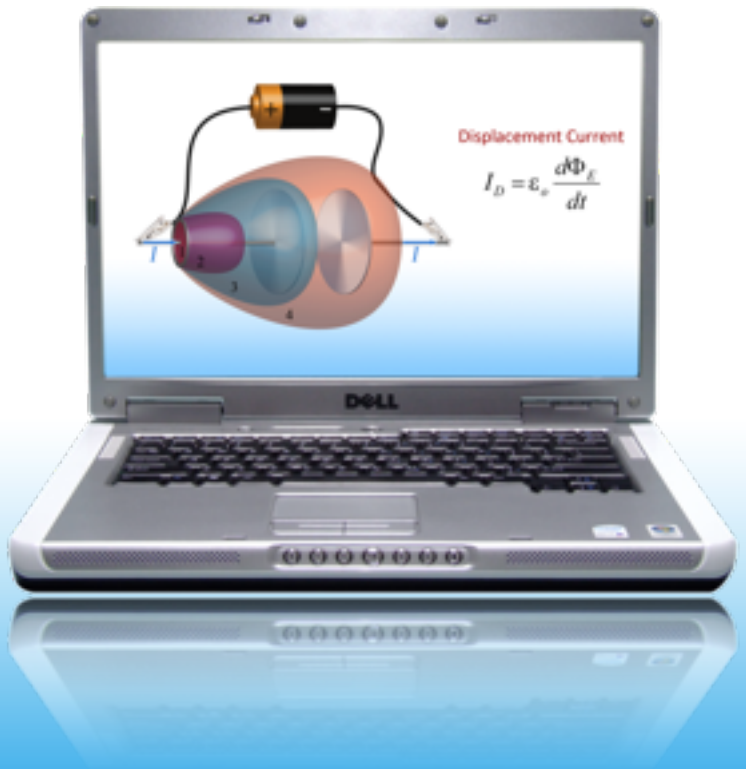
Transforming Student Learning at the University of Illinois

(**Clickers**, **Just in Time Teaching**, and **Flipping the Classroom**)



Mats Selen
UIUC Physics

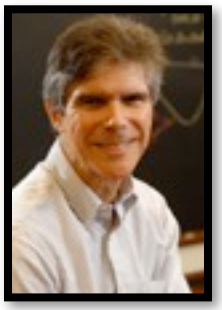
Physics Education Research

Department of Physics, University of Illinois at Urbana-Champaign

Physics Education Research

Faculty:


Gary Gladding


Jose Mestre


Mats Selen


Tim Stelzer

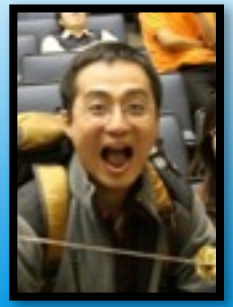
Affiliates:


Michel Herquet


Morten Lundsgaard

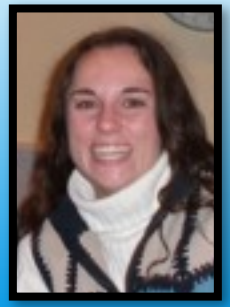

Michael Scott

Grad Students:


Zhongzhou Chen


Katie Crimmins


Witat Fakcharoenphol


Sara Rose


Noah Schroeder

Hardware & Software meet Pedagogy

Bennie

Tim

Mats

Gary

2002

2003

2004

2005

2010

2012

Pedagogical Approaches

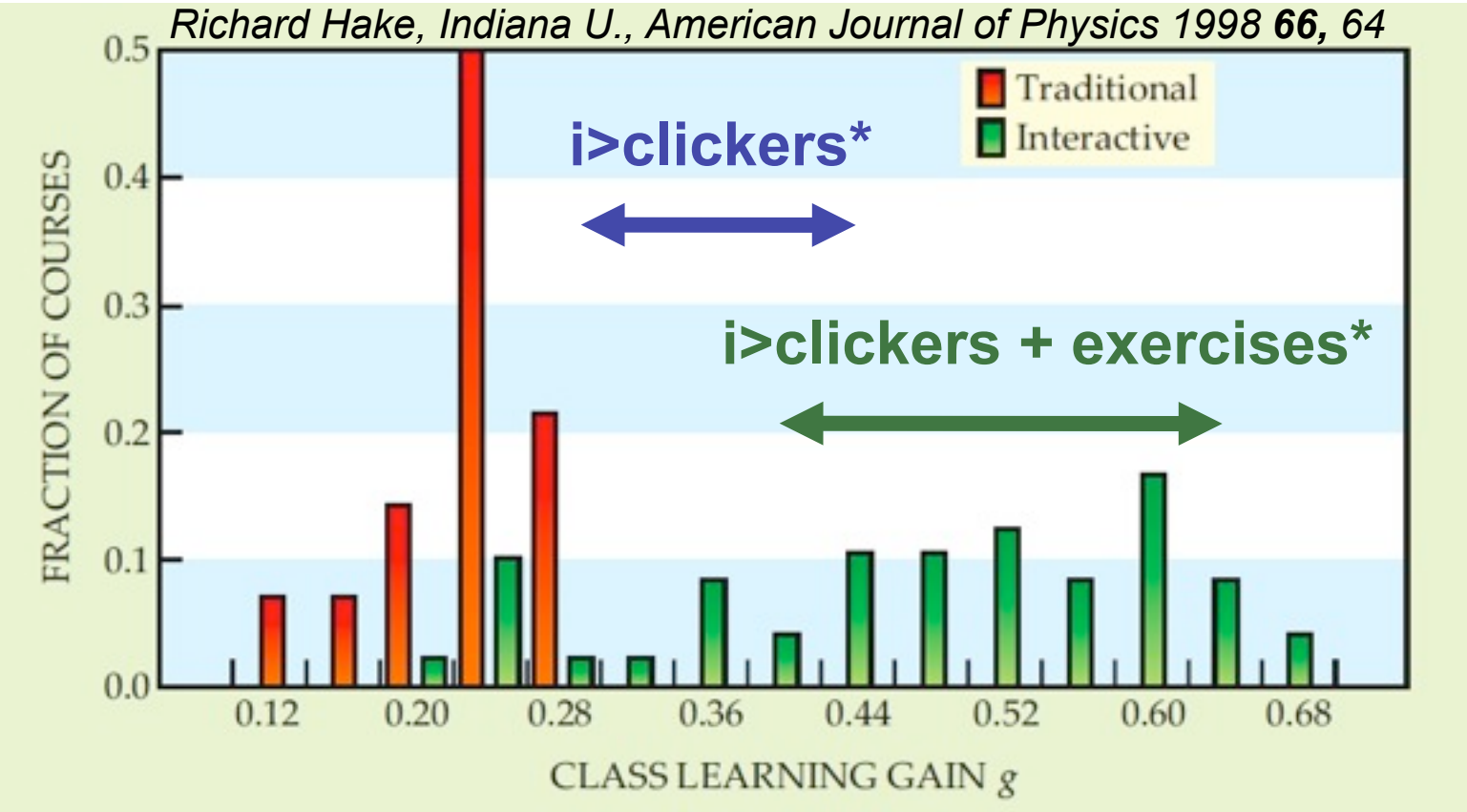
There are two main approaches to using clickers in class:

1) As a standalone classroom tool.

2) For enabling something even bigger.

Clicker use and student learning gains

Roger Freedman, UCSB
airboy@physics.ucsb.edu



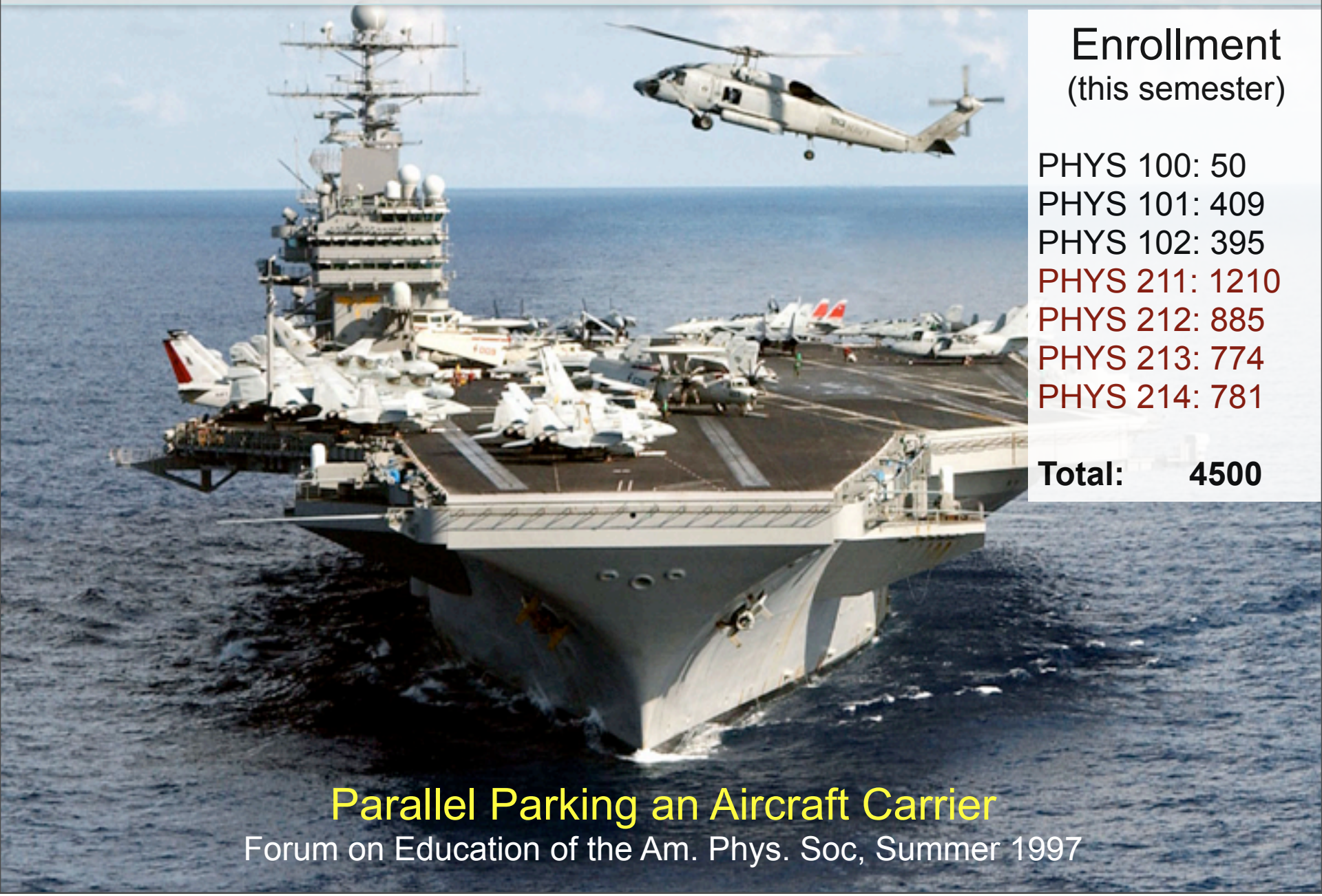
** U. of Colorado (Stephanie Chasteen et al.)*

As a standalone classroom tool

clickers help with this !

Clickers can play an important role as part of a bigger reform.

Intro Physics at Illinois



Enrollment
(this semester)

PHYS 100: 50
PHYS 101: 409
PHYS 102: 395
PHYS 211: 1210
PHYS 212: 885
PHYS 213: 774
PHYS 214: 781

Total: 4500

Parallel Parking an Aircraft Carrier

Forum on Education of the Am. Phys. Soc, Summer 1997

Intro Calculus Based Physics at Illinois

Physics 211 (4 hrs, mechanics)

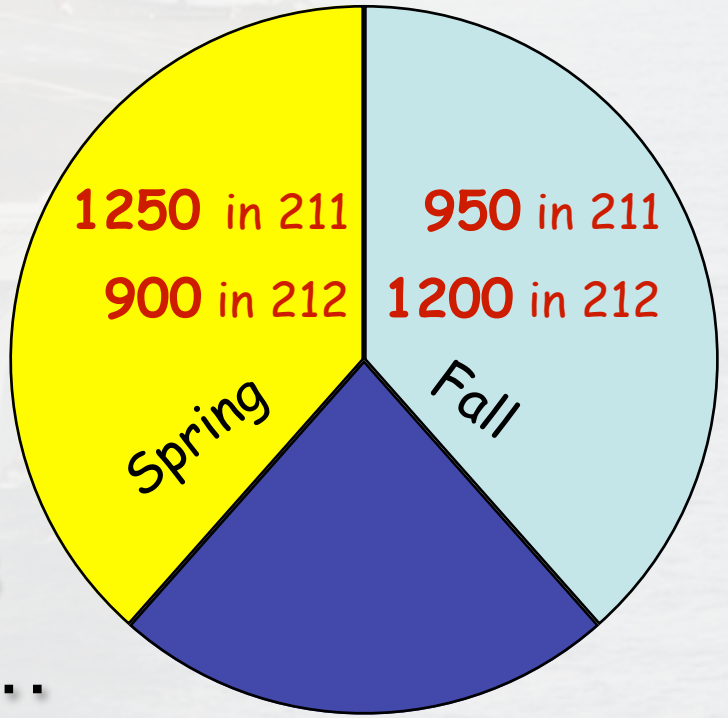
Physics 212 (4 hrs, E&M)

Physics 213/214 (2+2 hrs, SM, QM)

About 4300 students/year in these 2 classes

Mostly Engineering & Physics majors

Pretty Typical Class Structure:
Lecture, Lab, Discussion…



Big changes in these courses happened over 15 years ago…

How we changed things ~ 1996:

- Typically 3-4 faculty share the load:
  - Lecturer(s), Discussion Director, Lab Director

- Permanent Infrastructure
  - Course material is basically fixed
  - Recycled & tuned from semester to semester
  - Significant administrative support from department
  - Changes are incremental

Advantages of this approach:

- Existing infrastructure lowers the bar for participation.
  - This is now seen as a reasonable teaching load.
  - Faculty have time to do other things.
  - **This approach enables innovation**

- Pain & Gain are shared
  - No burnout & No heroes.
  - Consistent high quality.
  - **This approach is sustainable.**

If this didn't happen I wouldn't have anything else to talk about today.

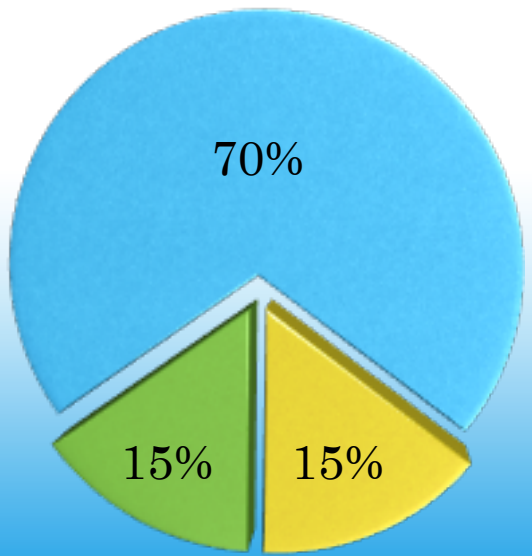
The Challenge:

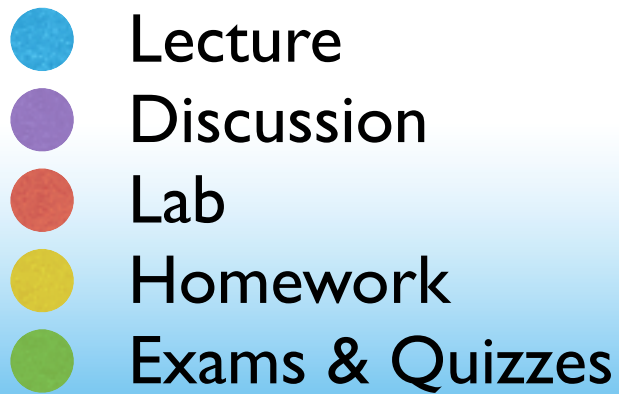
Faculty Buy-in

"The Course" is no-longer just "My Lectures"

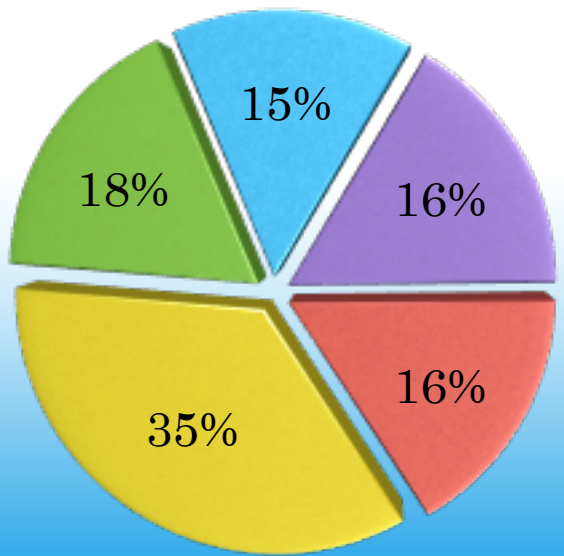
Question: How do lectures fit right now?

Time (Professor)





Time (Students)



The Challenge:

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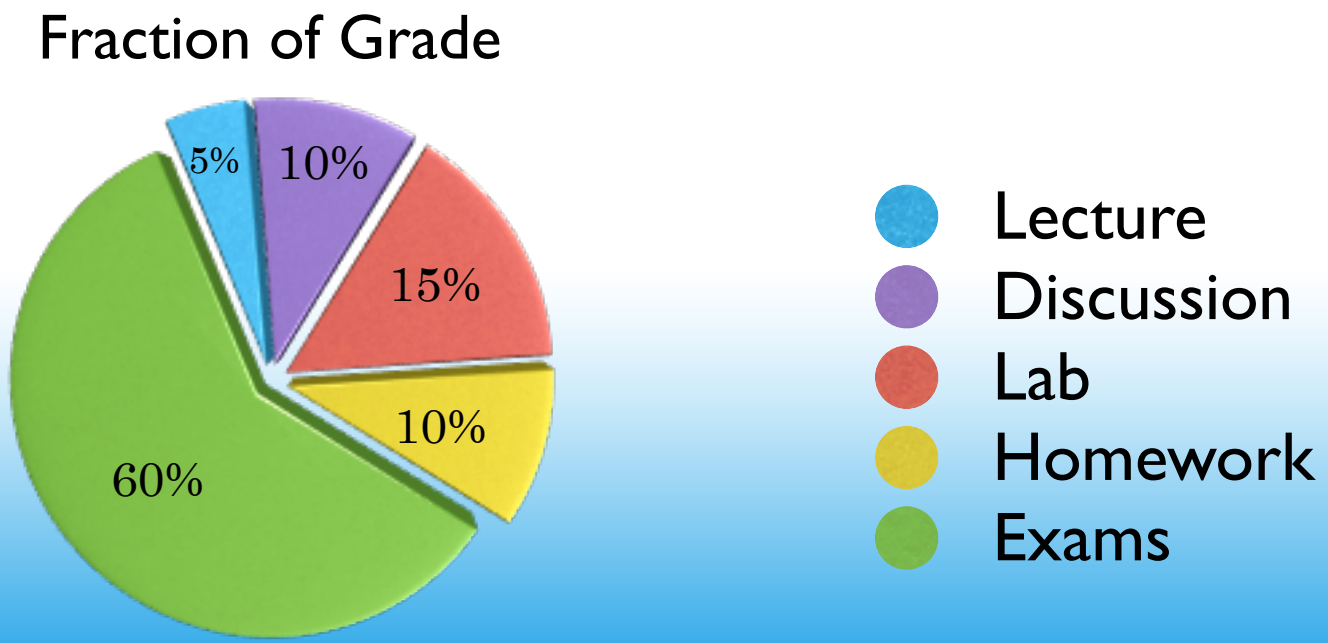
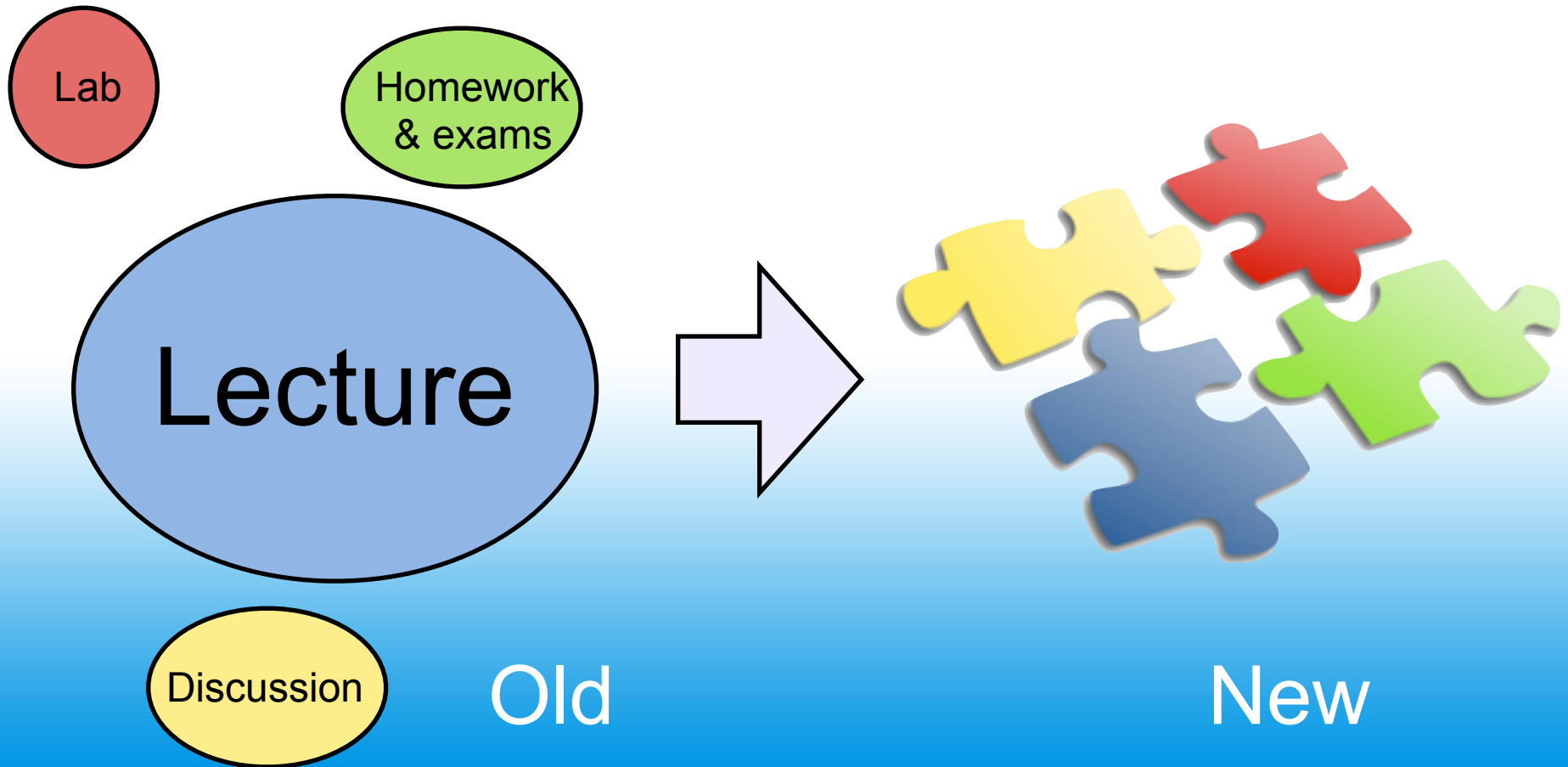


The Challenge:

Need a paradigm shift:



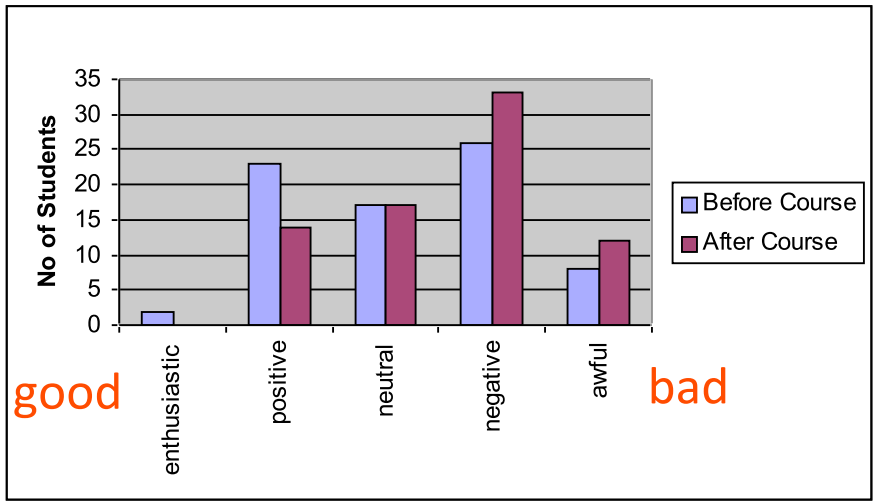
Paradigm shift

Reluctant Prof:	Counter argument:
It won't be my own course anymore!	This is good. You won't have to do it all by yourself.
But I like to do stuff my way	You can still personalize it, you just can't wreck it.
Whats in it for me	Time to do other things.

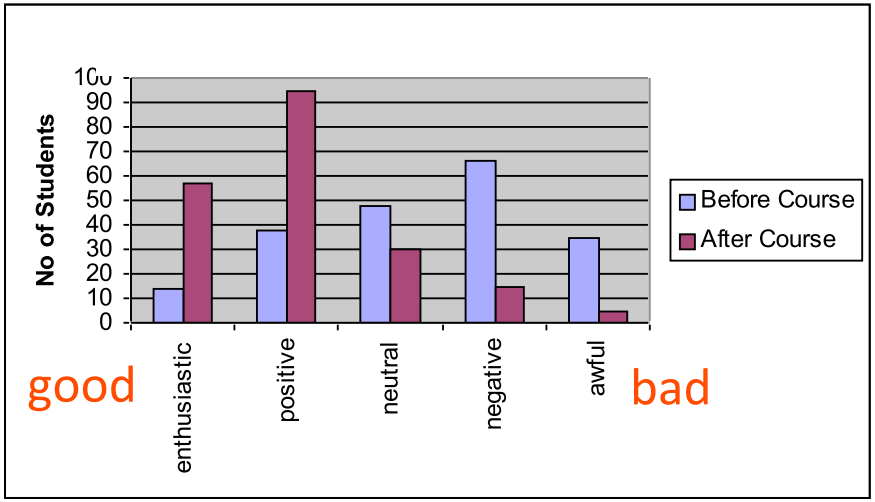
Infrastructure is the key to making reform a win-win scenario!

Effect of initial structural changes:

Before (1995)



After (2001)



Before (Spring 95)
Total Physics TAs = 77
 # "Excellent" = 15
19 ± 5 %

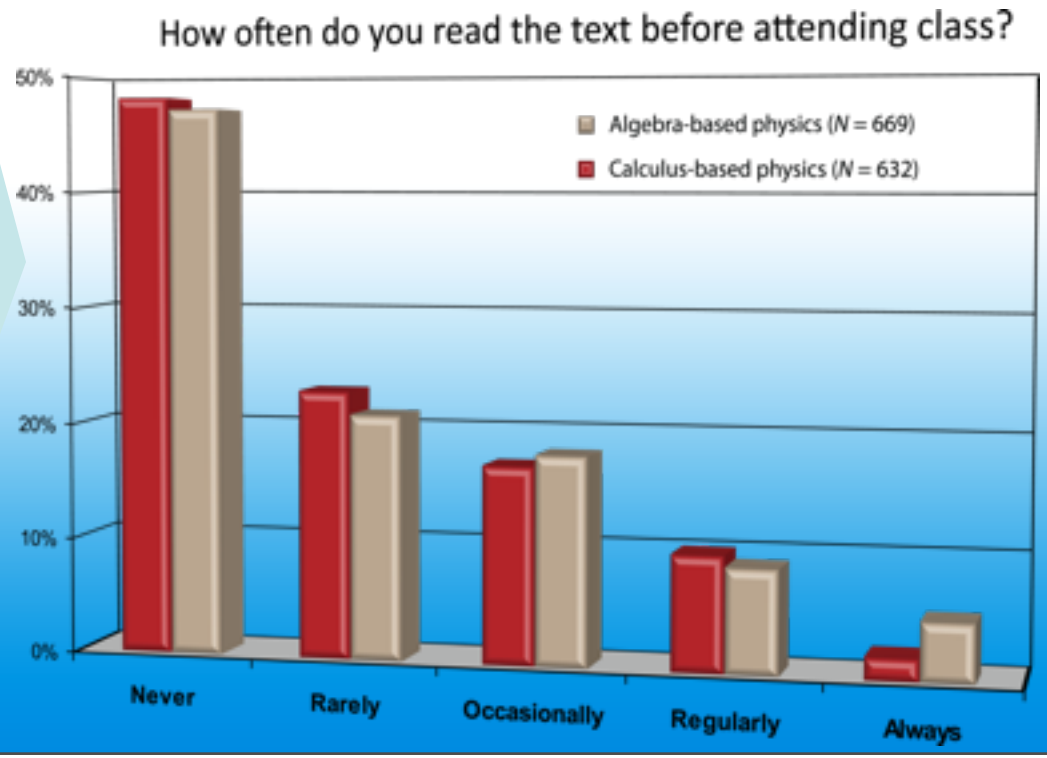
After (Spring 01)
Total Physics TAs = 75
 # "Excellent" = 58
77 ± 6 %

Incentive for further innovation...

What's the next big problem?

Students are not reading the text and aren't prepared for class

- Lecturer has to assume that students know nothing coming into the classroom.
- We spend (waste) a lot of time going over very basic material.
- Difficult material is often rushed and student only see it once.



“The Flip” (ca 2008)

Pre Lectures

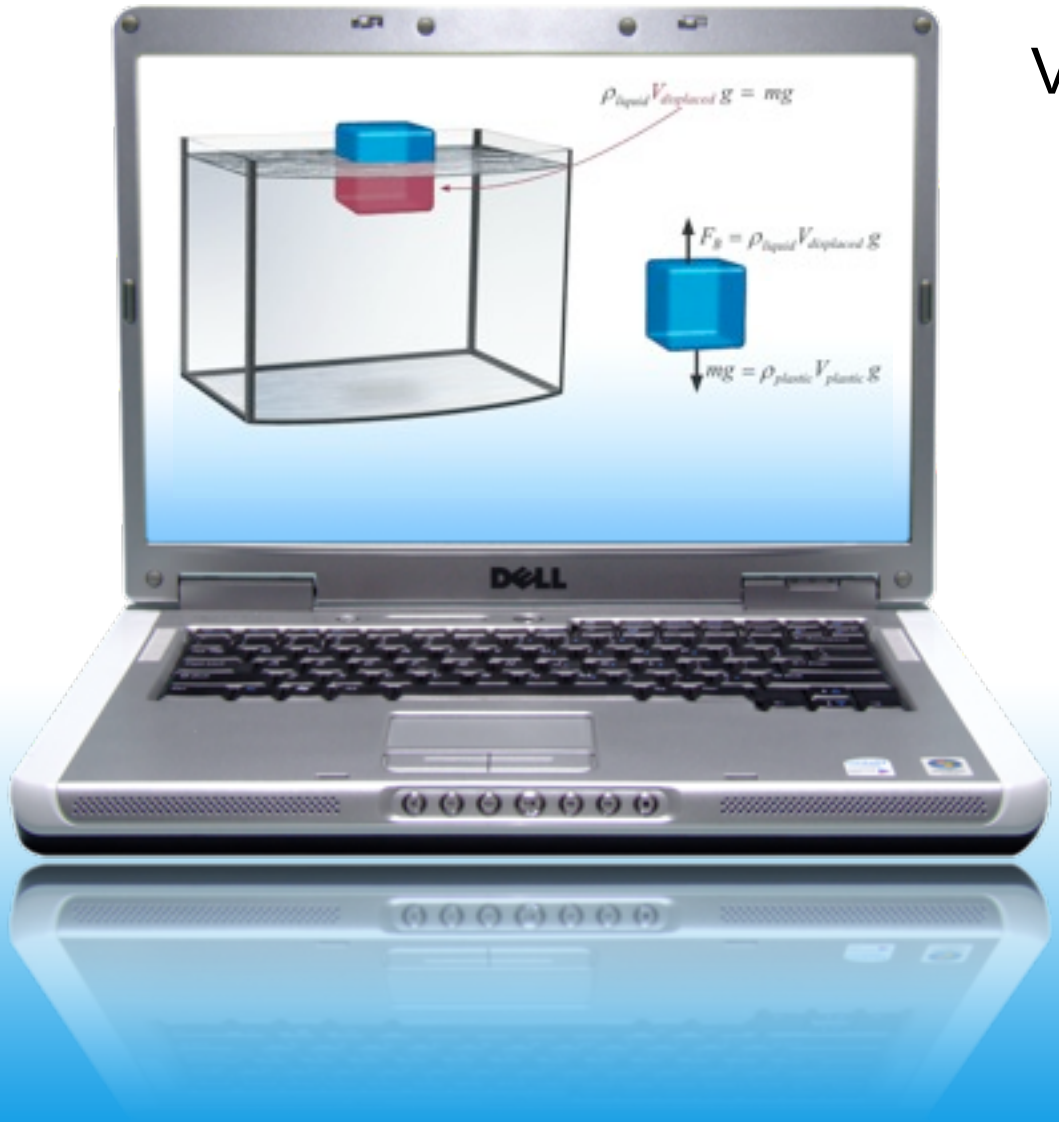
Checkpoints (JiTT)

Peer Instruction

We pulled out all the stops - you can do this with much less effort !

(old: 75 min, new: 50 min)

Pre Lectures



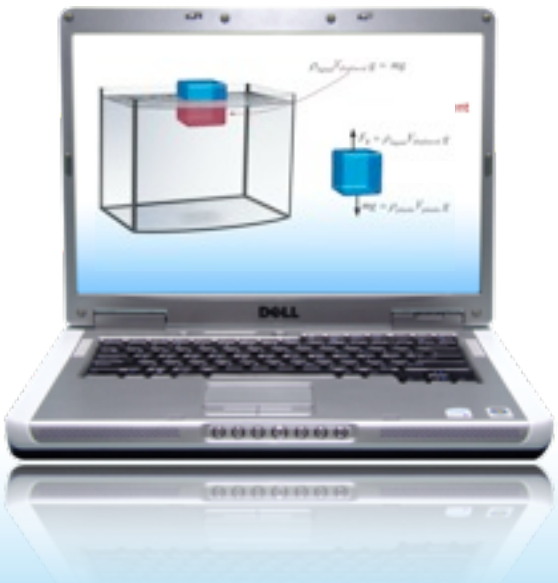
Viewed prior to each lecture (usually the night before)

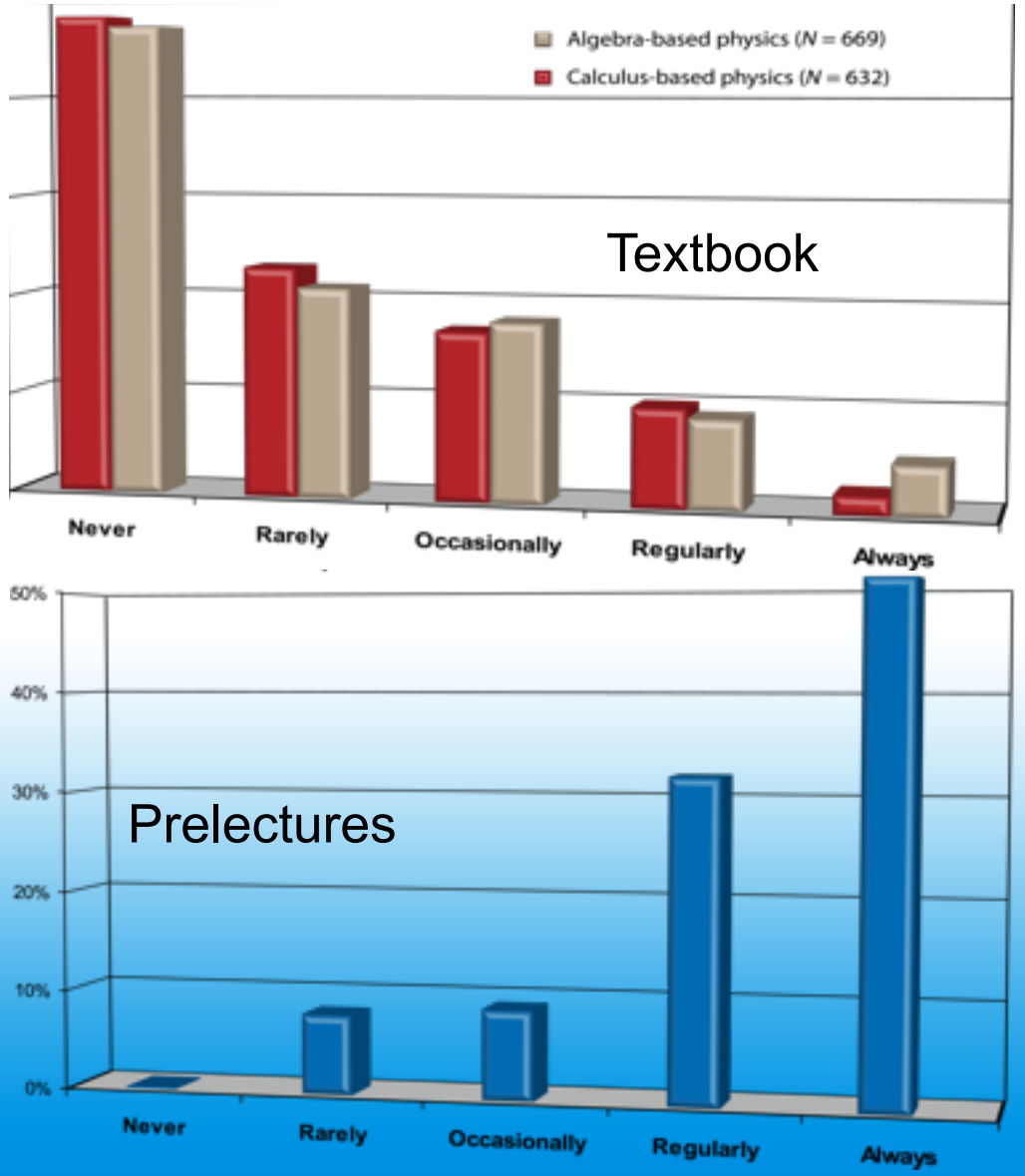
Students do this instead of reading a textbook

Introduces all concepts for the coming lecture and provides feedback to both students and professor

Show Example

Our students watch the prelectures





Next: Checkpoints
(aka Just in Time Teaching)

Online knowledge check of prelecture concepts

Completed after Prelecture but before Lecture.

Increases student buy-in for upcoming lecture

Feedback to professor helps lecture prep.

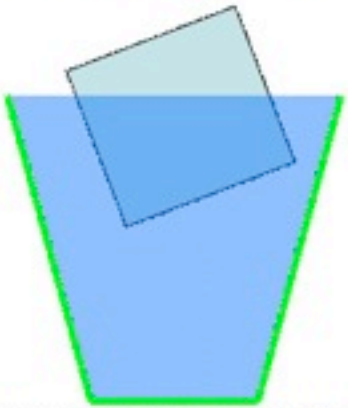
(we've been doing this for 15 years)

Checkpoint Example

Static Fluids

Deadline: Past-Due as of Thursday, April 26 at 8:00 AM

Ice Melting in Cup of Water



An ice-cube is floating in a class filled with water as shown above.

1)When the ice melts, the level of the water in the glass will:

- Go up, causing water to spill out of the glass
- Go down
- Stay unchanged.

submit

Your submissions:

2)Briefly explain your answer to the previous question.

Grade for participation, not for correctness

Problems | Instructor

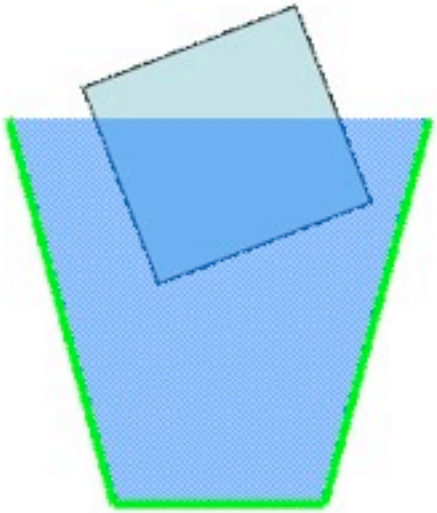
CheckPoint
Pressure under a ship
Try new random numbers

CheckPoint
Ice Melting in Cup of Water
Try new random numbers

CheckPoint
Ice Cube in Liquid
Try new random numbers

CheckPoint
Lecture Thoughts

Useful information…



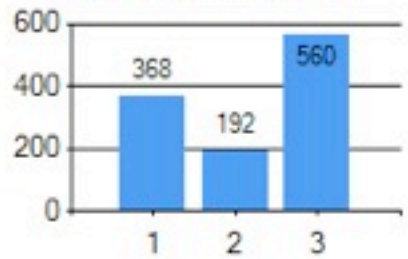
An ice-cube is floating in a class filled with water as shown above.

1)When the ice melts, the level of the water in the glass will:

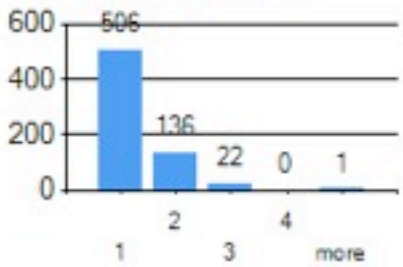
- [x] Include this choice ○ Go up, causing water to spill out of the glass
- [ ] Include this choice ○ Go down
- [ ] Include this choice ○ Stay unchanged.

Your submissions:

Answer Choice Distribution



Num Tries For Correct



Student explanations for “it spills over”…

	see if it spills.
il	water in ice must add somewhere to water in glass
mail	The water level will rise. I learned that from Al Gore in "An Inconvenient Truth"
ki email	since the ice completely melts the volume of ice not in the water will exceed the volume of the glass and surface tension will unlikely hold the excess in place
il	dope
mail	because the ice floats with some of its volume above the water, when it melts it will rise the level of the water
l	the melted water has a higher density as ice and will flow into the cup to cause the overflow
d email	meep!
il	The same percentage of the ice's volume is always above the water, which means when the ice cube gets smaller, the volume that is above gets smaller, and the extra volume makes the water spill.
nail	1
a email	The density will increase.
nail	same volume but there is water floating above the cup in the form of ice
ail	well the volumes gotta go somewhere am I right???
n email	Not all of the ice is in the cup, so once all of it melts, there will be more in the cup
n email	The volume of the ice cube that is submerged decreases as the the volume of the total ice cube decreases. In order to

Every Checkpoint includes this:

Lecture Thoughts

1)What concepts did you find most difficult, or what would you like to be sure we discuss in lecture?

submit

"This seems okay. But honestly, I didn't really watch it closely. I contemplated not watching it at all and using one of the freebies, but I hate going to lecture without an idea of what we're talking about."

(We had an exam the same night that students did this pre-lecture)

Lectures = Peer Instruction

- Lectures are very interactive
  - We know students are prepared (Prelectures)
  - We know their misconceptions (Checkpoints)
- Typically ask 6-10 clicker questions per lecture
- Valuable feedback for both teacher and students

CheckPoint

When the ice melts, the level of the water in the glass will:

A) Go up, causing the water to spill out of the glass.

B) Go down.

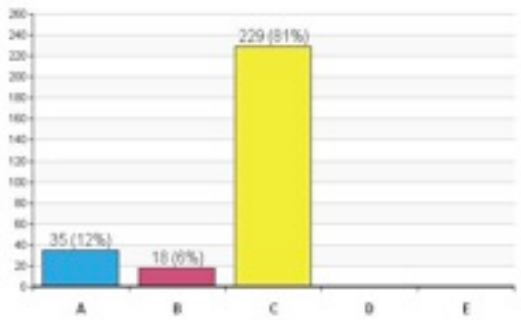
C) Stay right at the brim.

A) The water level will rise. I learned that from Al Gore in "An Inconvenient Truth"

B) volume of ice is greater than volume of water

C) The melted water has exactly the same mass as th ice cube, and the volume of water displaced is equal t the mass of the ice cube.

In Class

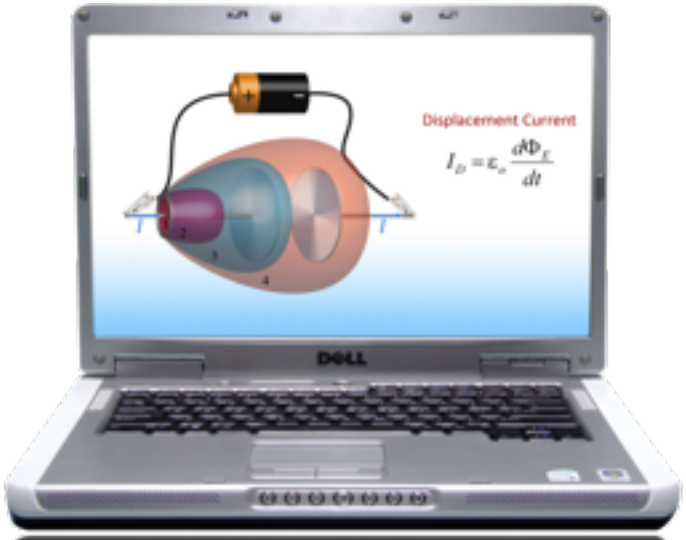


"So if the water level doesn't change, why worry about global warming?"

Lectures = Peer Instruction

15 years ago, peer instruction completely changed my ideas about teaching

How does all this impact our students?

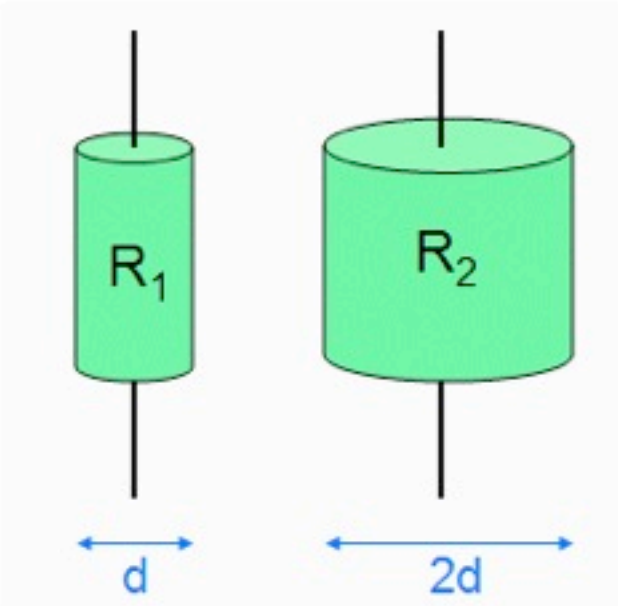


Am. J. Phys. **78,** 755-759, **2010**
Phys. Rev. ST Phys. Educ. Res. **6**, 1-5, **2010**

Checkpoint Study

A measurement of students concept knowledge

Two cylindrical resistors are made from the same material and are equal in length. The first resistor has diameter *d*, and the second resistor has diameter 2*d*.

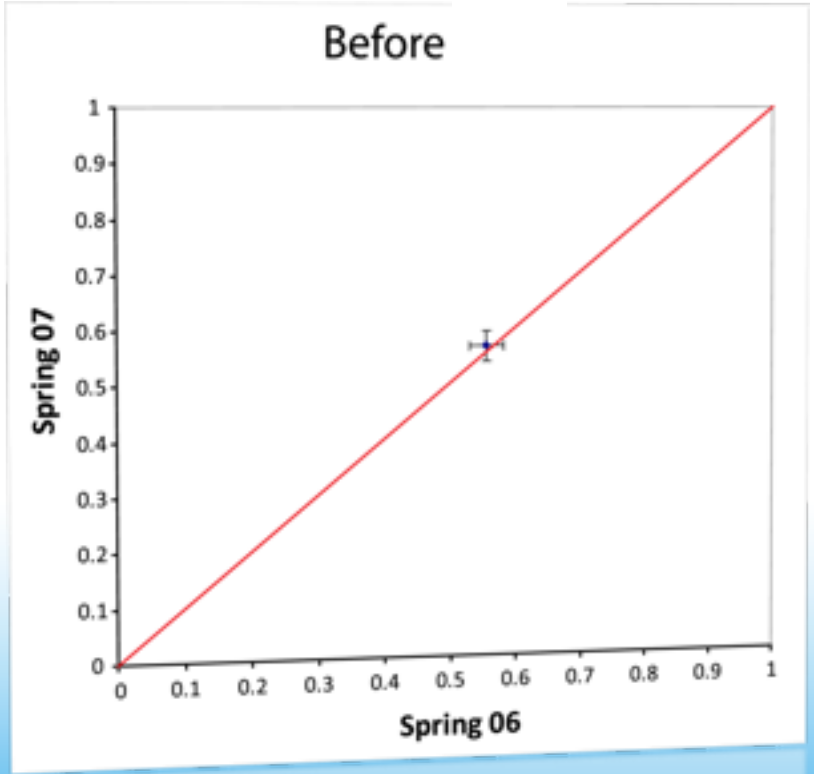


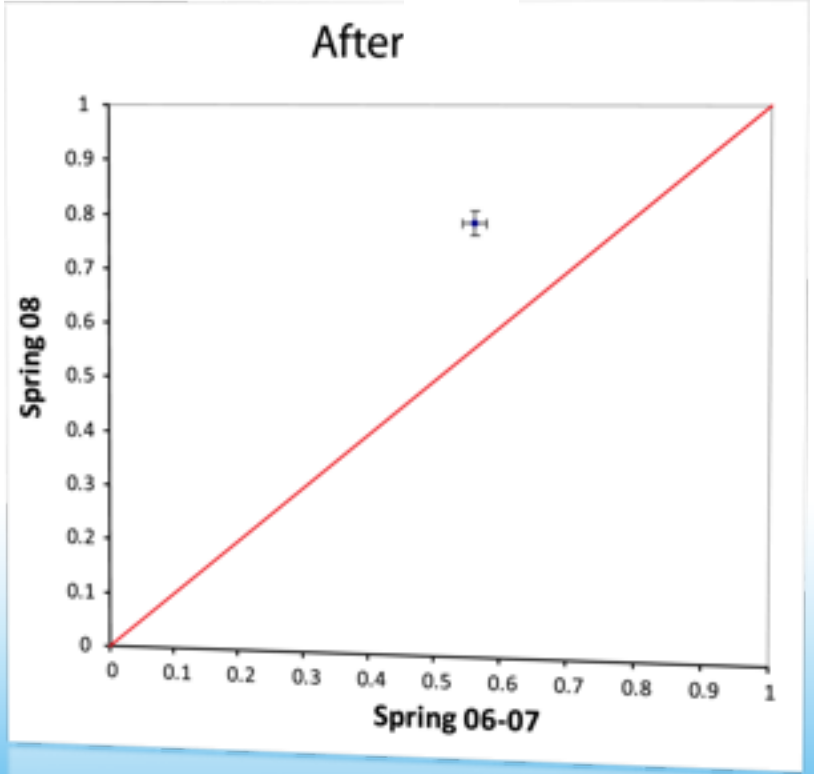
1)
If the same current flows through both, compare the voltage across the two resistors:

- $V_1 > V_2$
- $V_1 = V_2$
- $V_1 < V_2$

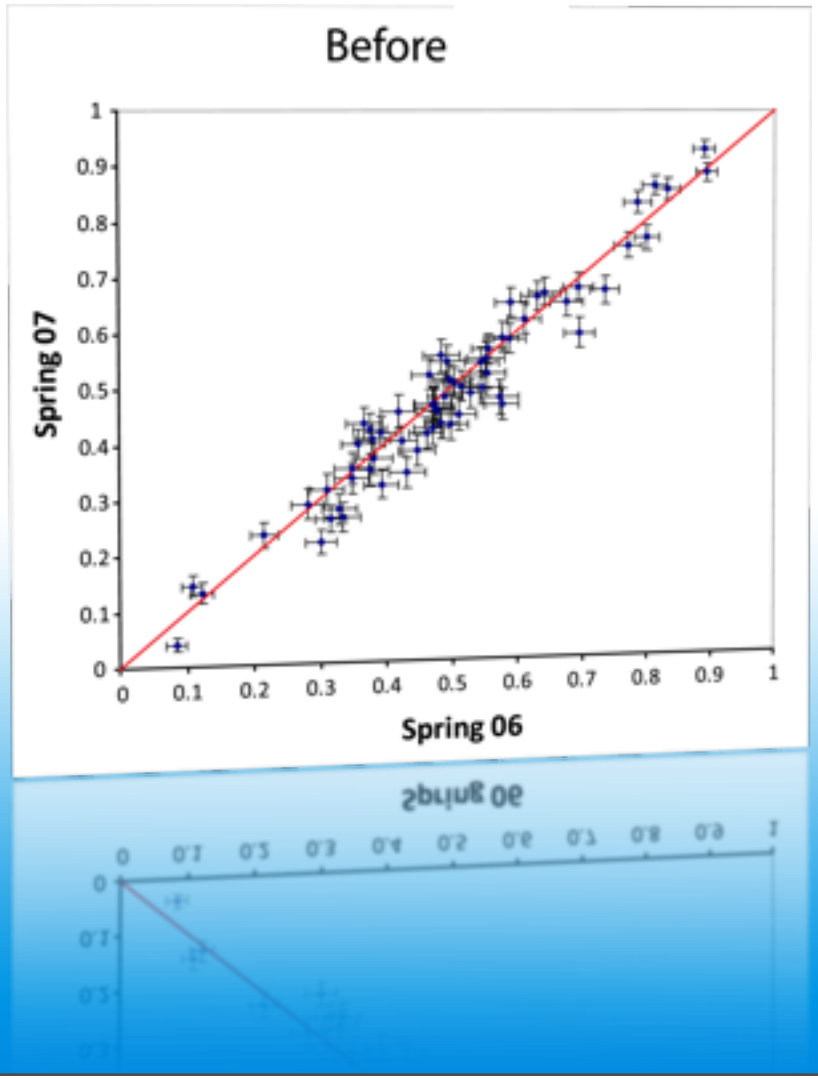
Spring 06	56%
Spring 07	57%

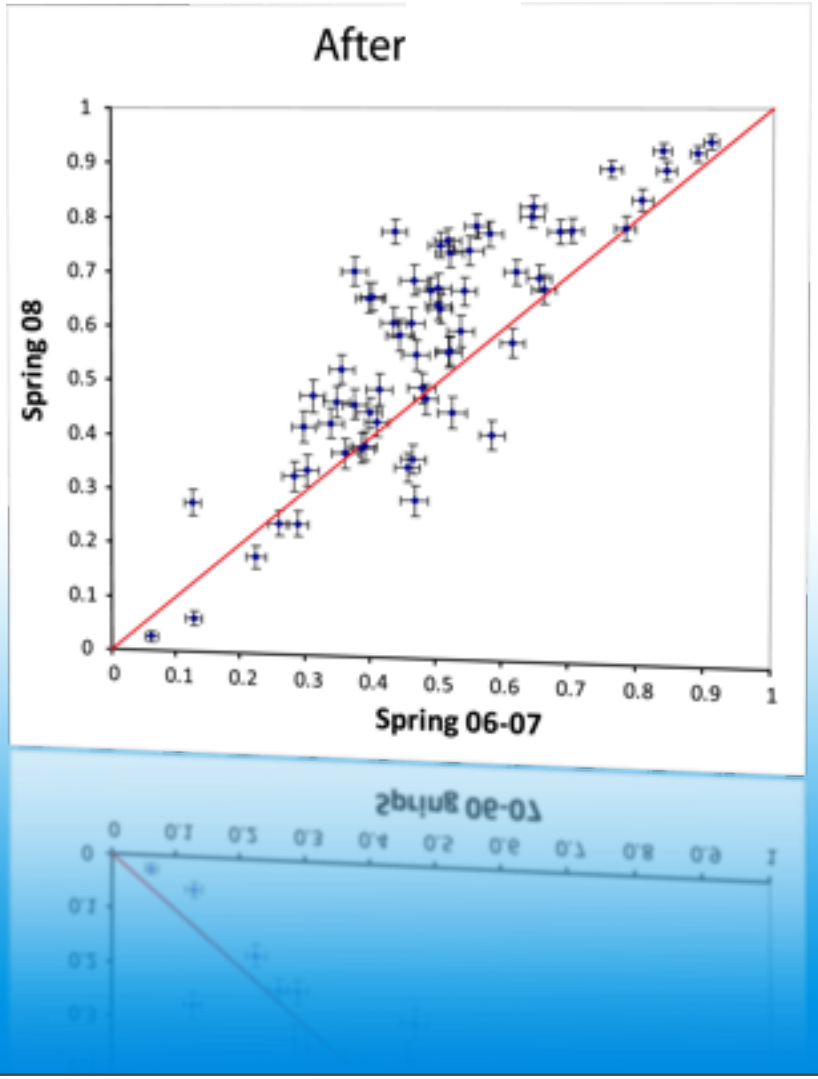
Checkpoint Study
Overall Results



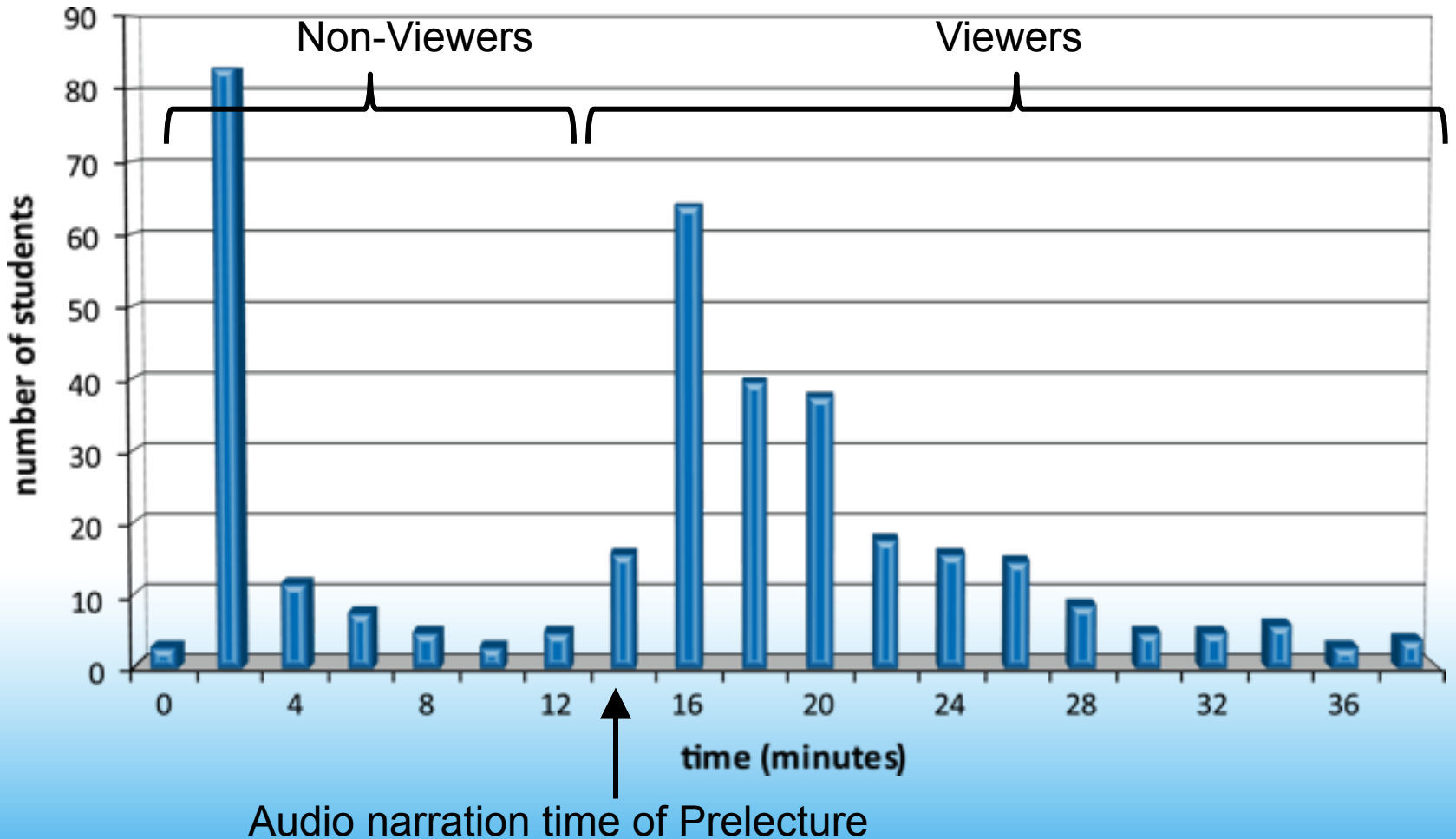


Checkpoint Study
Overall Results





Viewers vs. Non-Viewers



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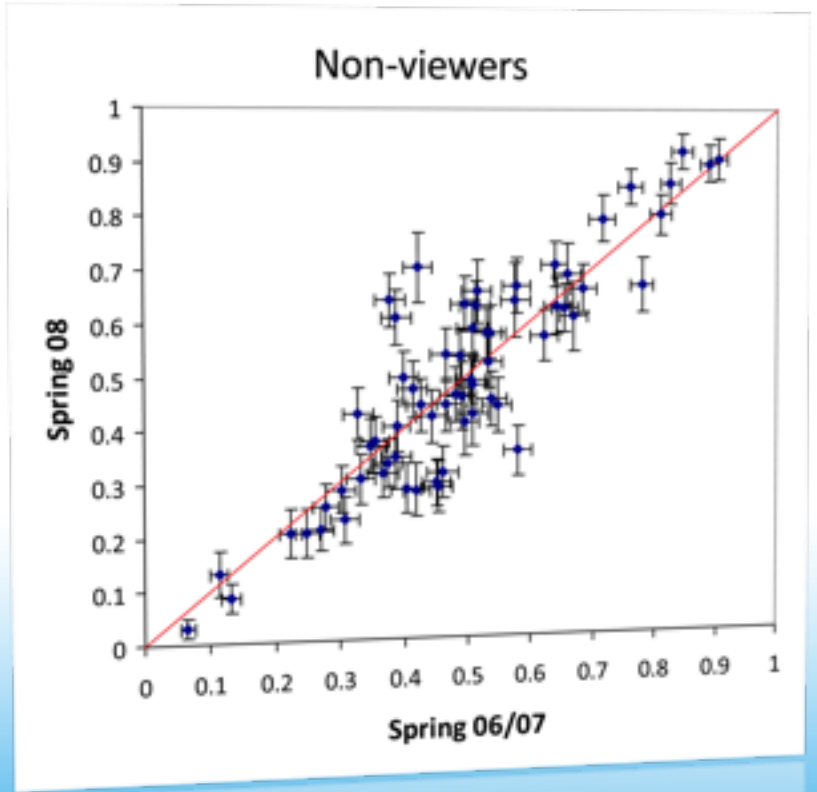
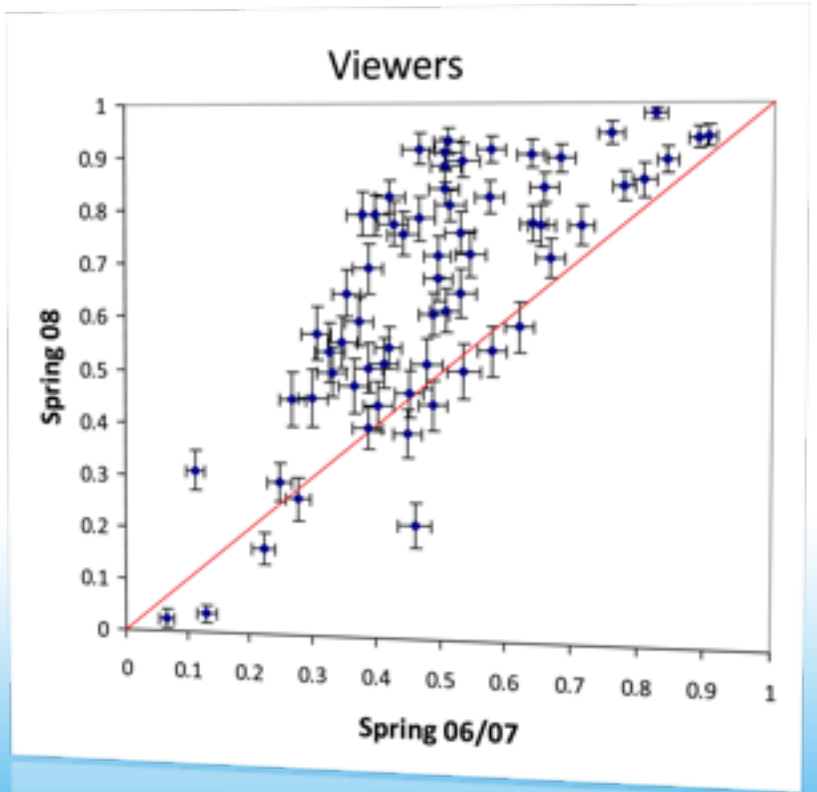
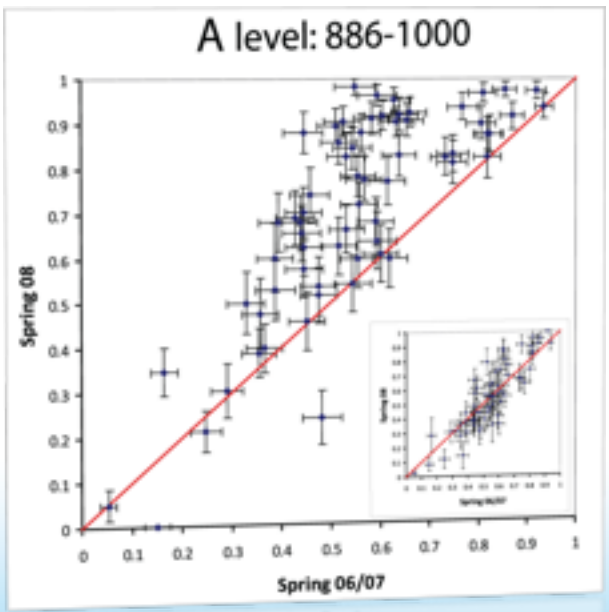
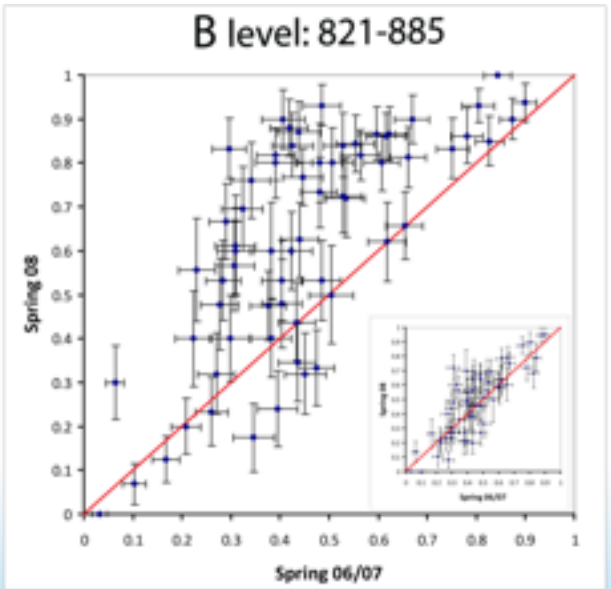


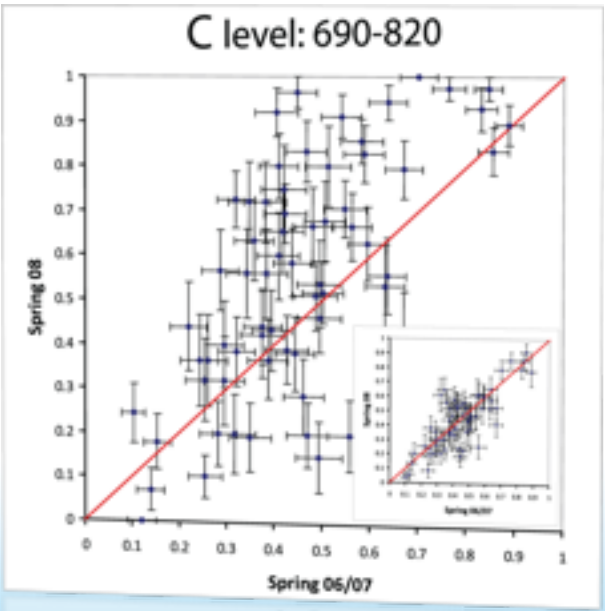


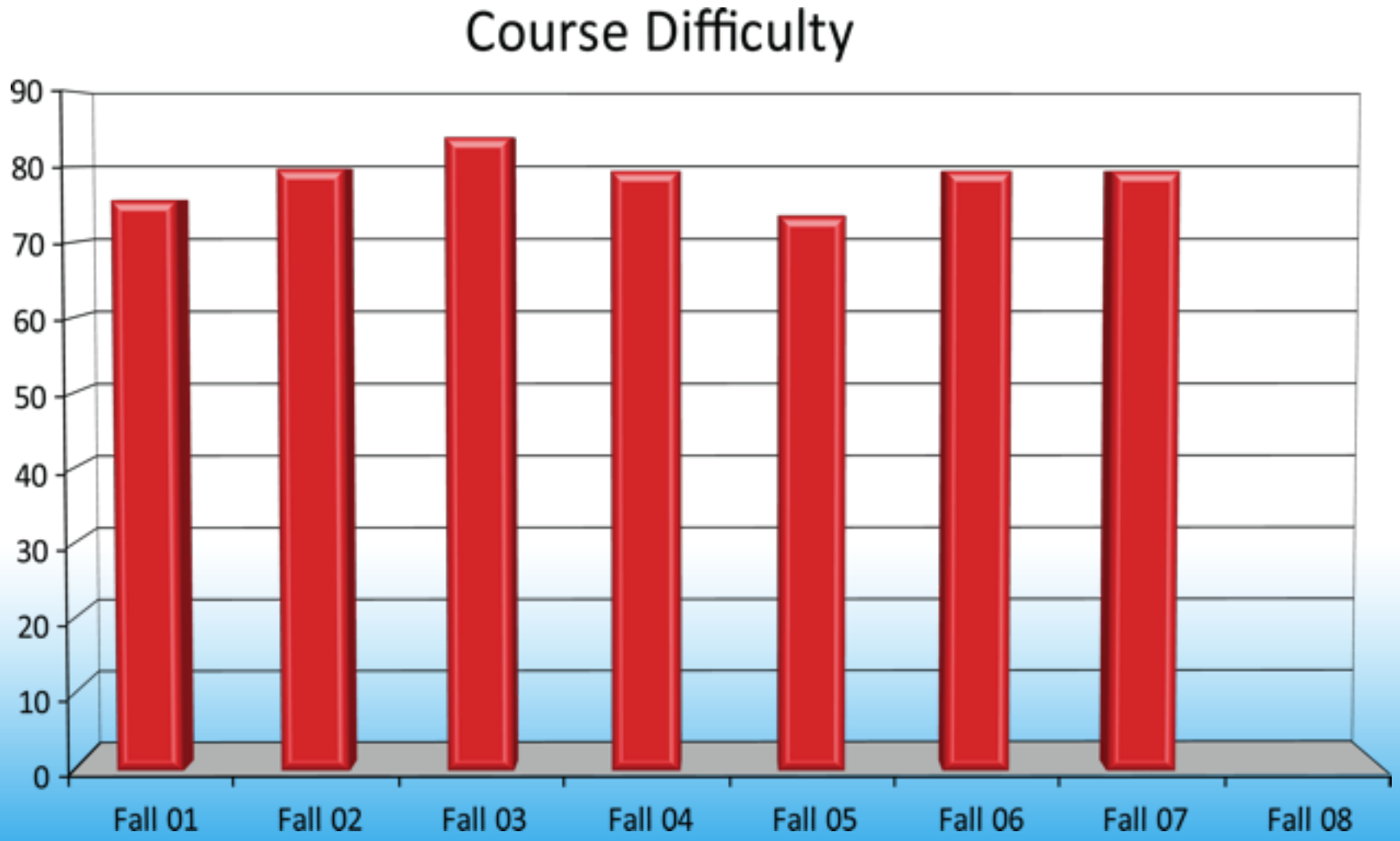
Checkpoint Study

Significant improvement seen for all students

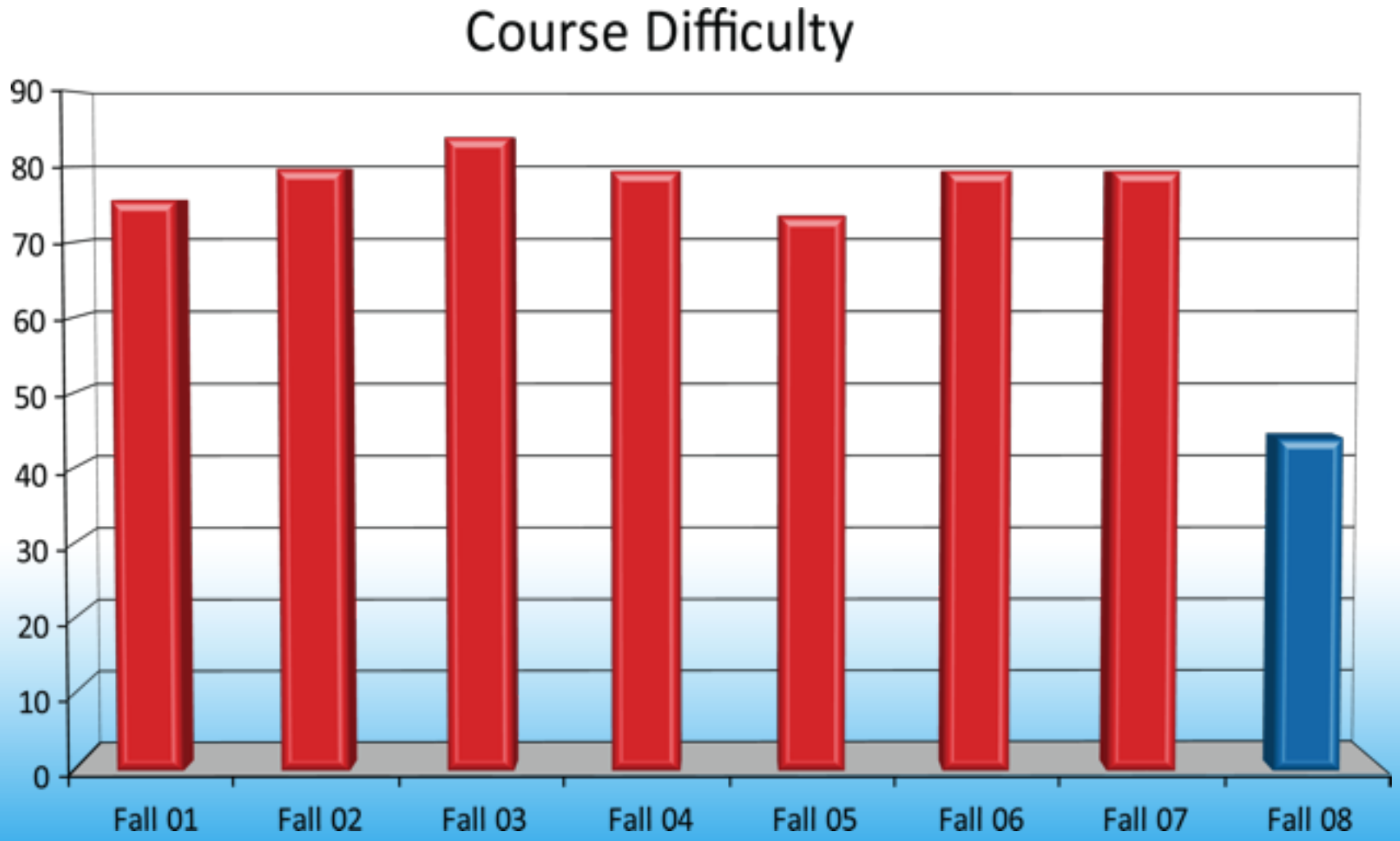




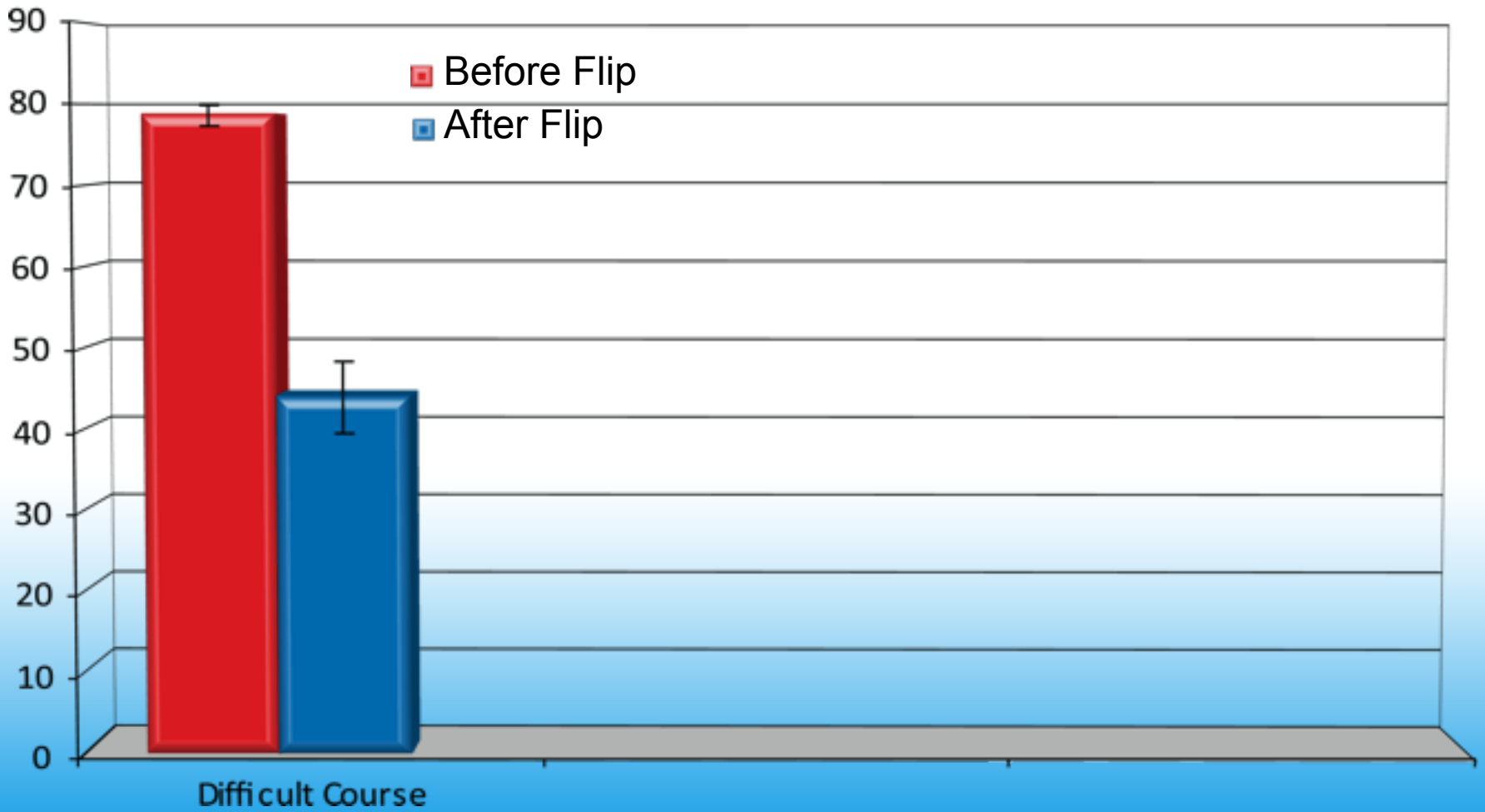



Course Difficulty
90
80
70
60
50
40
30
20
10
0
Fall 01
Fall 02
Fall 03
Fall 04
Fall 05
Fall 06
Fall 07
Fall 08

Changes Made Learning Easier!



Student Perception of Course



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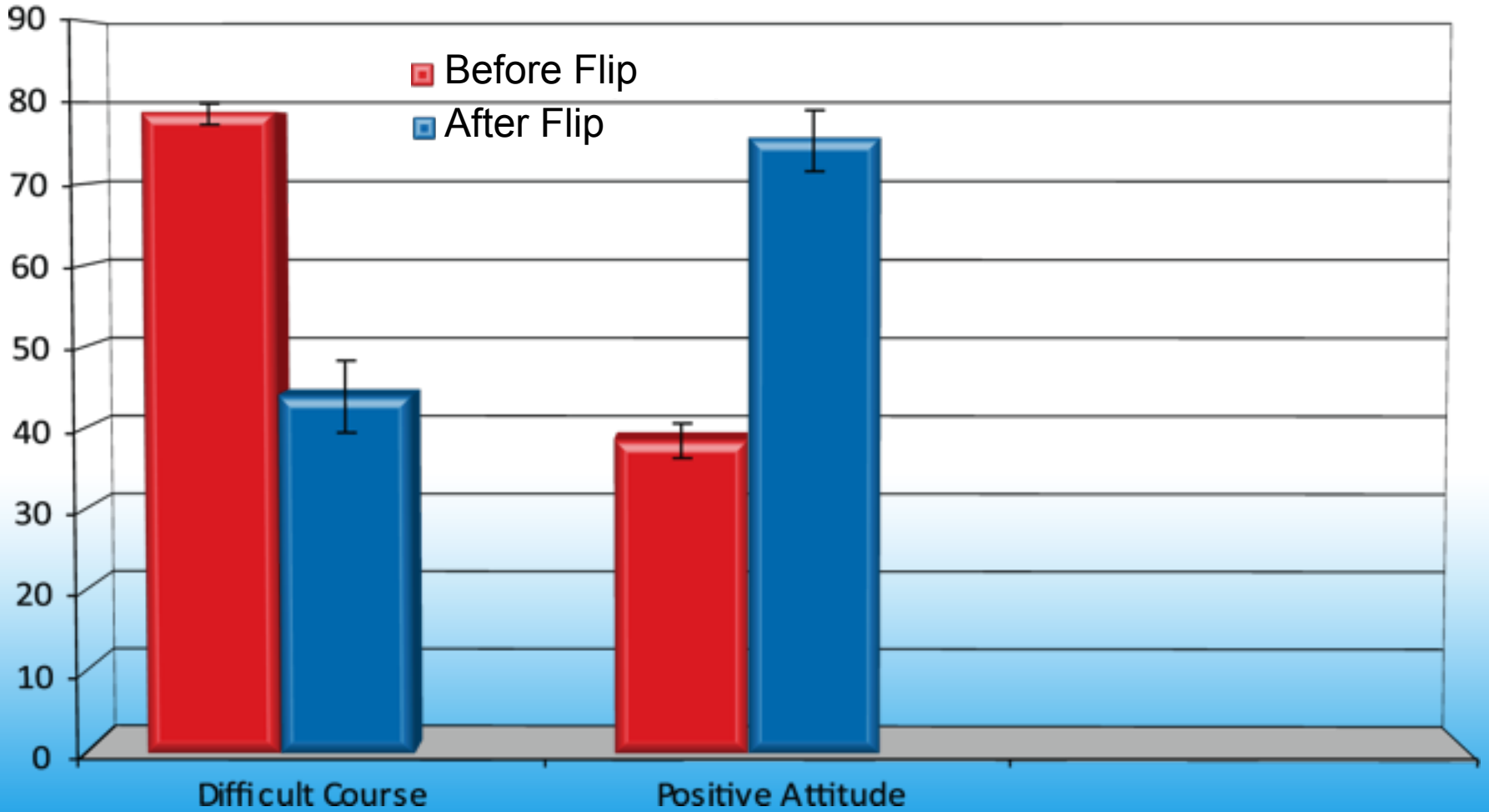
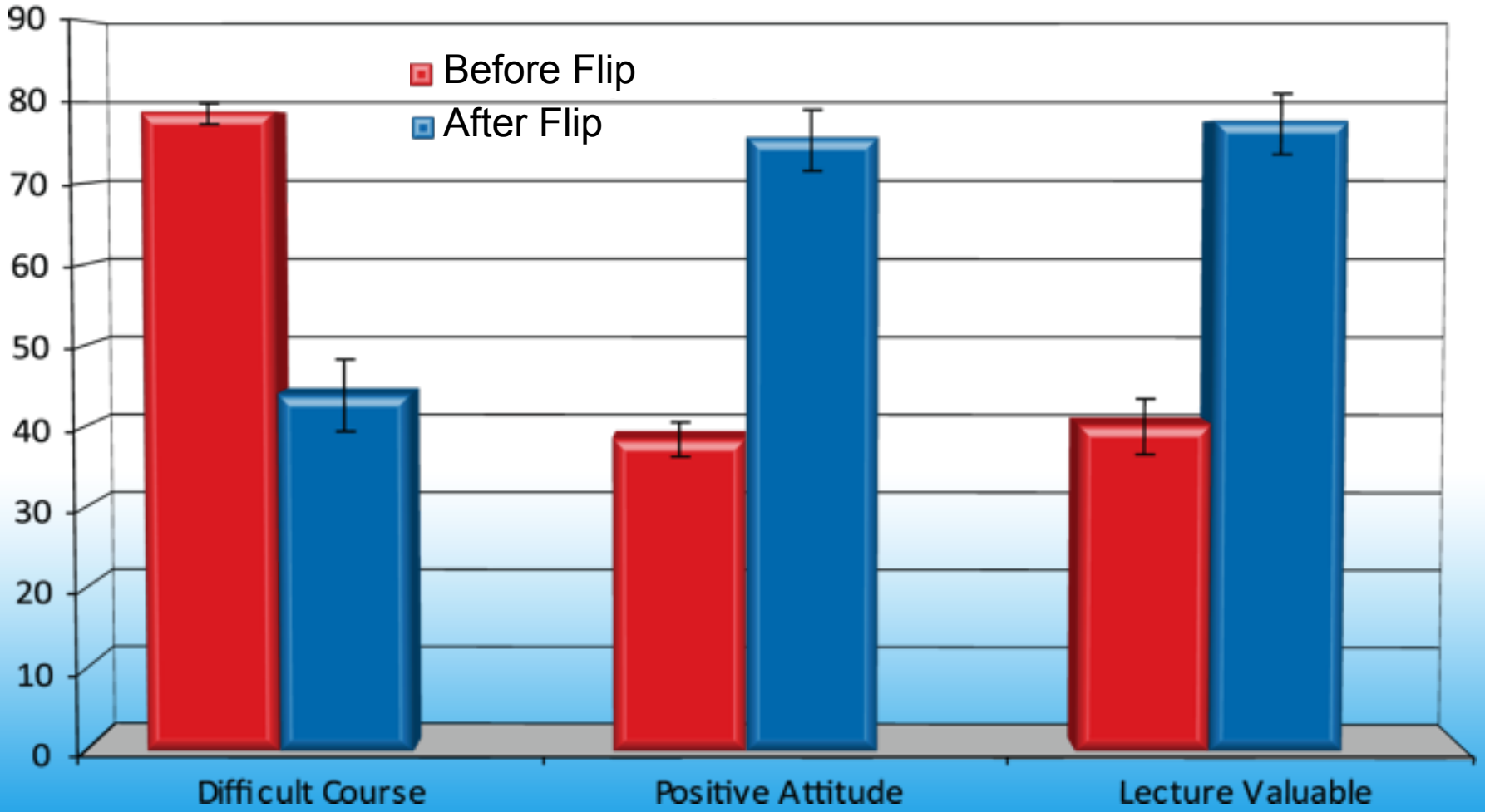


Student Perception of Course



How to Get Started (if you haven't already)

- Make a few JiTT questions for each lecture.
  - Including "What do you want to discuss"
- Use these responses to build clicker questions
  - They could be exactly the same to start with
- Do it every class, starting with the first one
  - Shows students its important to you.
- Iterate next semester.
- There are great free tools out there to help you:
  - Jing, YouTube, ByteShelf (behind smartPhysics)