Peer Instruction: Methods and Techniques

Suvendra Nath Dutta

Mazur Group & DEAS IT Group

Division of Engineering & Applied Sciences

Harvard University

Ohio University

6 June 2003

Outline

- **Problem**

  Classes focused at future professional Physicists

- **Cause**

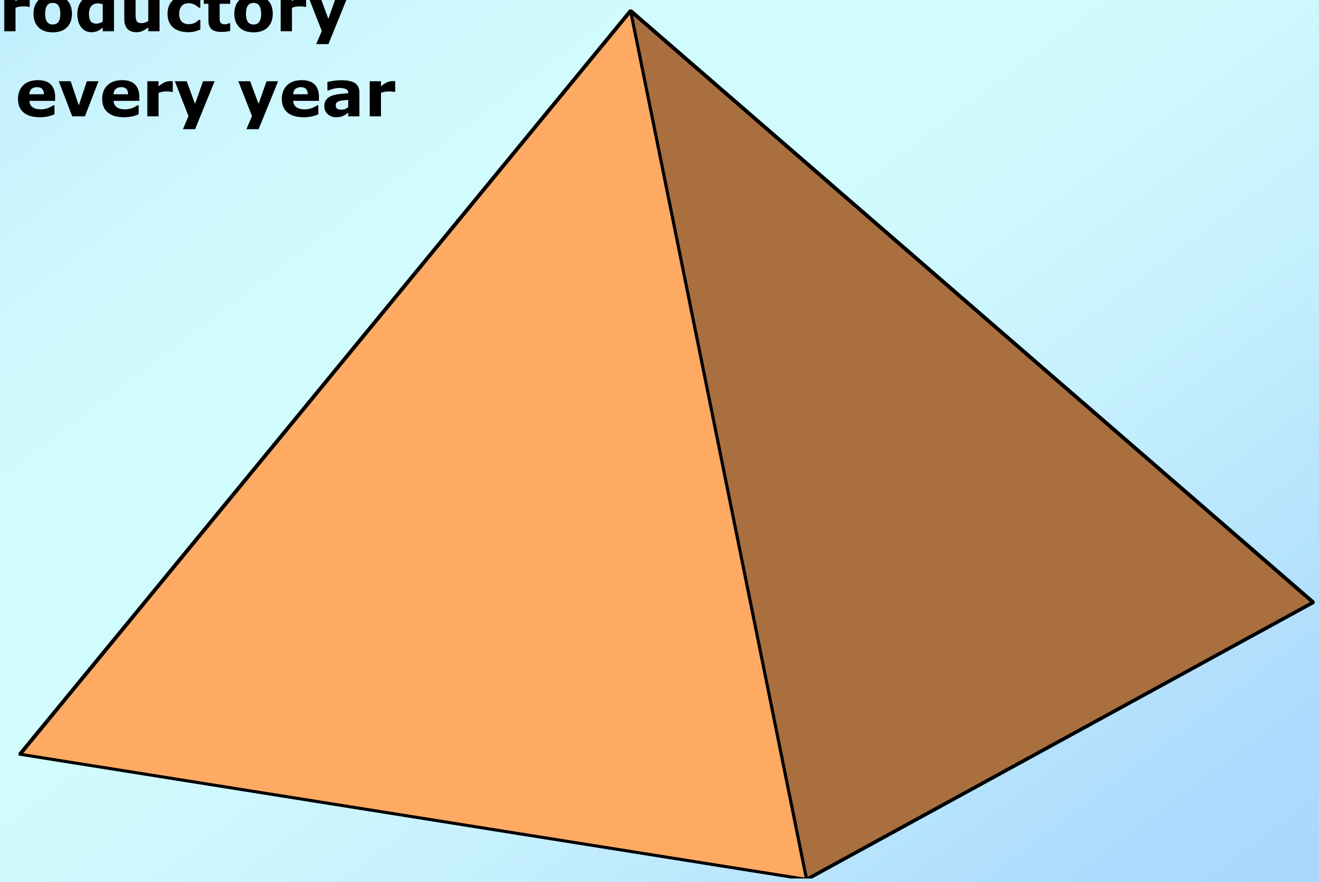
  High bandwidth, unidirectional flow of information

- **Solution**

  An interactive classroom

Problem

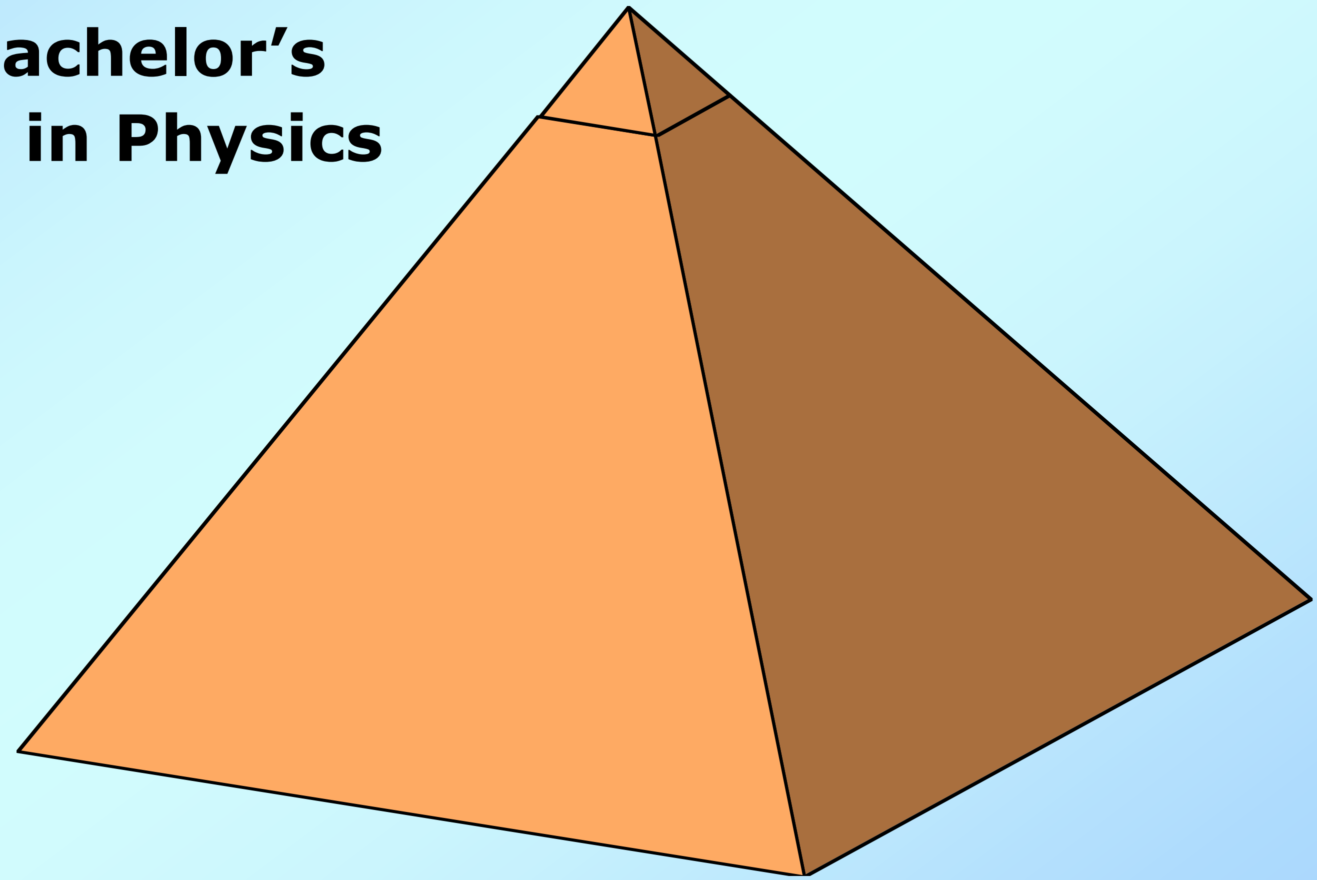
- **380,000 students take introductory Physics every year**



AIP Report R-151.33 (1997)

Problem

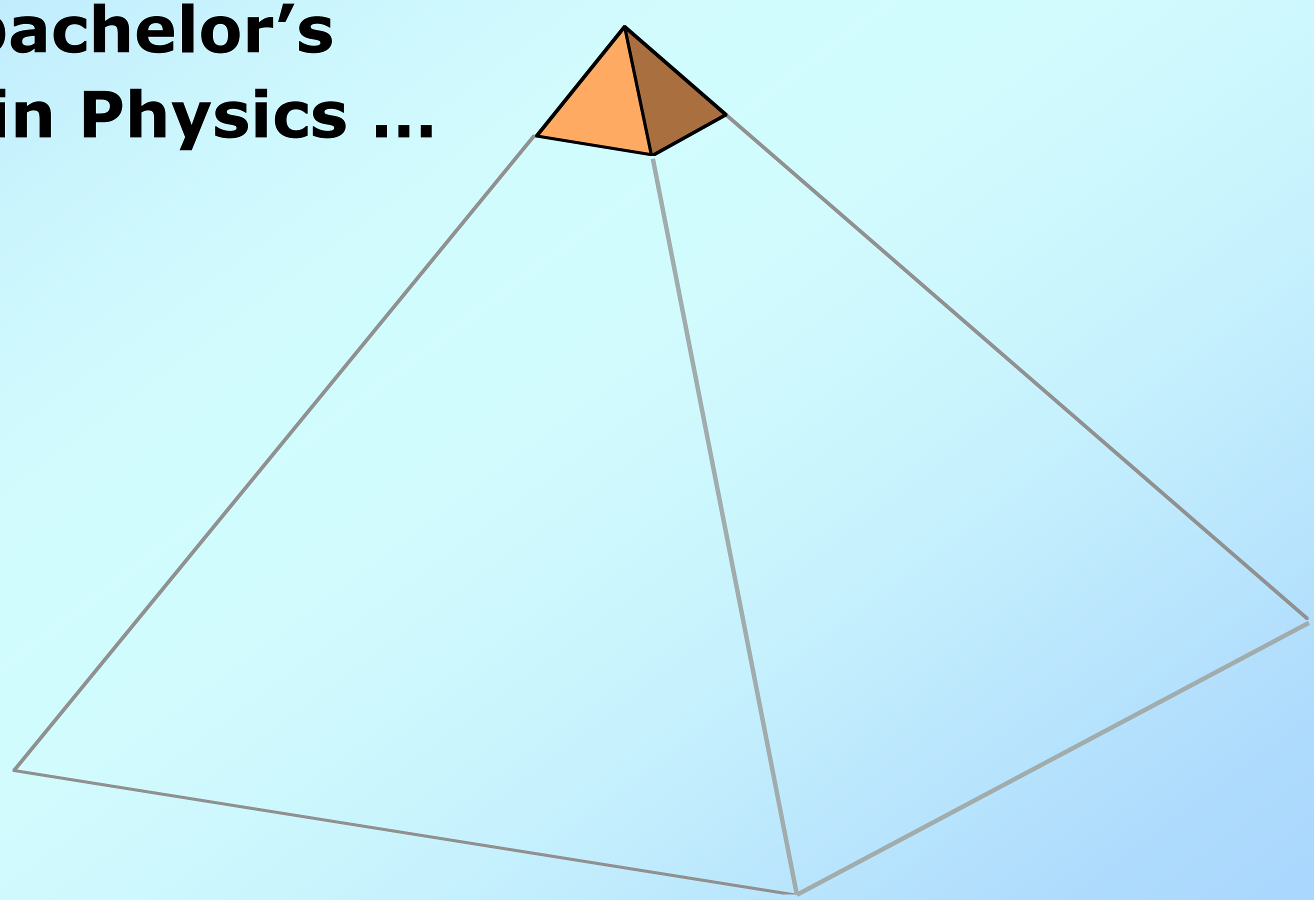
- **About 1% of these get a bachelor's degree in Physics**



AIP Report R-151.33 (1997)

Problem

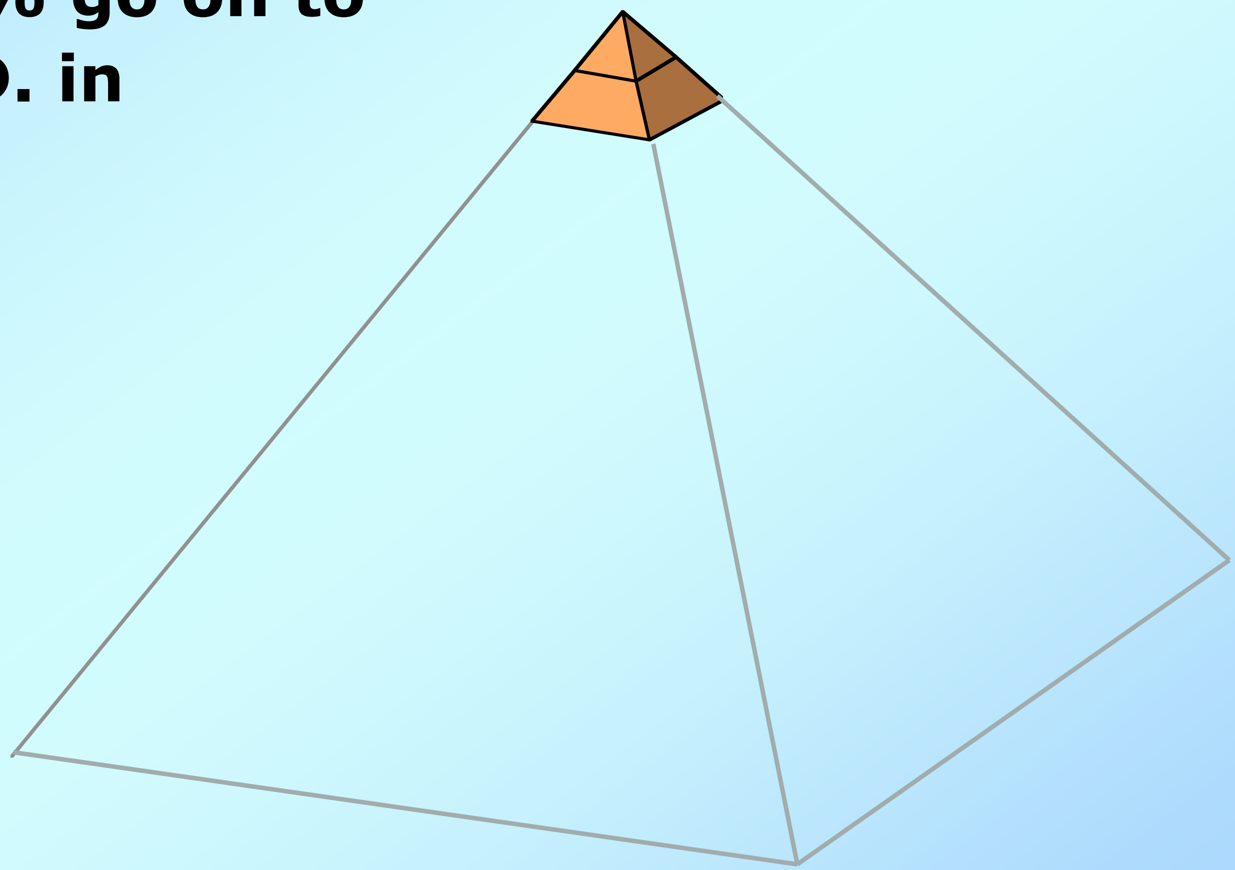
- **Of the 4300 students with a bachelor's degree in Physics …**



AIP Report R-151.33 (1997)

Problem

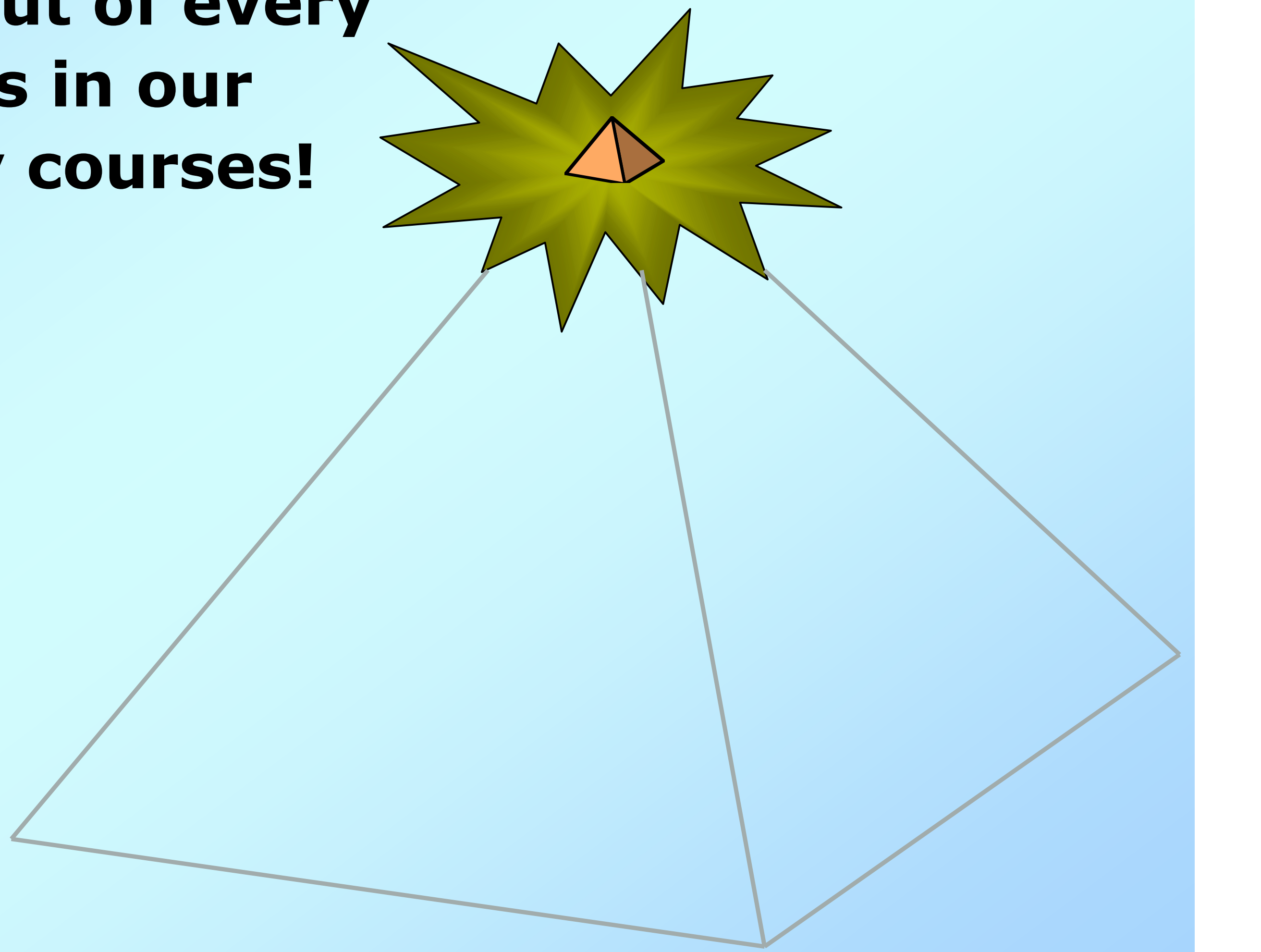
- **About 35% go on to get a Ph.D. in physics…**



AIP Report R-151.33 (1997)

Problem

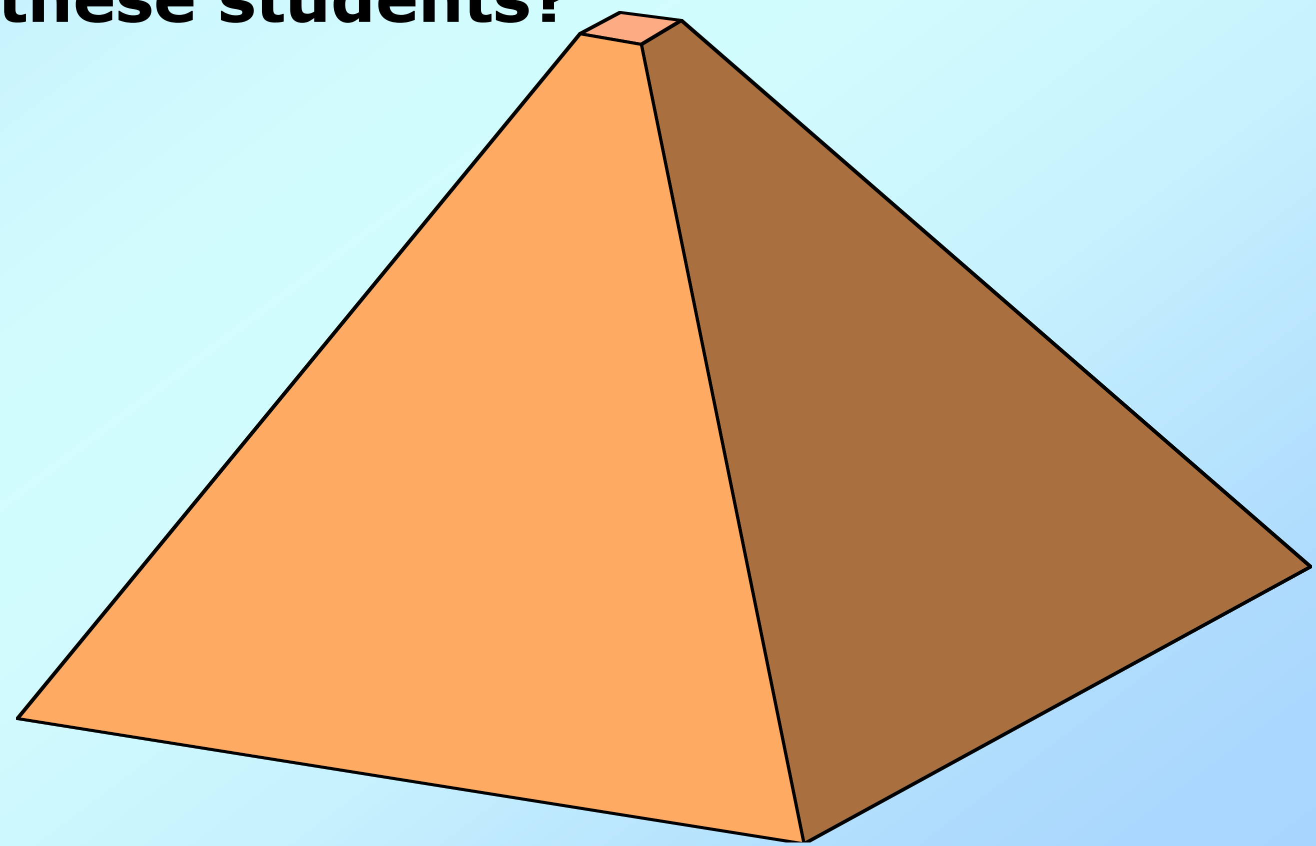
- **That's one out of every 260 students in our introductory courses!**



AIP Report R-151.33 (1997)

Problem

- **What about the other 259…?**
- **Who are these students?**



Problem

- **Some disturbing symptoms:**
  - Frustration
  - Lack of basic knowledge
  - Lack of understanding

Problem

Problem

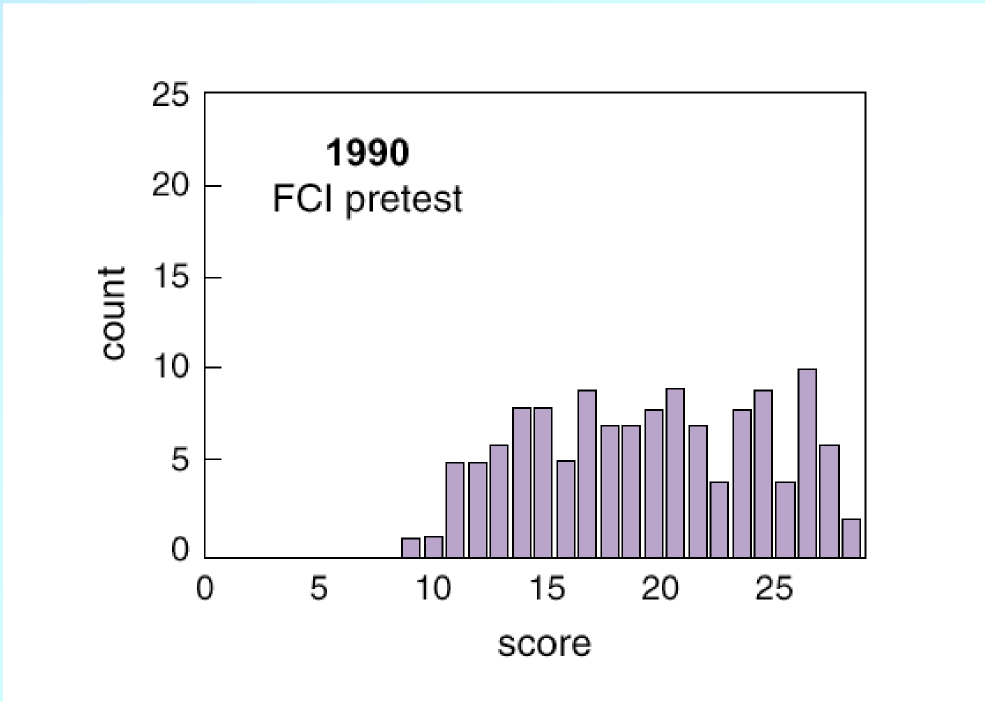
- **Students know some jargon:**
  - "circular motion"
  - "barometric pressure"
  - "something to the power times ten to the something"
- **They know they don't really understand:**
  - "I graduated from college but didn't study astronomy"
  - "Its been a while since I had physics…"
- **But the most worrying thing is:**
  - They don't care!

Problem

Should we be worried?

Problem

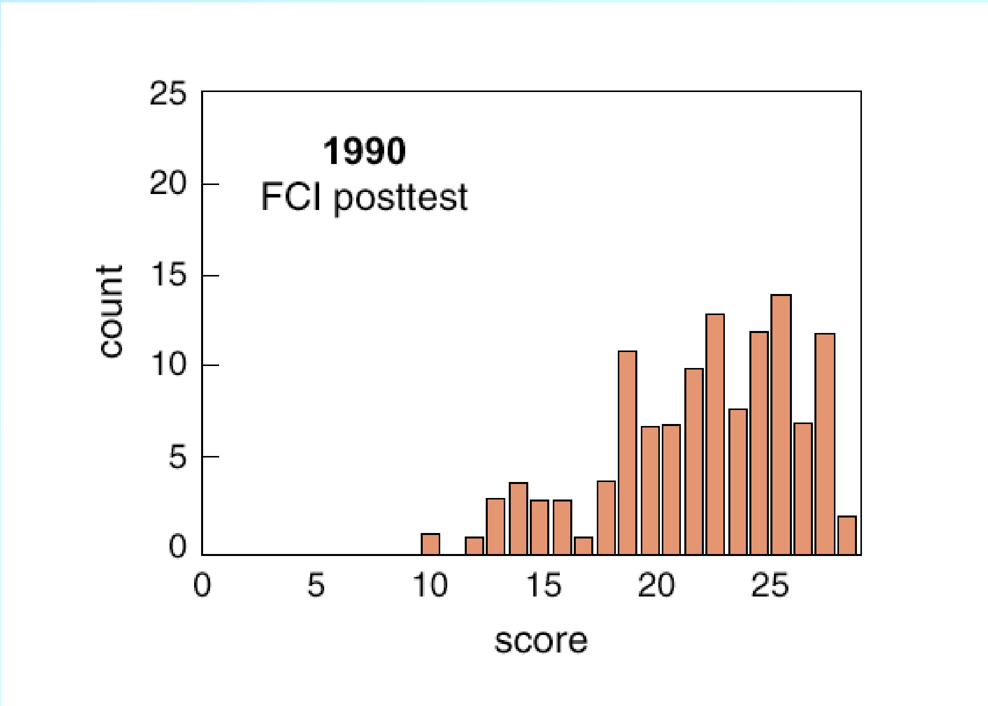
- **Results of standardized test focusing on concepts rather than problems**



Ref: D. Hestenes *et al*. 1992. *The Phys. Teach.* 30: 141-158.

Problem

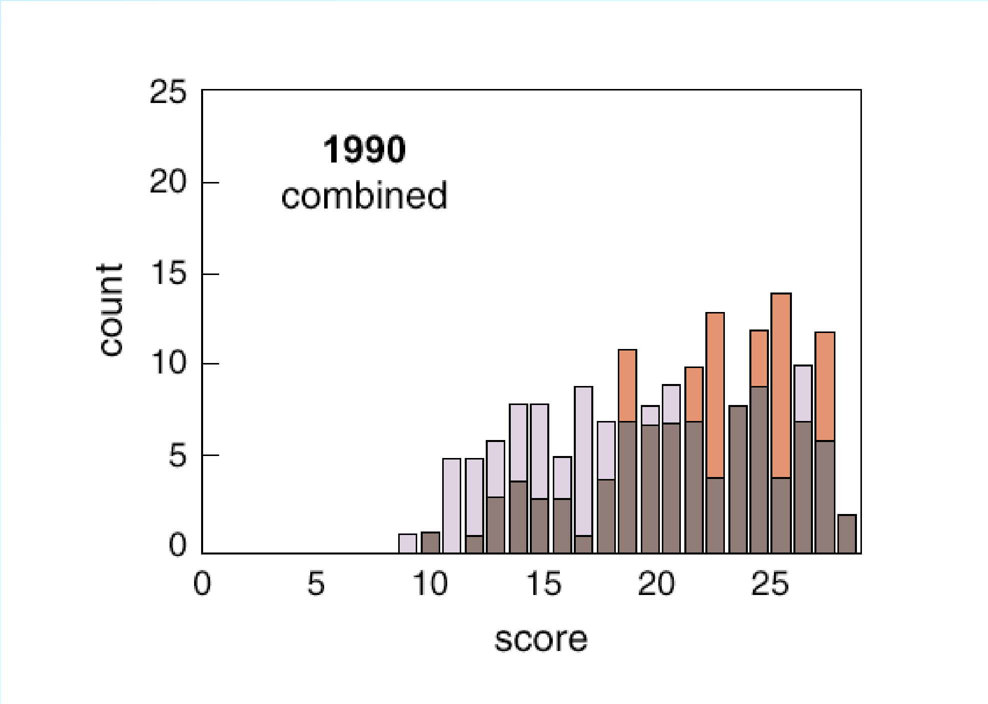
- **Results of standardized test focusing on concepts rather than problems**



D. Hestenes *et al*. 1992. *The Phys. Teach.* 30: 141-158.

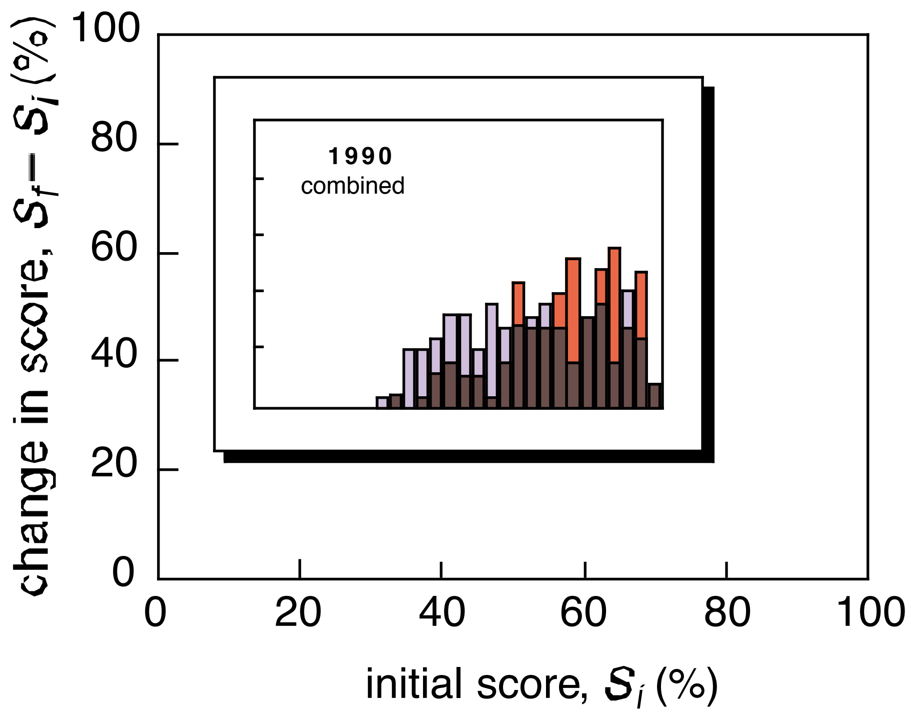
Problem

- **Results of standardized test focusing on concepts rather than problems**



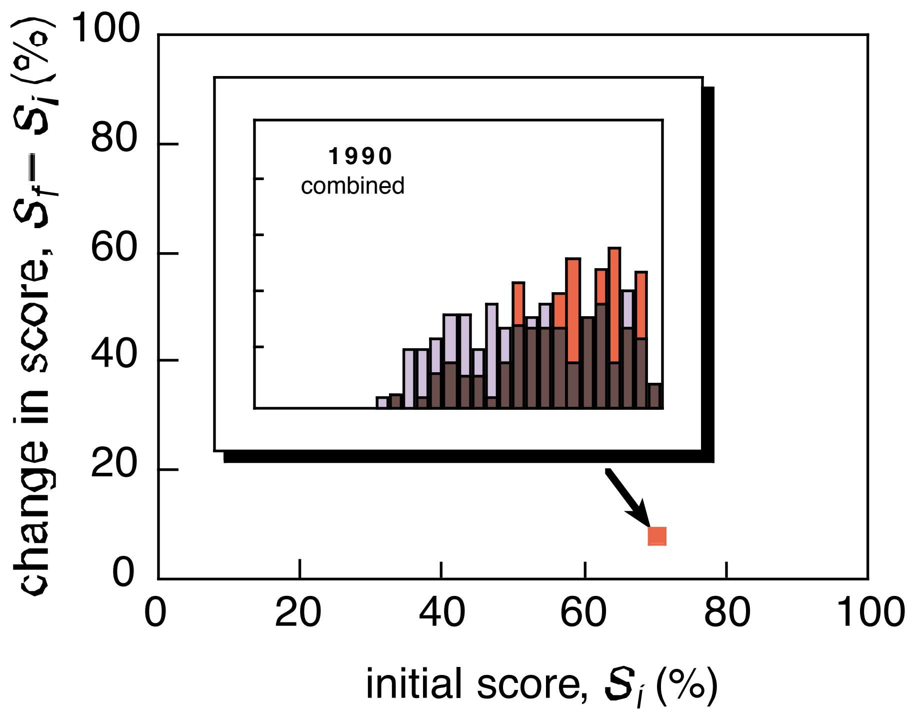
D. Hestenes *et al*. 1992. *The Phys. Teach.* 30: 141-158.

Problem



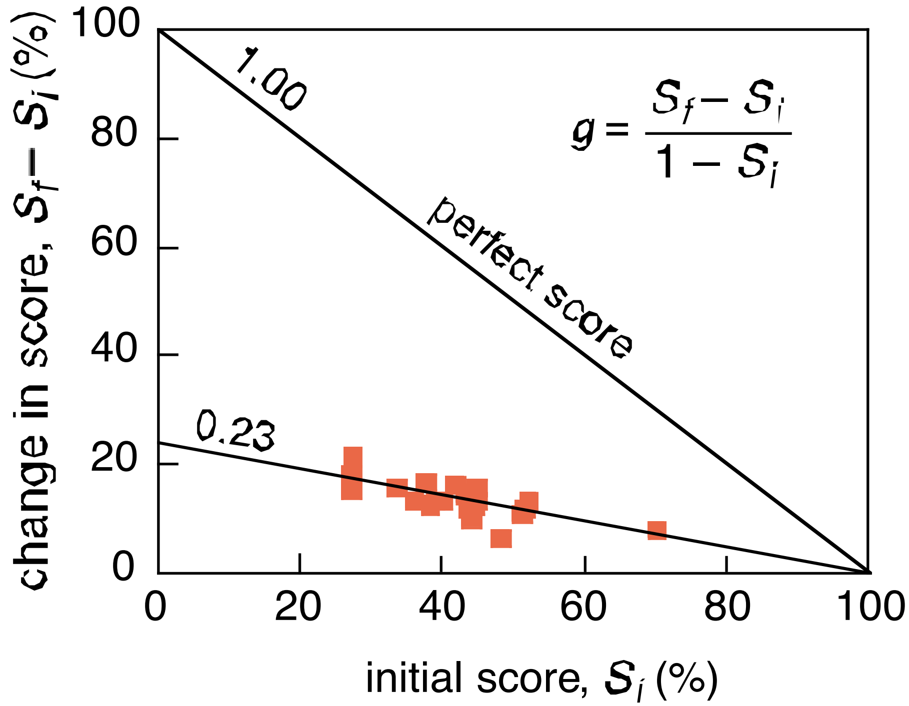
1990
combined
change in score, $S_f - S_i$ (%)
initial score, S_i (%)
0
20
40
60
80
100

Problem



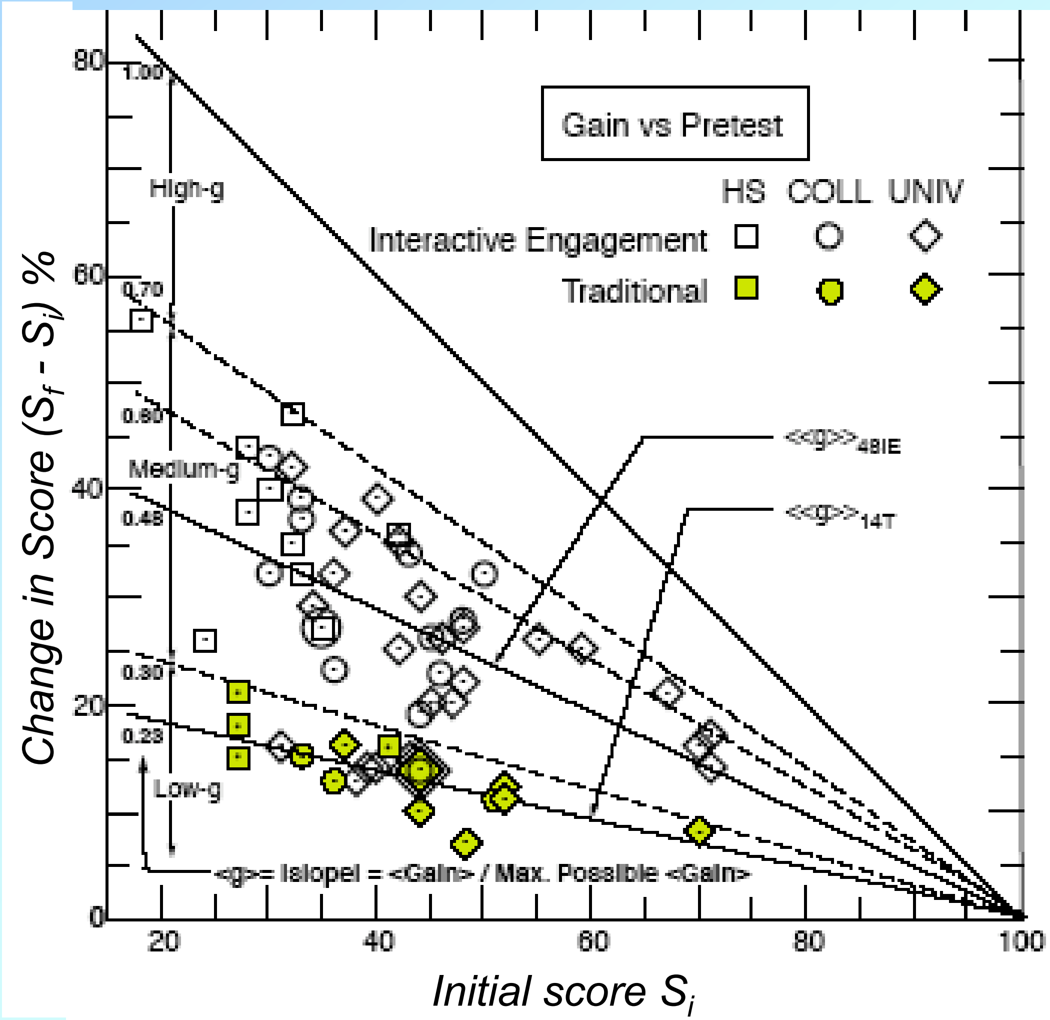
change in score, $S_f - S_i$ (%)
100
80
60
40
20
0
0
20
40
60
80
100
initial score, S_i (%)
1990
combined

Problem



R.R. Hake, *Am. J. Phys*. 66, 64- 74 (1998)

What should we do?



62 courses -- 6542 students

■ -- traditional (14) courses; 2084 students

□ -- “interactive” (48) courses; 4458 students

$<<g>>_T = 0.23 \pm 0.04$ (□)

$<<g>>_{IE} = 0.48 \pm 0.14$ (□)

$<g> = (S_f - S_i) / (100 - S_i)$

$<<g>> \equiv$ ave. of averages

R.R. Hake, *Am. J. Phys*. 66, 64- 74 (1998)

What should we do?

- **Two approaches:**
  - Hands on Physics
    - Interactive experiments
    - Computer animations
    - Small group activities
  - “Socratic methods”
    - Peer Instruction
    - Increased student / teacher interactions
- **Basic necessity**
  - Information transfer done outside of classroom

Hands on methods

MIT TEAL room

Capacity: ~ 100 students

Cost: ~ $1.5 \times 10^6

John Belcher, MIT
http://www.swiss.ai.mit.edu/projects/icampus/projects/teal.html

What should we do?

Peer Instruction at Harvard:

- **Low impact - low cost**
- **Demonstrated results**
- **Core elements**
  - Information transfer outside of class
  - Classroom focused on student confusion
  - Instructor acts as a facilitator
  - Students learn through peer discussions

Peer Instruction

- **After discussing a significant concept:**
  - Stop; ask ConcepTest question
  - Steps:
    1. Question
    2. Thinking
    3. Individual answer
    4. Peer discussion
    5. Individual answer
    6. Instructor explanation
- **Adjust lecture based on feedback**

ConcepTest

A boat carrying a large boulder is floating in a lake. The boulder is thrown overboard and sinks to the bottom of the lake. Does the level of the water in the lake (with respect to the shore):

1. go up
2. go down, or
3. stay the same?

ConcepTest

Most of the mass accumulated by a tree to go from a seed to a fully grown tree comes from:

1. Nutrients in the soil
2. Water
3. Air
4. None of the above

How can technology help?

- **Information collection**

  Collect student responses in classroom and outside

- **Information distribution**

  Deliver materials and information to students

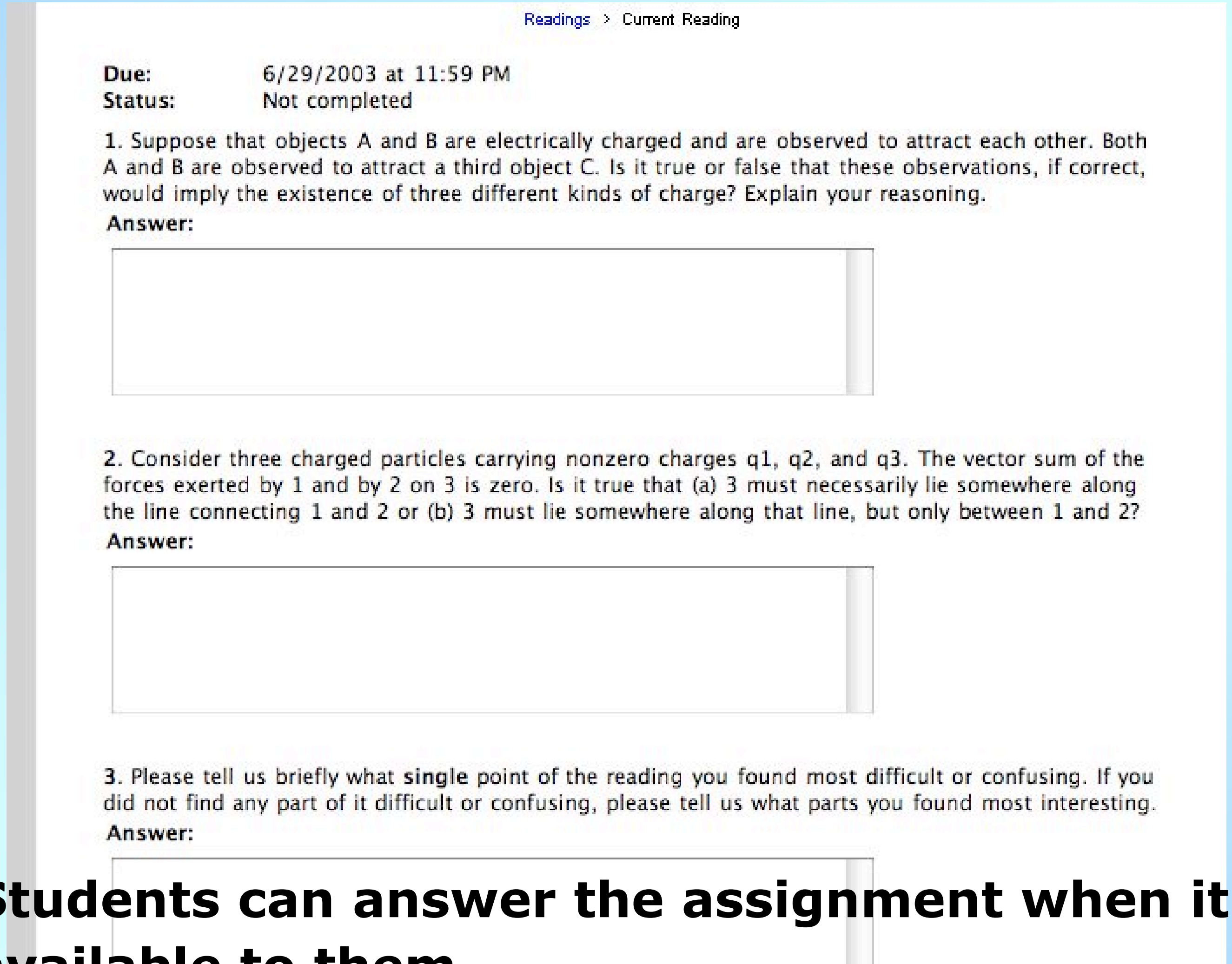
- **Information presentation**

  Discover connections between all the different pieces of information that go with a course

Steps in teaching a PI class

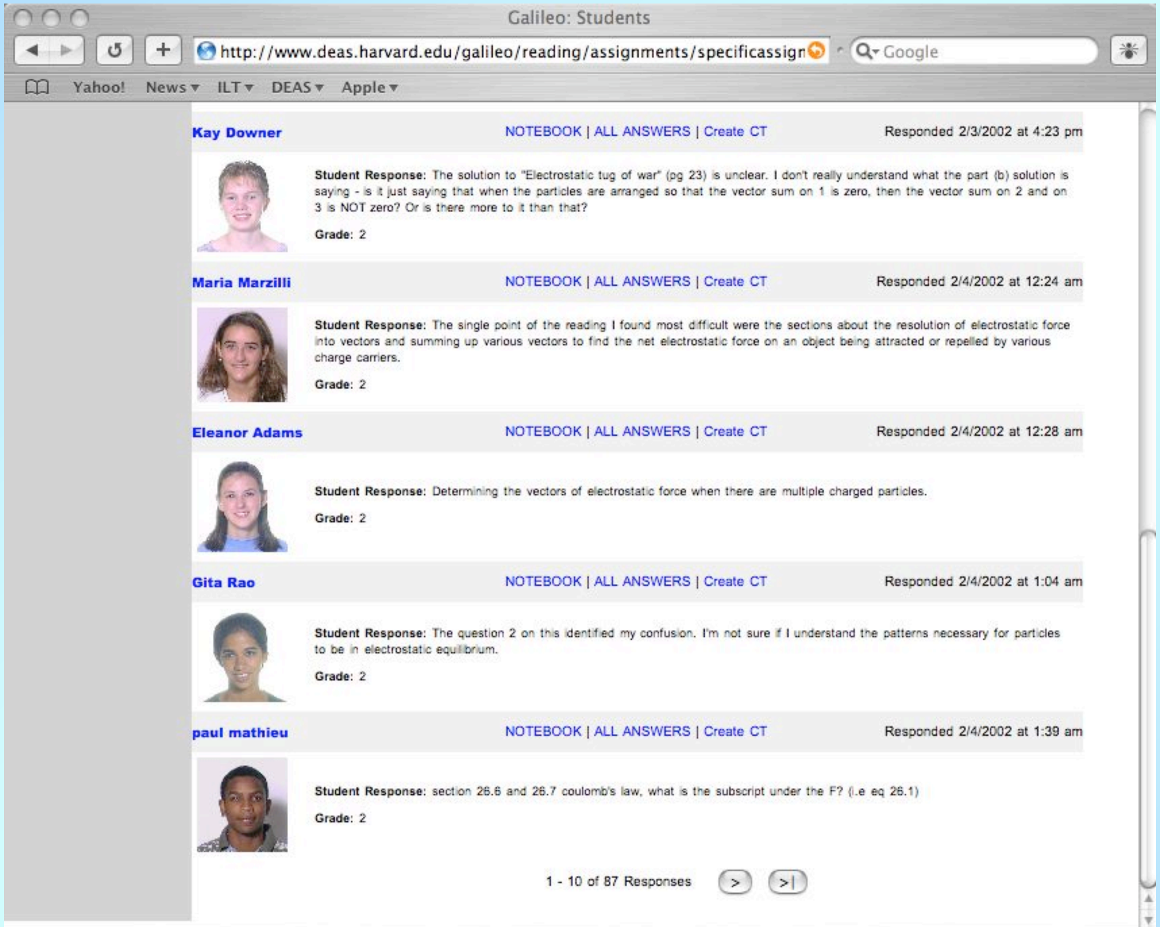
1. Prepare students
2. Review student confusion before class
3. Initiate discussions in class
4. Use feedback from student responses to moderate progress in class
5. After class use feedback to assign reading material for the next class

Reading assignments in ILT



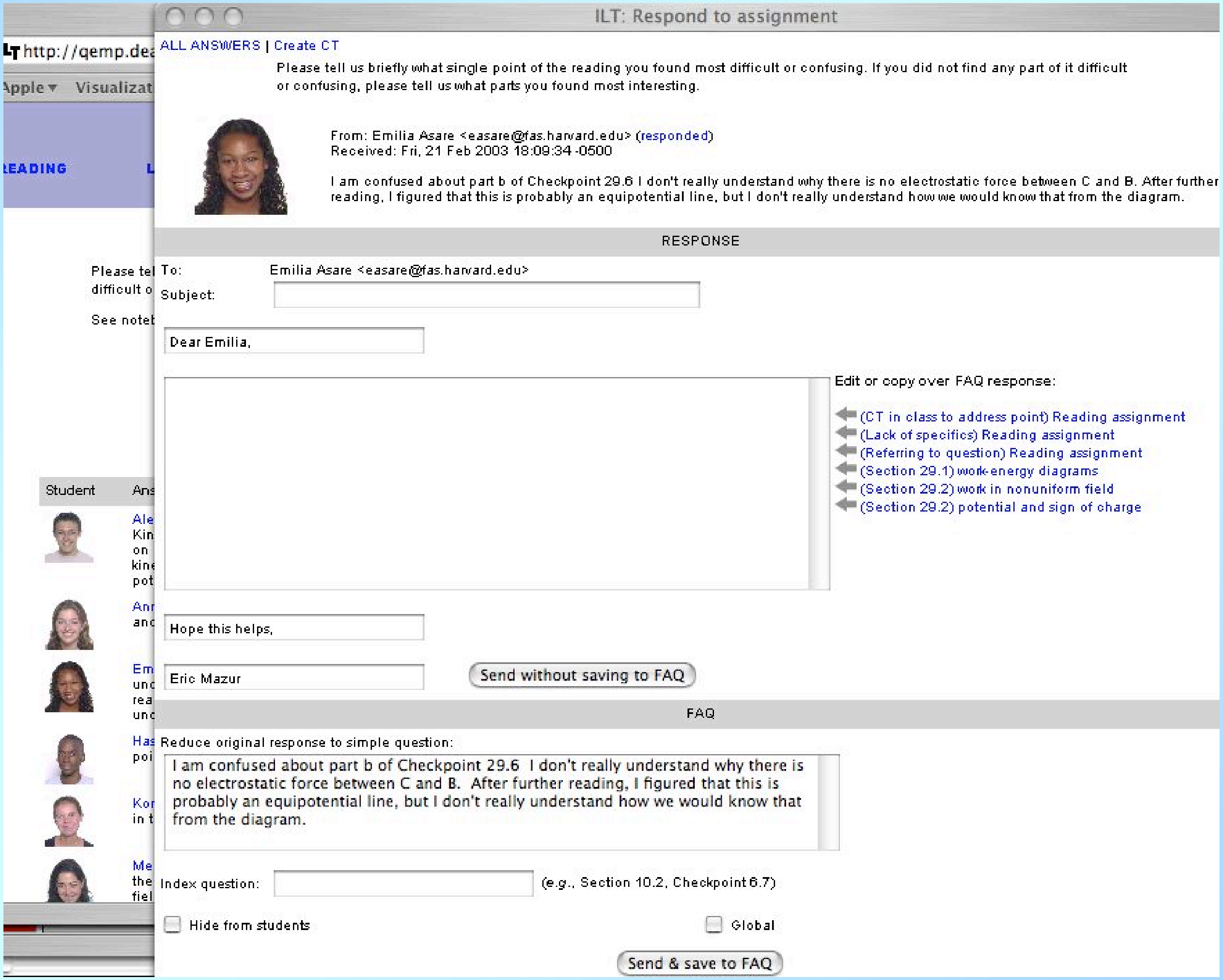
- **Students can answer the assignment when it is available to them**

Reading assignments in ILT

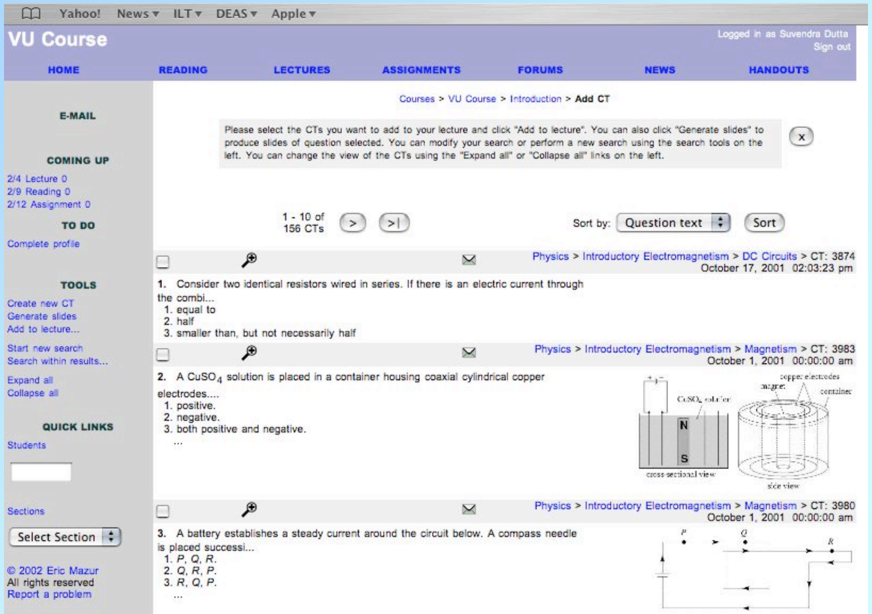


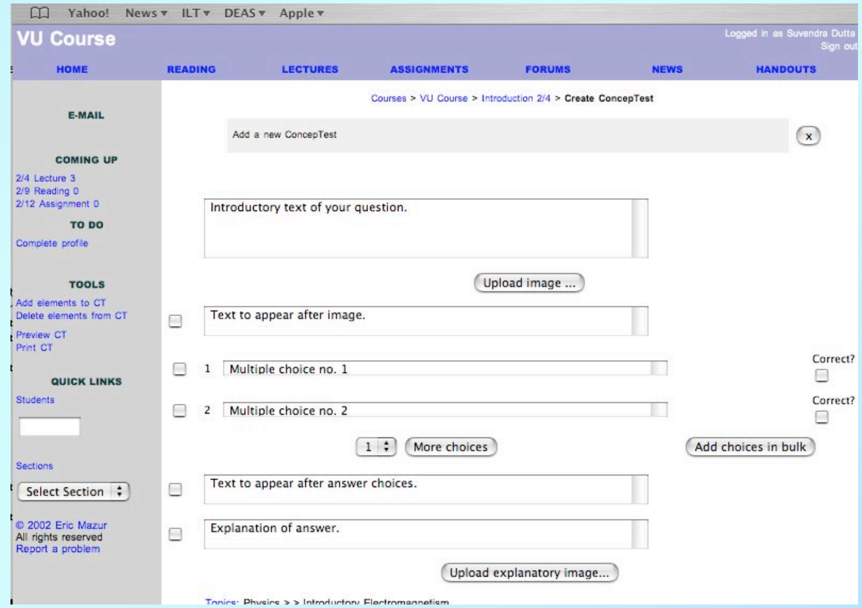
- **Students' work, face and names are all connected**

Reading assignments in ILT



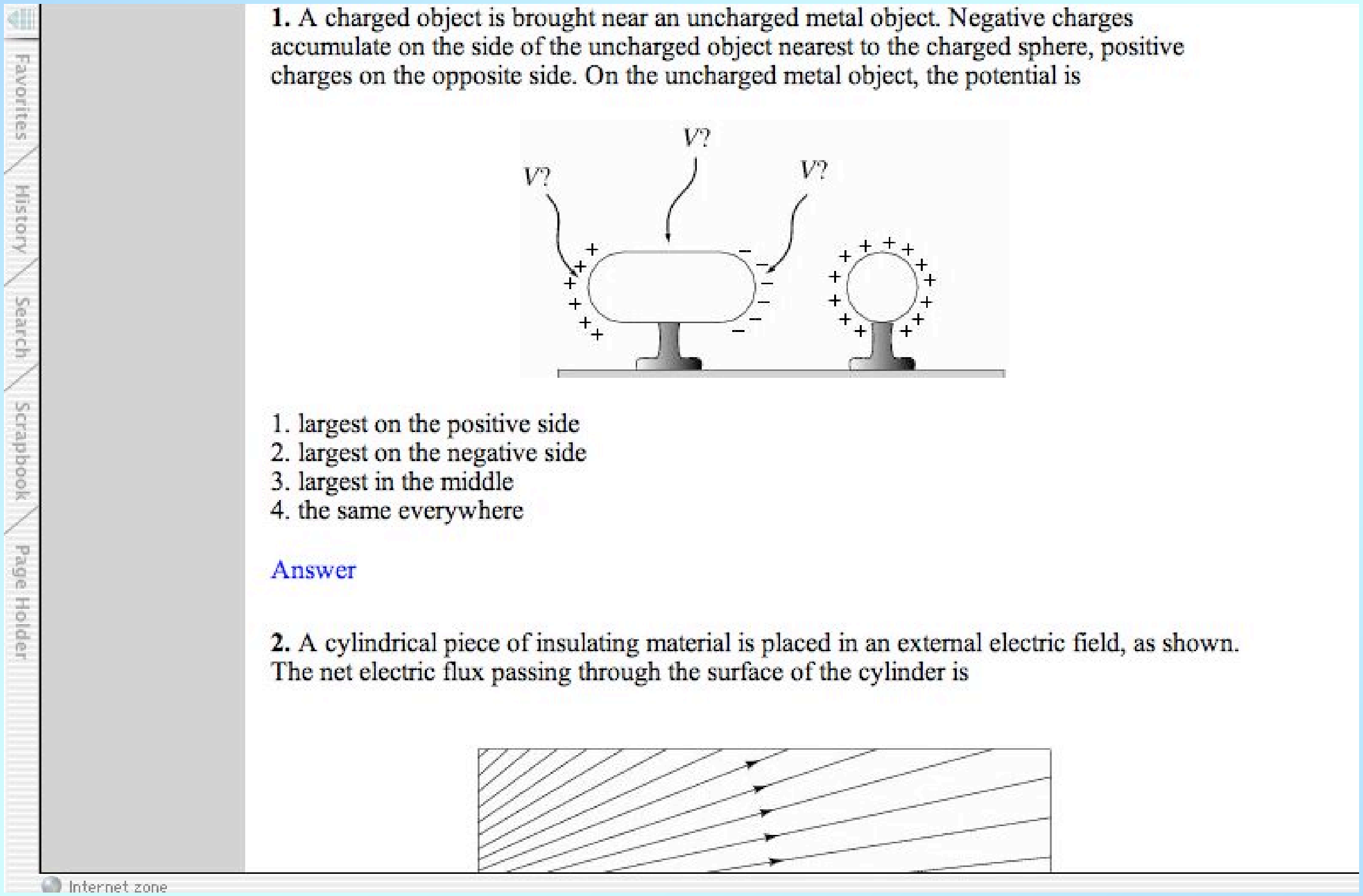
Peer Instruction in ILT





- **Pull in ConcepTest questions from a database**
- **Create new ones yourself and add to the database**

Peer Instruction in ILT



1. A charged object is brought near an uncharged metal object. Negative charges accumulate on the side of the uncharged object nearest to the charged sphere, positive charges on the opposite side. On the uncharged metal object, the potential is

1. largest on the positive side
2. largest on the negative side
3. largest in the middle
4. the same everywhere

Answer

2. A cylindrical piece of insulating material is placed in an external electric field, as shown. The net electric flux passing through the surface of the cylinder is

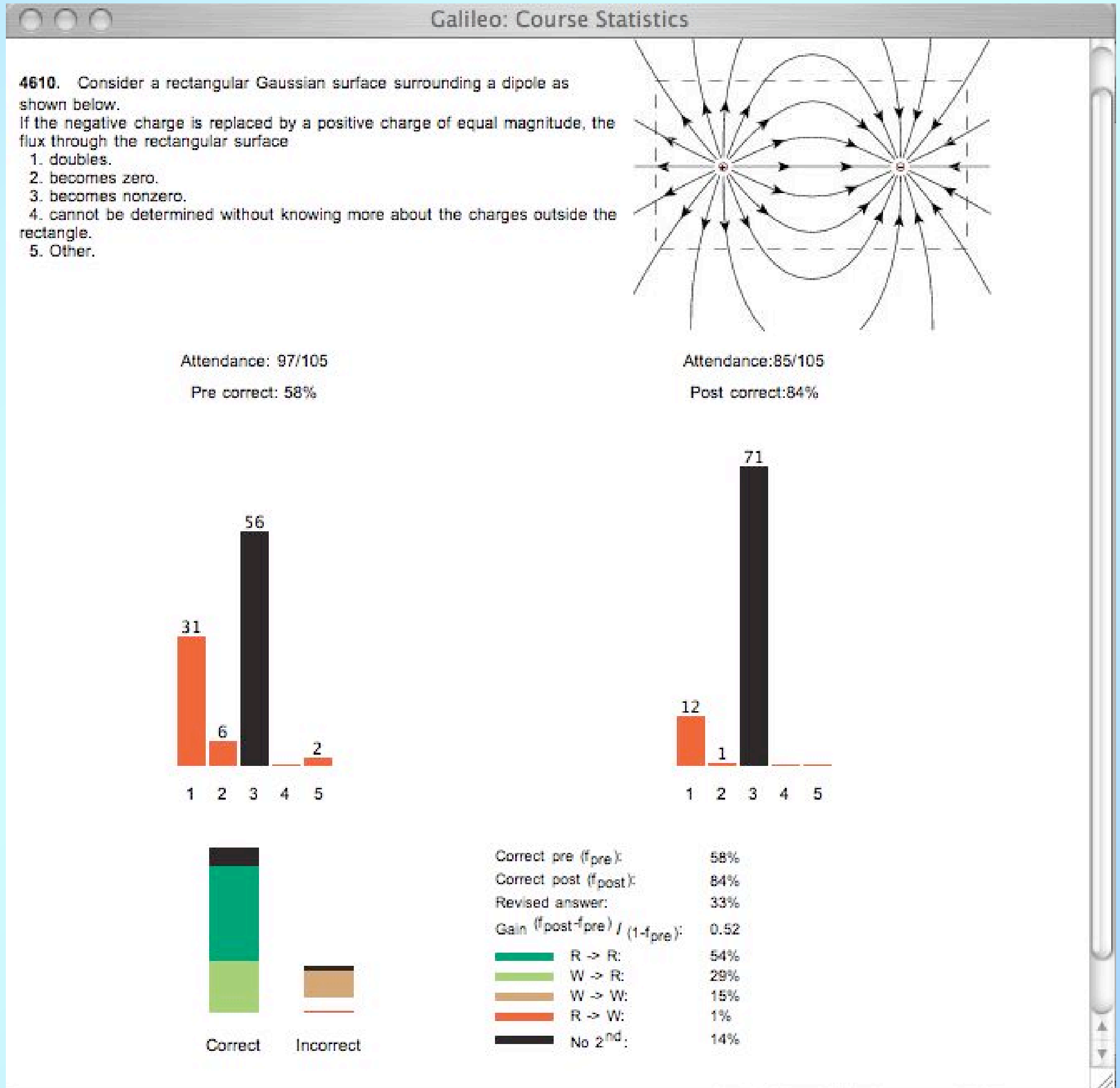
- **Student view of lecture automatically created**
- **And published to students when specified**

Peer Instruction in ILT

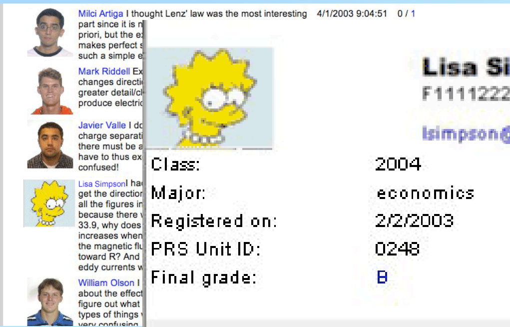
- **In class students follow the PI process**
- **Technology is useful in collecting data**
- **Easy to do simple analysis**
- **But Severe limitations:**
  a) Restricted to multiple choice
  b) No location information on students
  c) One way communication
  d) Data is volatile, not linked to rest of the course

Peer Instruction in ILT

- **Upload PRS session files**
- **Automatically grade students for participation**
- **Grade questions for effectiveness**



Face book



Laboratory 8 Tue 1:00:pm
Section 5 Wed 4:00:pm

Lisa Simpson
F11112222

lsimpson@fas.harvard.edu

Class:	2004	Forums:	4 posts
Major:	economics	Email:	36
Registered on:	2/2/2003	No. of self-tests	1 self-tests
PRS Unit ID:	0248	Reading FAQs:	1
Final grade:	B		

RA	CT	PT	L	PS	HE	OT	FE
6/6	1/1	2/2	9/10	40/40	20/35	5/5	39/60
4/6	5/6	2/2	9/10	28/35	14/35	15/15	
5/6 *	5/6	0/2		35/35	25/35	18/18	
5/6 *	2/3	2/2	9/10	35/35 *			
5/6 *	6/9	2/2	10/10	35/35			
6/6	7/8	0/2		35/35			
6/6	3/4	2/2		35/35			
5/6 *	5/9	2/2		35/35			
6/6	9/9	2/2					
6/6	8/11						
5/6 *							
6/6	5/5						
6/6	10/10						
6/6	8/9						
6/6	10/10						
6/6	7/7						
6/6							
6/6							
6/6	11/11						
6/6	9/9						
6/6	8/8						
	13/13						
119/126	132/148	14/18	37/40	278/285	59/105	38/38	39/60
94%	89%	78%	93%	98%	56%	100%	65%

RA: Reading assignments; CT: ConcepTests; PT: Pretest; L: Laboratory; PS: Problem Set; HE: Hour Exam; OT: Online Test; FE: Final Exam;

- **By connecting every element of the course together with the student, ILT makes it easier to get to "know" a large class**

Summary

- **Fundamental problem in classes - concepts not getting across to students**
- **Small changes in the class can have significant positive effect on students learning**
- **Technology can help implement pedagogical changes**

Acknowledgments

This work is funded by:

NSF Distinguished Teaching Scholar Award

DEAS Information Technology Group

For more information please visit:

http://mazur-www.harvard.edu

http://www.deas.harvard.edu/galileo

Useful Resources

- **Old Project Galileo site (useful information on education research):**
  - http://galileo.harvard.edu
- **New Galileo site (updated ConcepTests and tools):**
  - http://www.deas.harvard.edu/galileo
- **JiTT web-site:**
  - http://webphysics.iupui.edu/jitt/jitt.html
- **Mazur Group papers & talks:**
  - http://mazur-www.harvard.edu/library
- **Prof. Mazur's Spring Physics course web-site:**
  - http://physics1.harvard.edu
- **Suvendra Nath Dutta contact info:**
  - Email: sdutta@deas.harvard.edu
  - Phone: (617) 495-9616