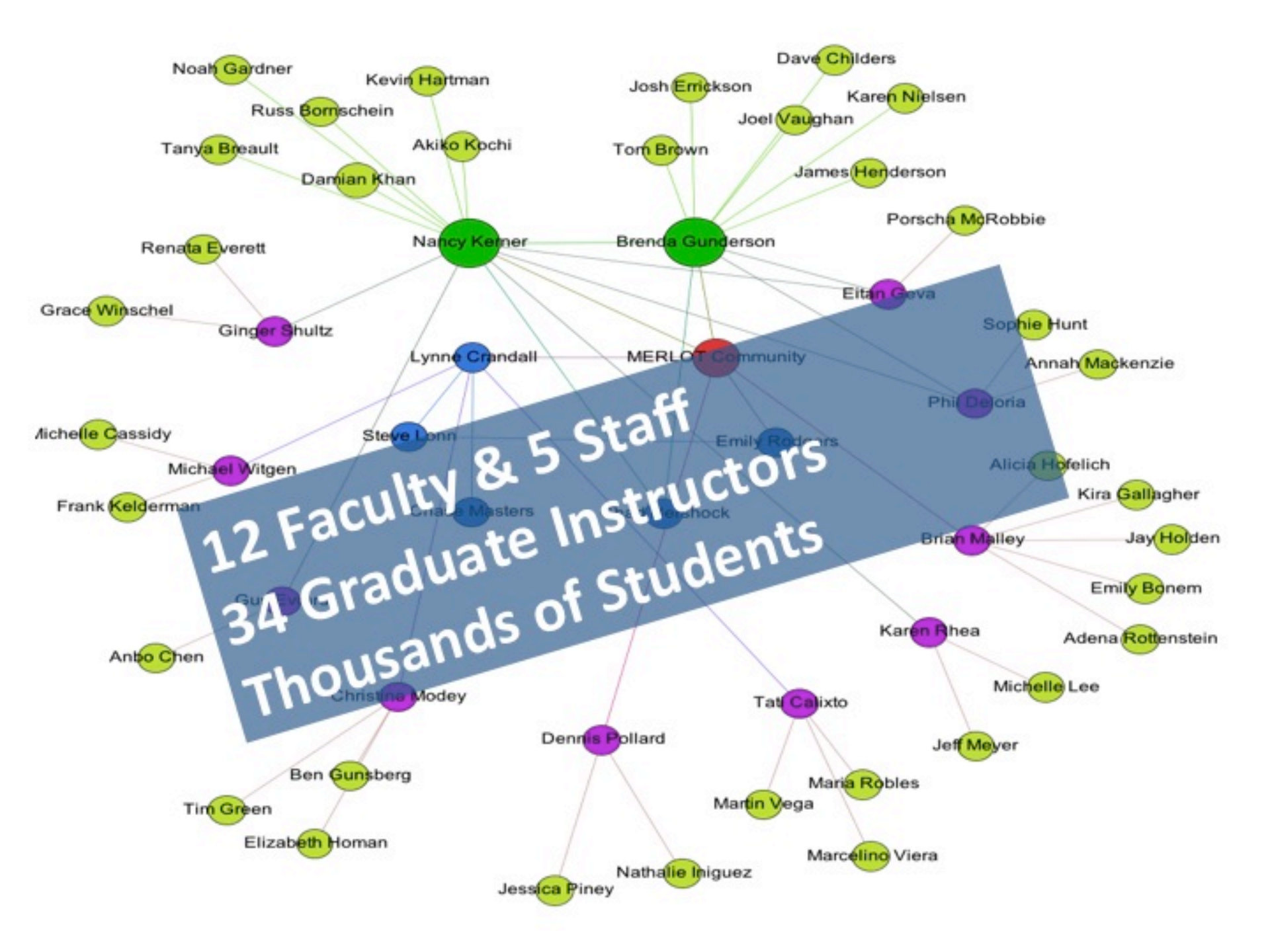
Maria Robles
Martin Vega
Tim Green
Elizabeth Homan
Marcelino Viera
Nathalie Iniguez
Jessica Piney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Jessica Piney
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34 Graduate Instructors
Thousands of Students

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