

# Understanding or memorization Are we teaching the right thing?



CETP-PA Summer Conference, Clarion University  
Clarion, PA, 19 August 2004

# Outline

- Problem



# Outline

- Problem

- Cause



# Outline

A photograph of a group of people in a meeting. A man in a blue shirt is on the left, gesturing with his hands. A woman in a white shirt is on the right, also gesturing. Other people are visible in the background, some looking at papers. The image is slightly blurred and has a warm, somewhat faded color palette.

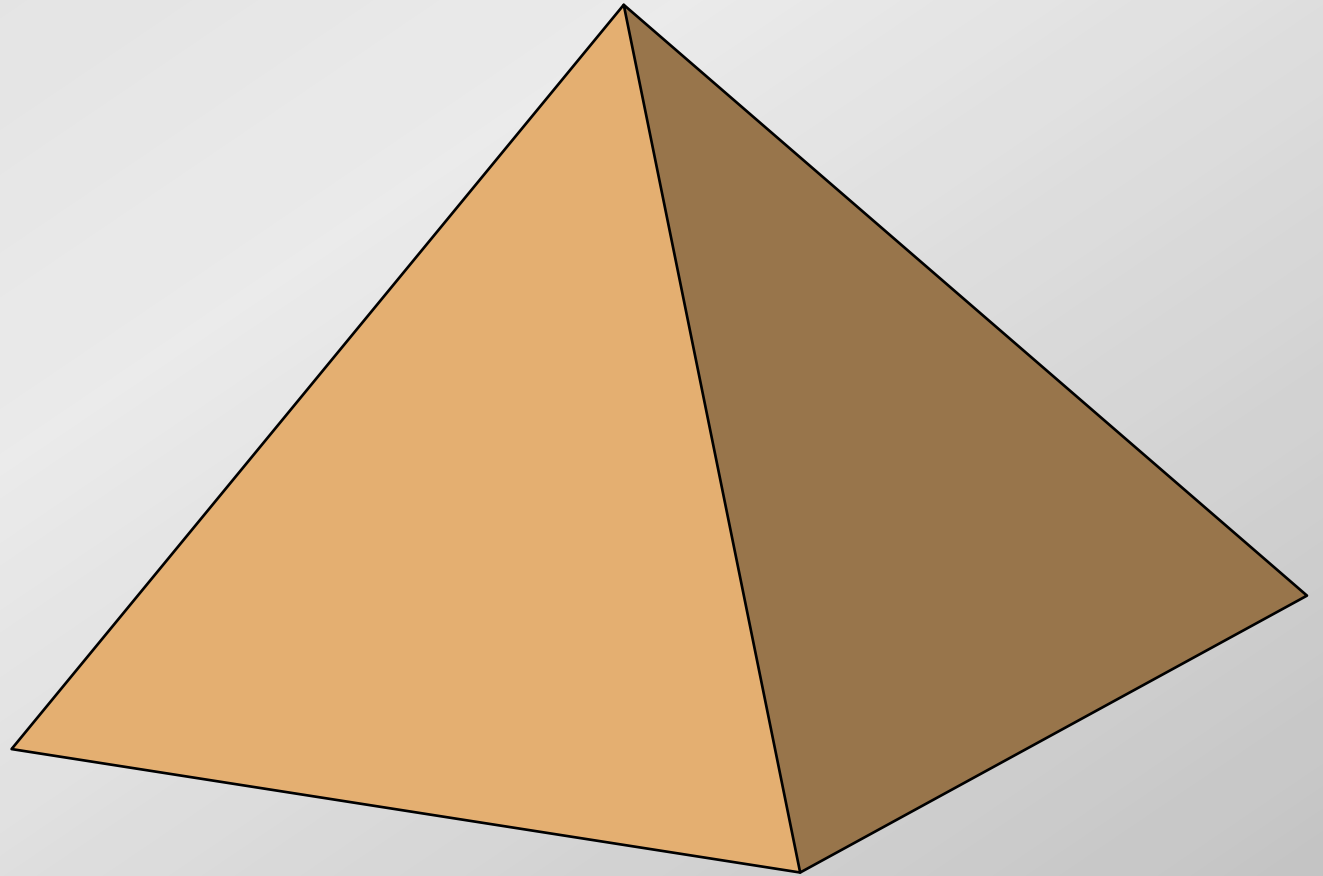
- Problem

- Cause

- Remedy

# We have a problem

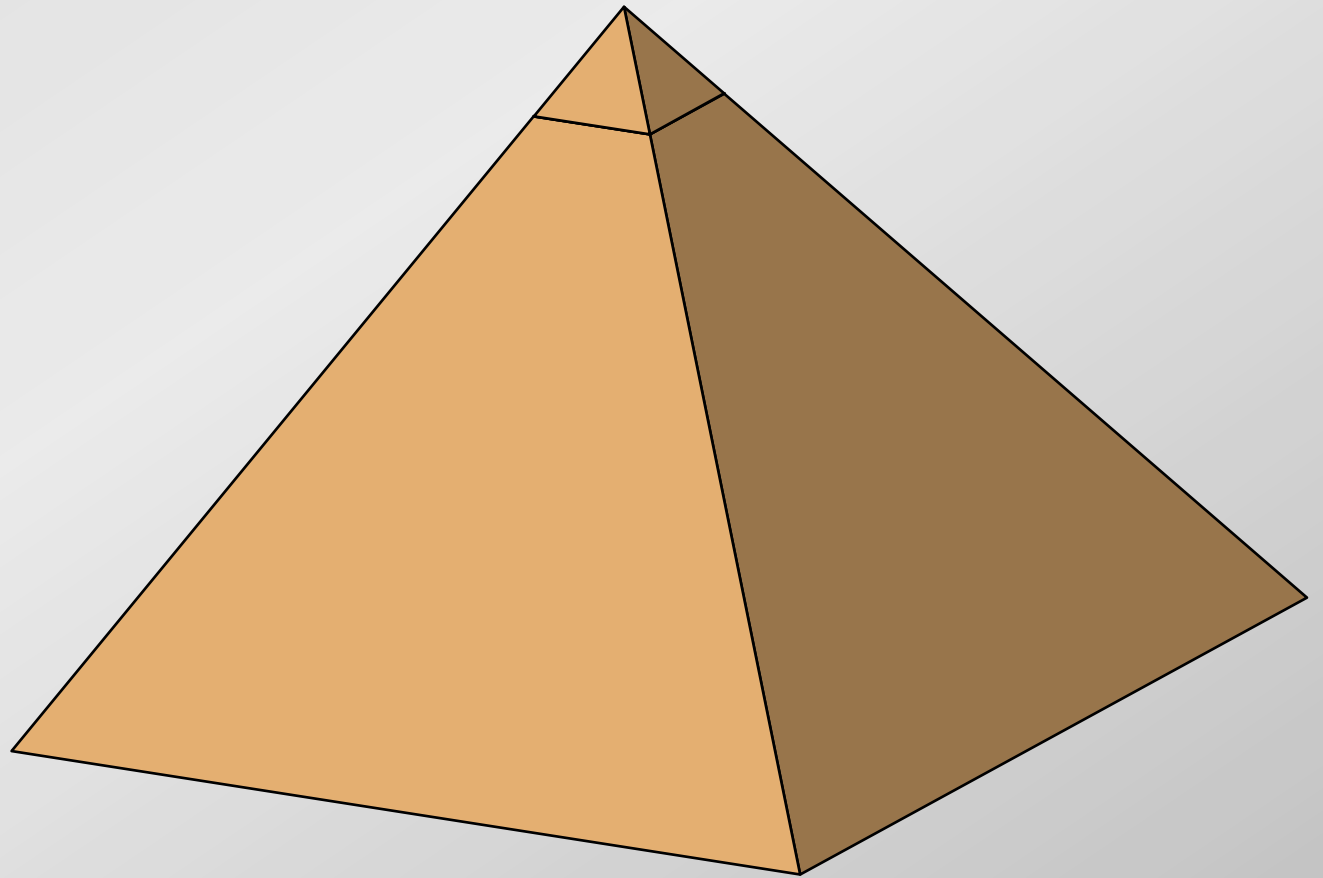
340,000 students take  
introductory physics  
each year



AIP Report R-151.39 (2003)

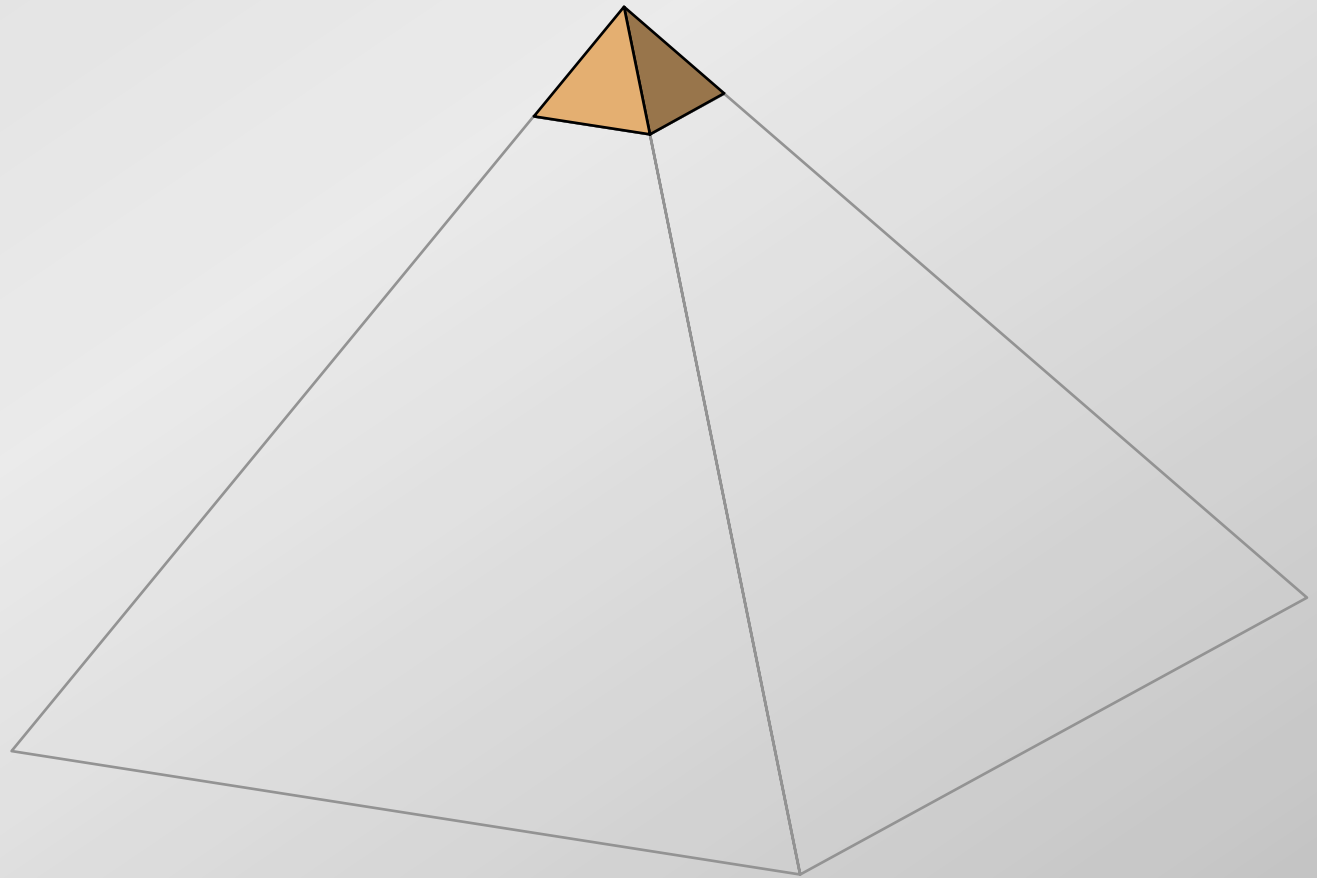
# We have a problem

about 1% of these get  
a bachelor's degree  
in physics



# We have a problem

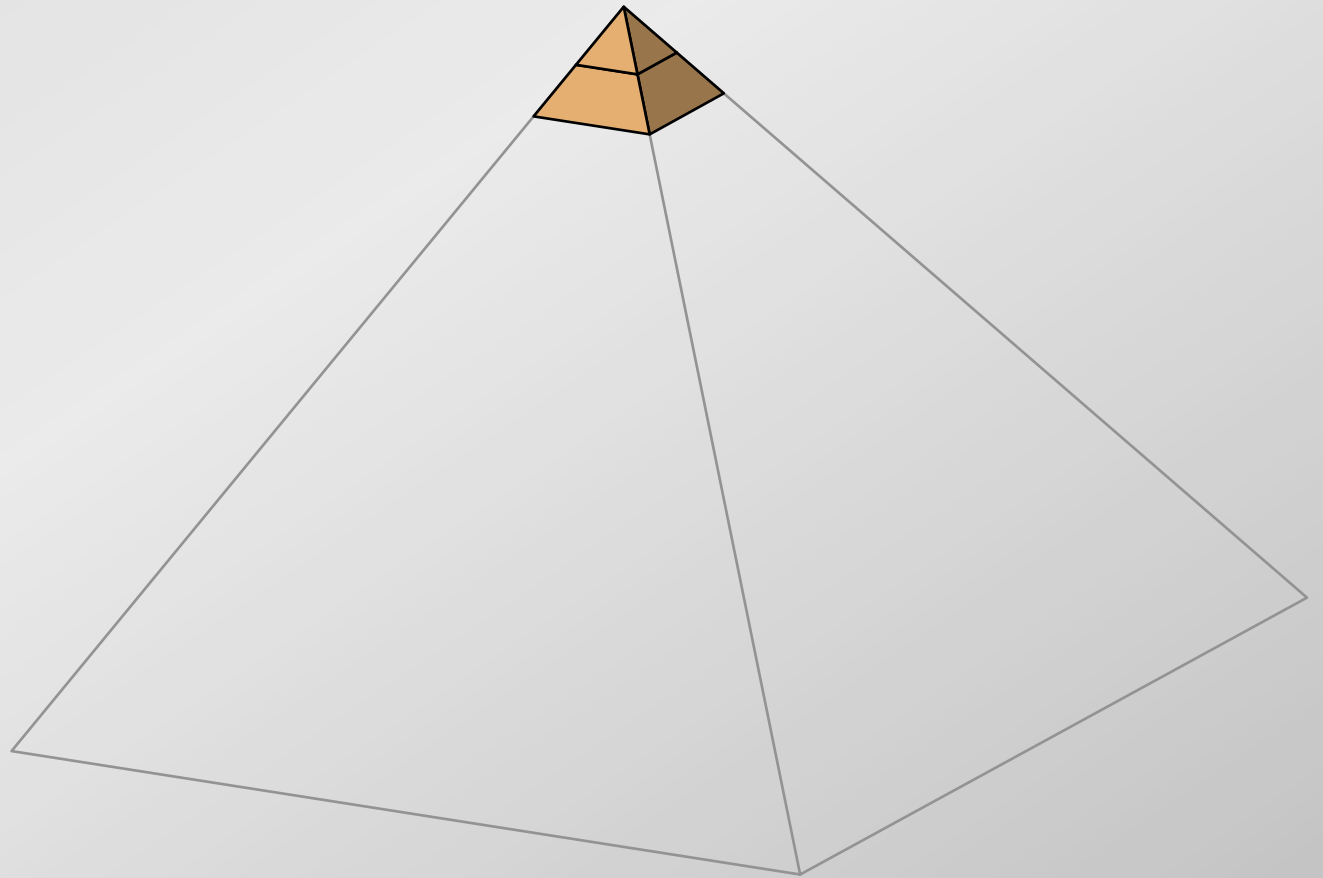
Of the 4,100 students with  
a bachelor's degree  
in physics...





# We have a problem

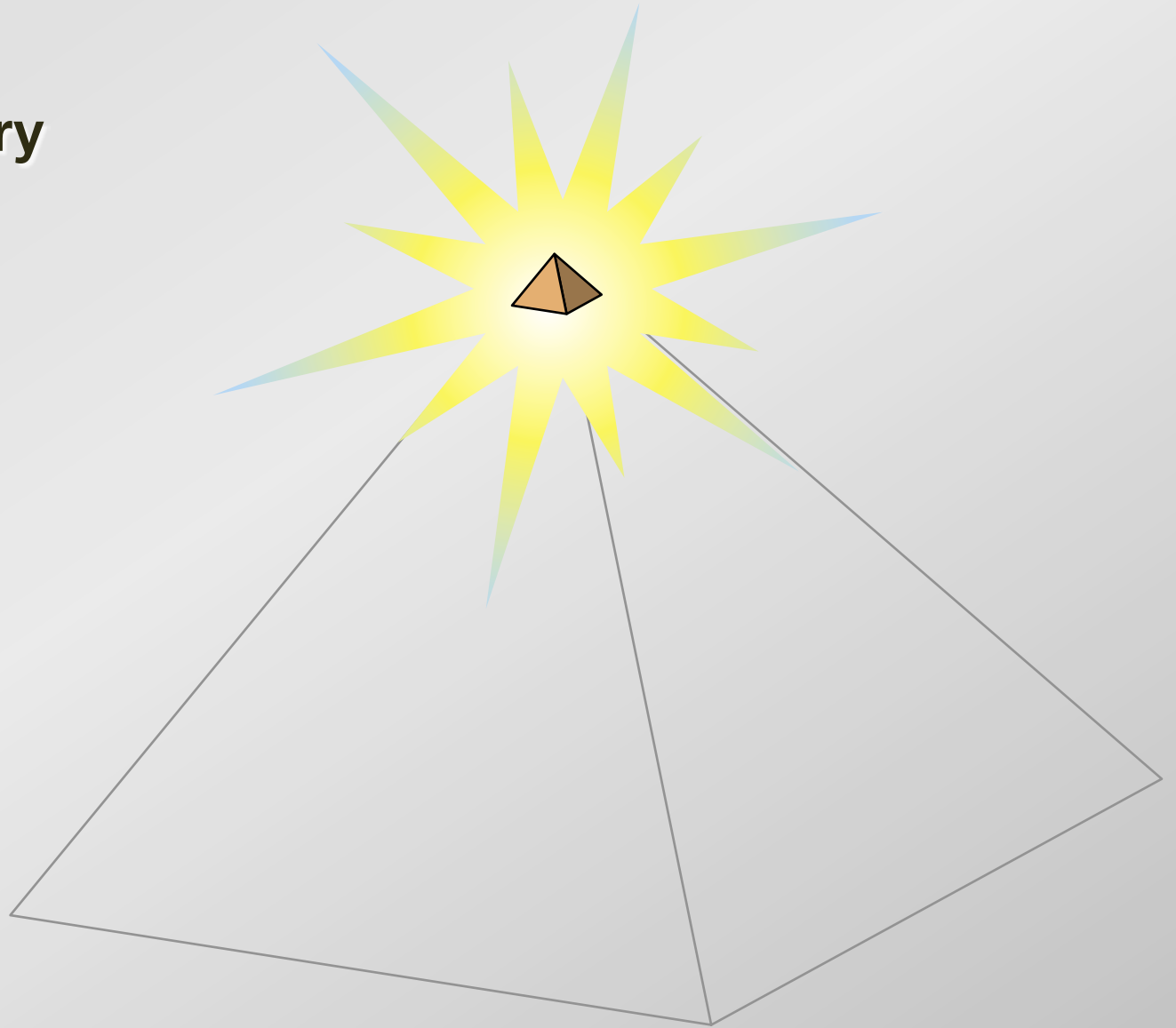
about 28% go on to get a  
Ph.D. in physics...





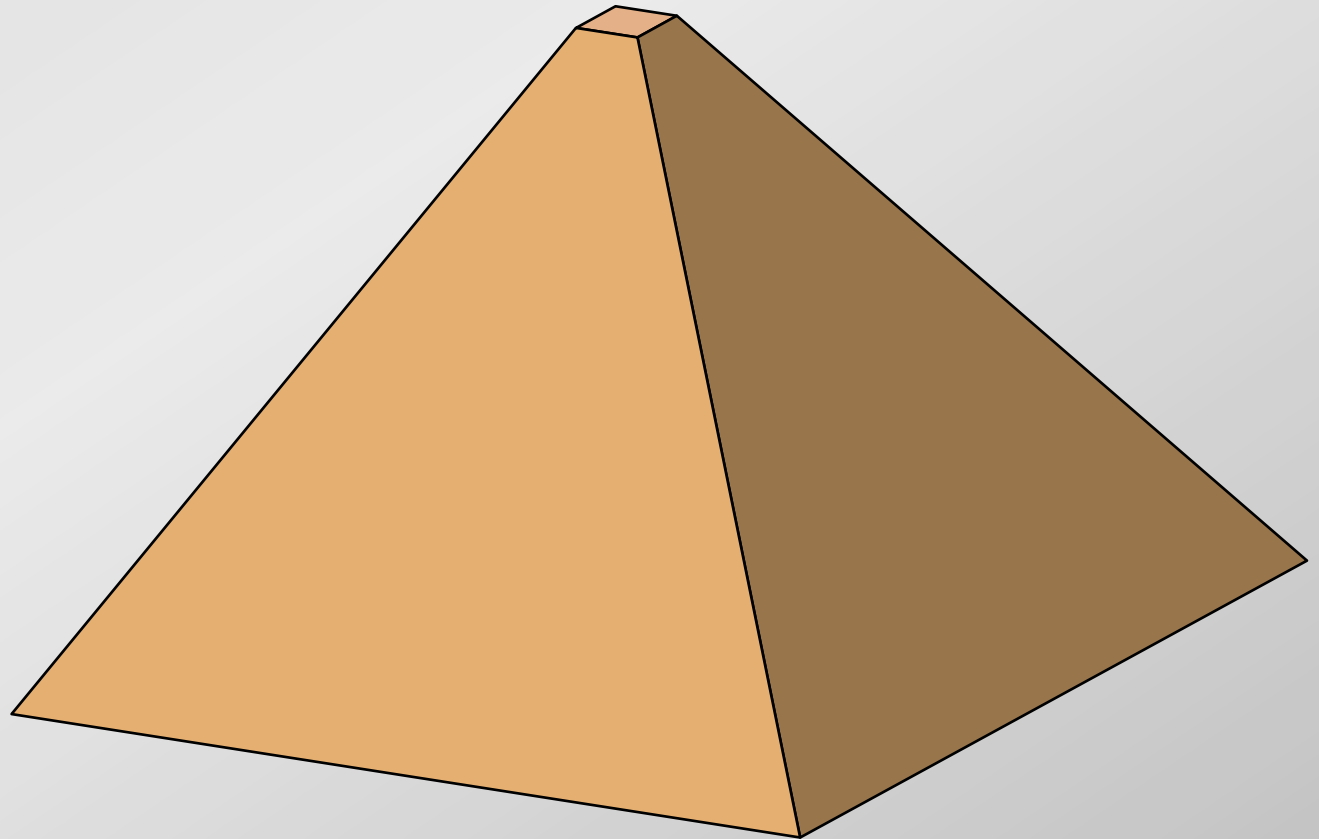
# We have a problem

That's one out of every  
300 students in our  
introductory  
courses!



# We have a problem

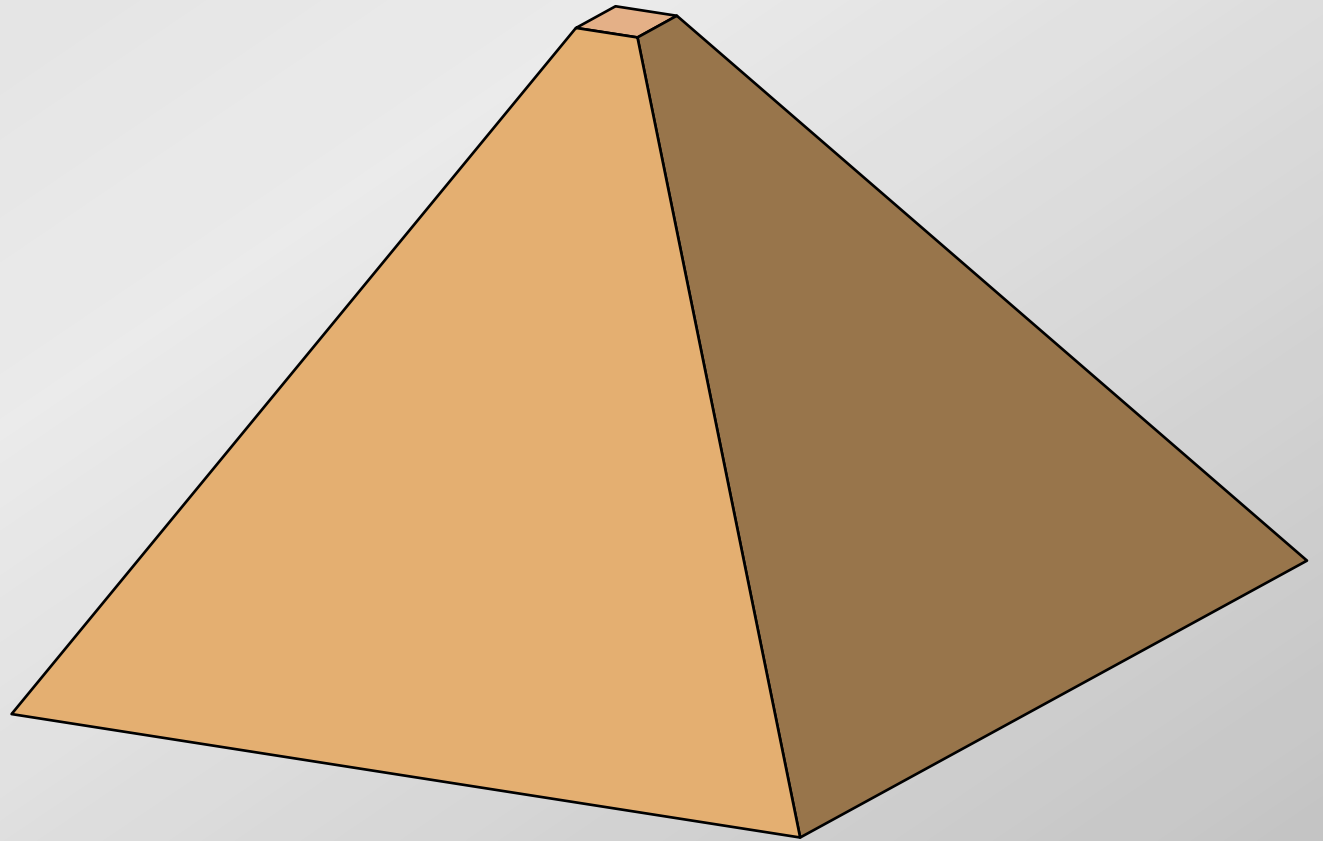
What about the  
other 299...?



AIP Report R-151.39 (2003)

# We have a problem

What do we know  
about these  
students?



# **We have a problem**

**Some disturbing symptoms:**

- **frustration**
- **lack of understanding**
- **lack of basic knowledge**



# We have a problem

They know the jargon:

- circular motion
- barometric pressure
- light radius
- something to the power times ten to the something

# We have a problem

They are aware of their lack of knowledge:

- I graduated from college, but I didn't study *astronomy*
- It's been a while since I've had physics



# **We have a problem**

**They are aware of their lack of knowledge:**

- **I graduated from college, but I didn't study *astronomy***
- **It's been a while since I've had physics**

**...and they don't care!**

# **We have a problem**

**Should we worry?**

# **We have a problem**

**We'd better!**



# We have a problem

"I took four years of science  
and four years of math...

A waste of my time,  
a waste of the teacher's time,  
and a waste of space...

You know, I took *physics*.

For *what?*"





**Why do we have this problem?**

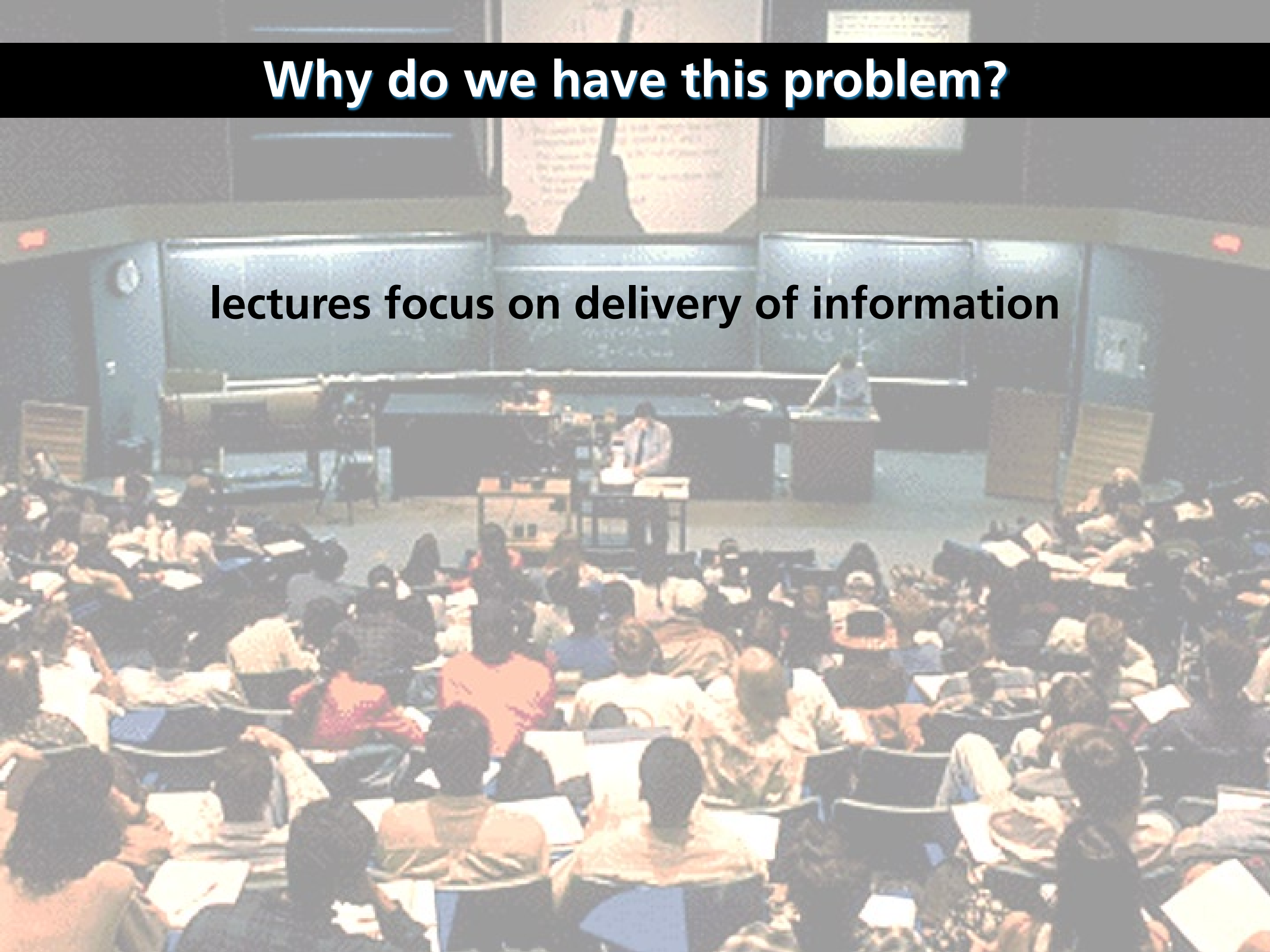
# Why do we have this problem?





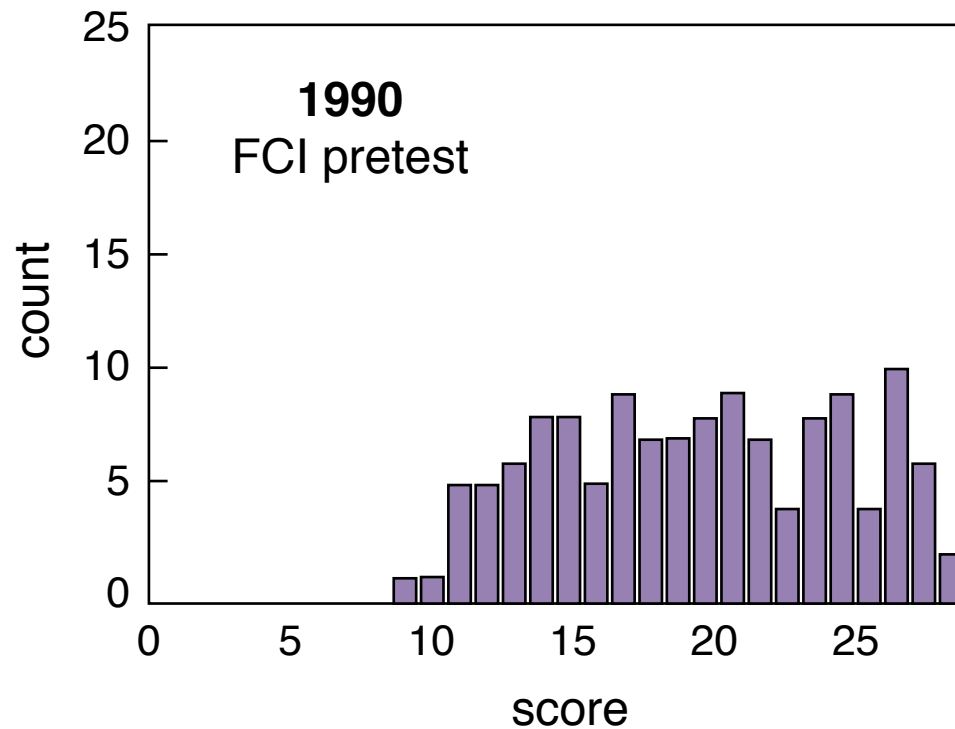
# Why do we have this problem?

lectures focus on delivery of information



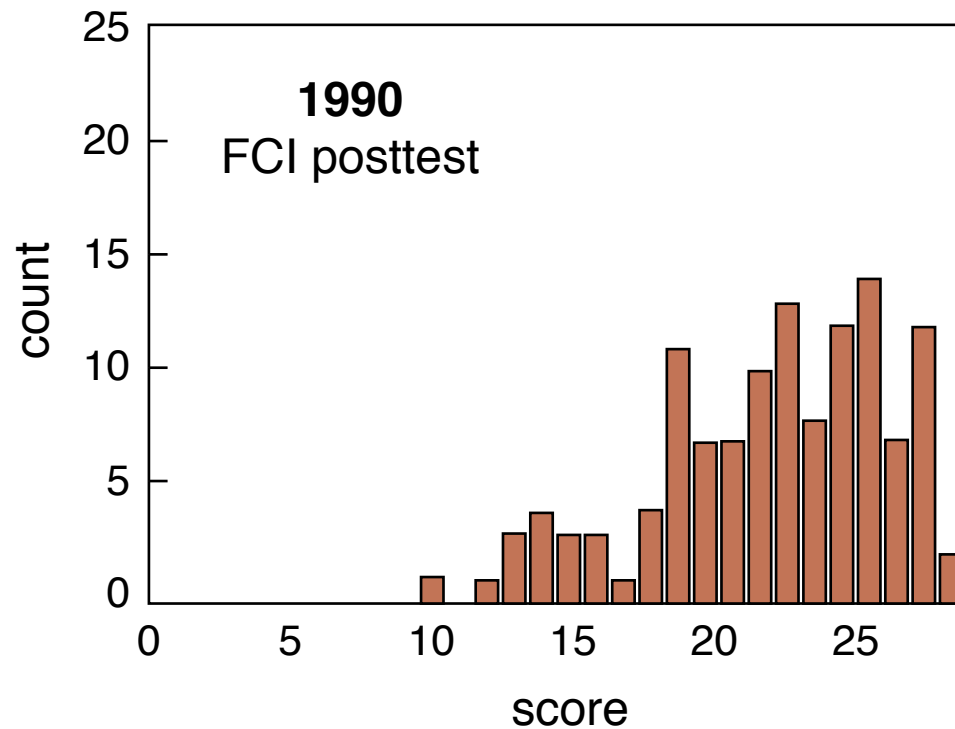
# Why do we have this problem?

education is not just information transfer



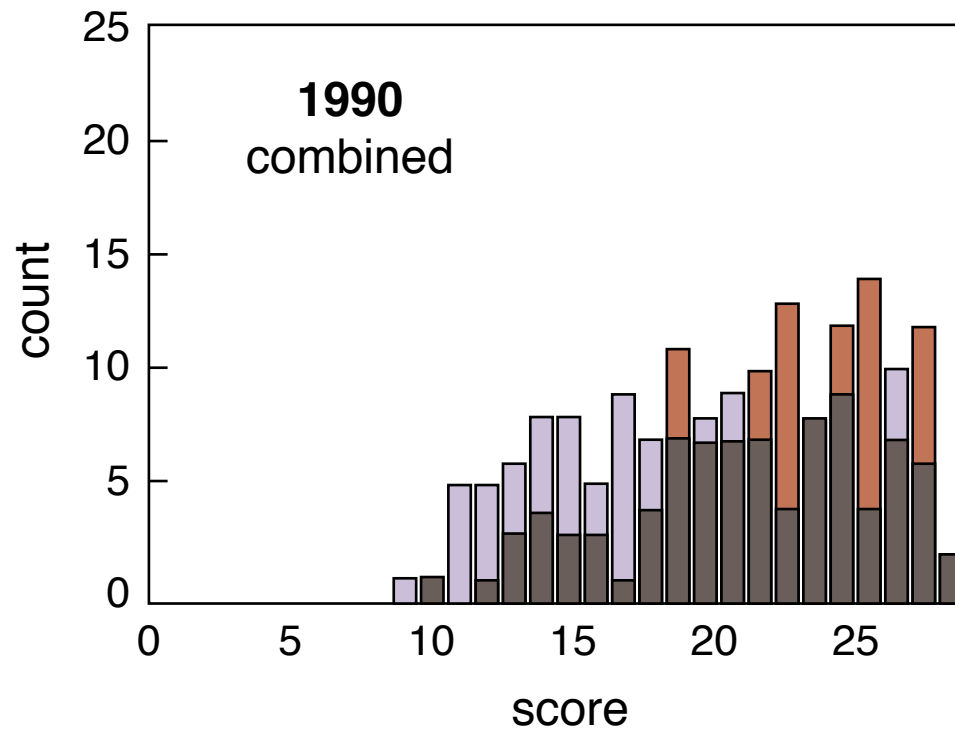
# Why do we have this problem?

education is not just information transfer

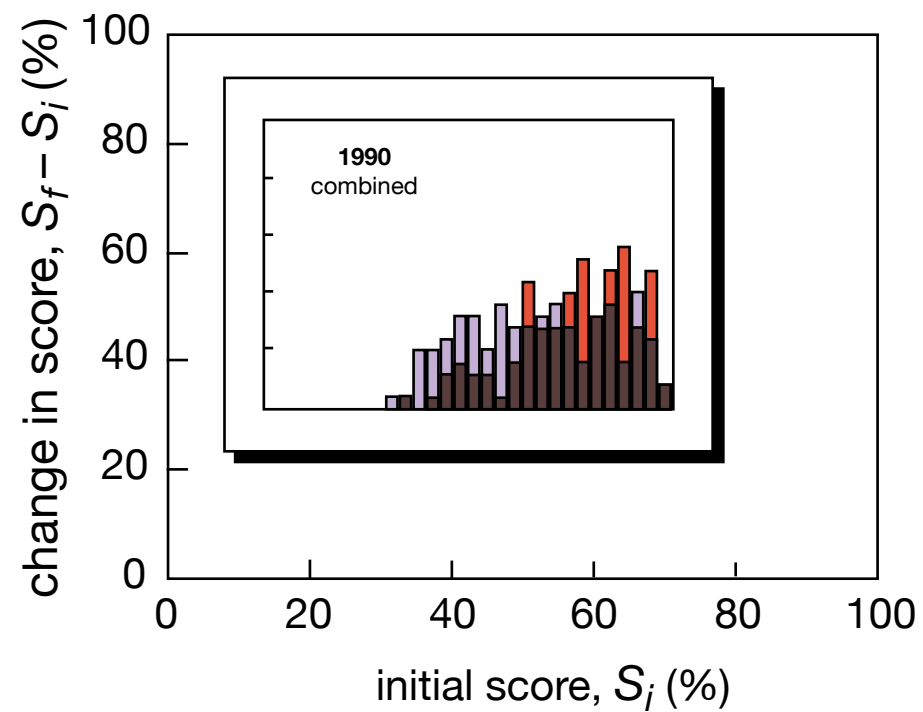


# Why do we have this problem?

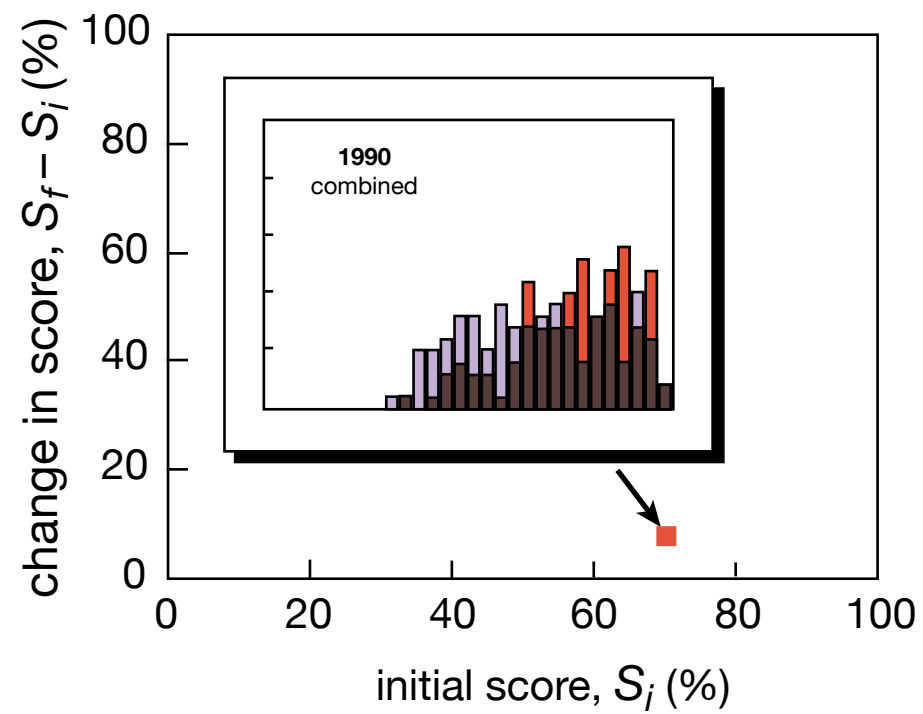
education is not just information transfer



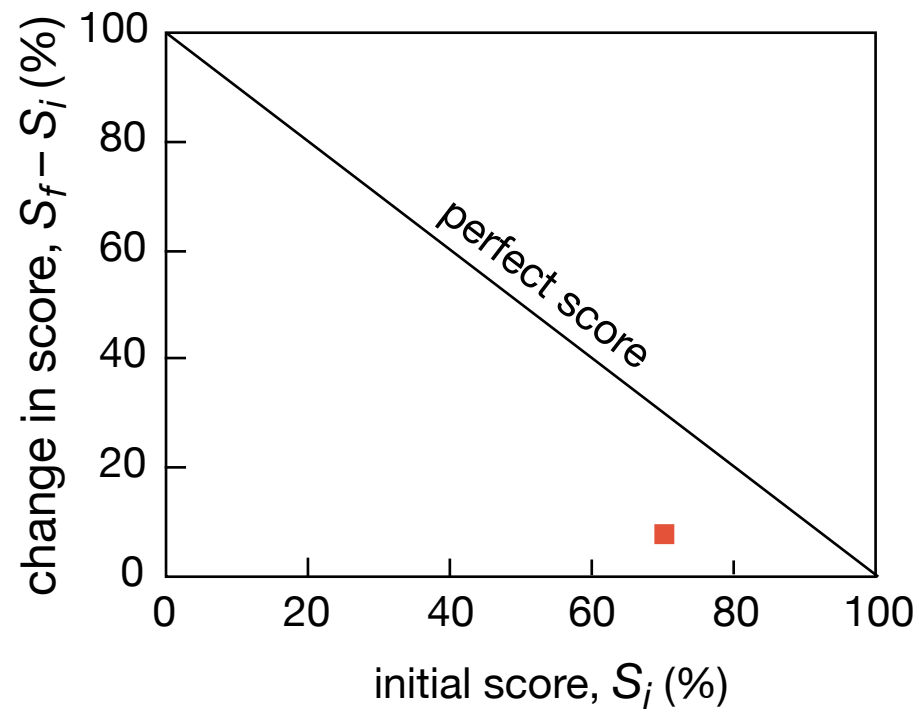
# Why do we have this problem?



# Why do we have this problem?

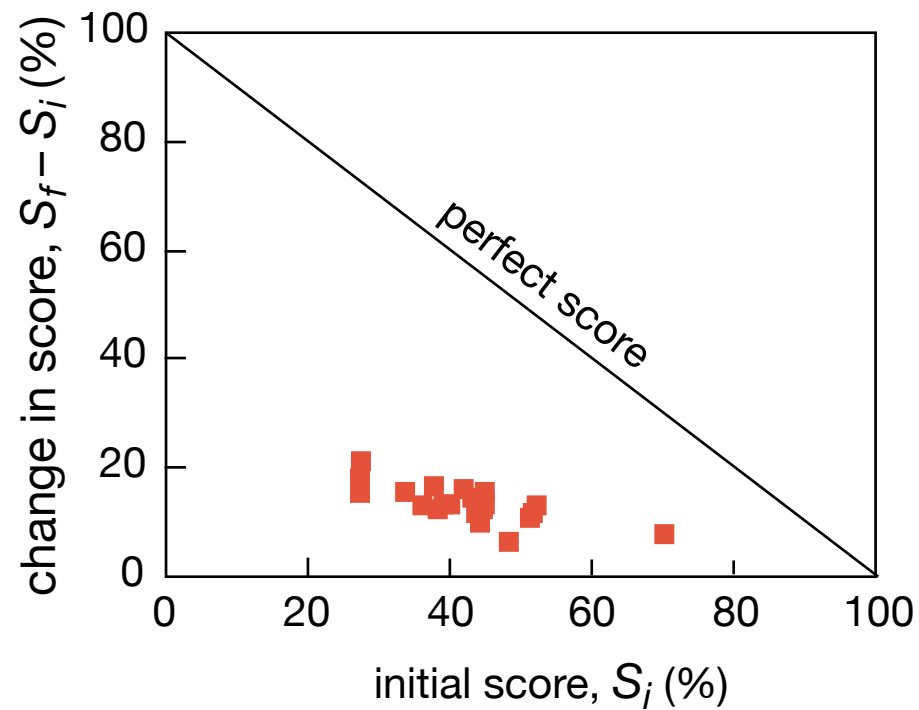


# Why do we have this problem?





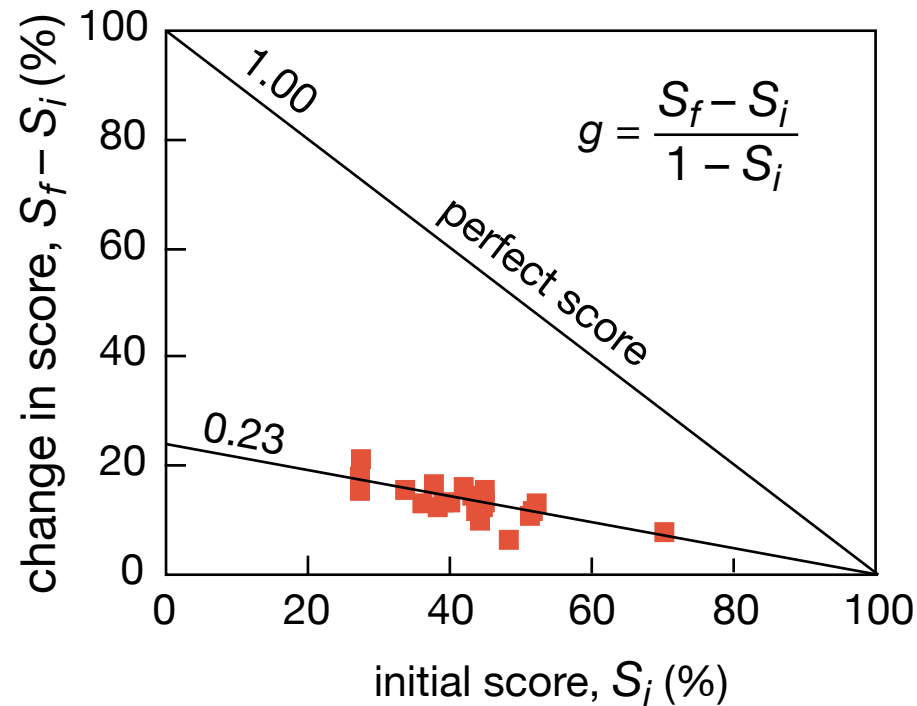
# Why do we have this problem?



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

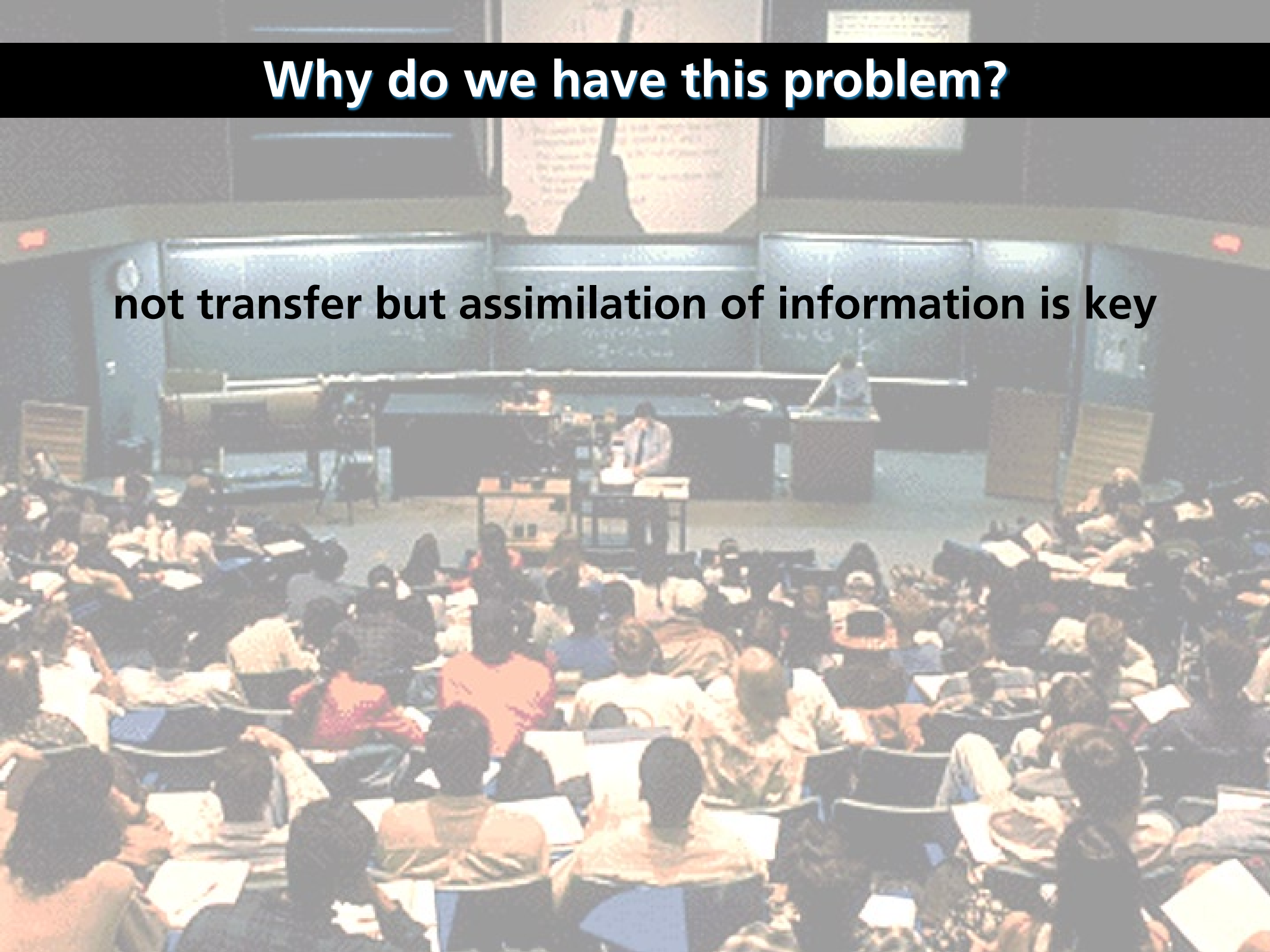
# Why do we have this problem?

only one quarter of maximum gain realized



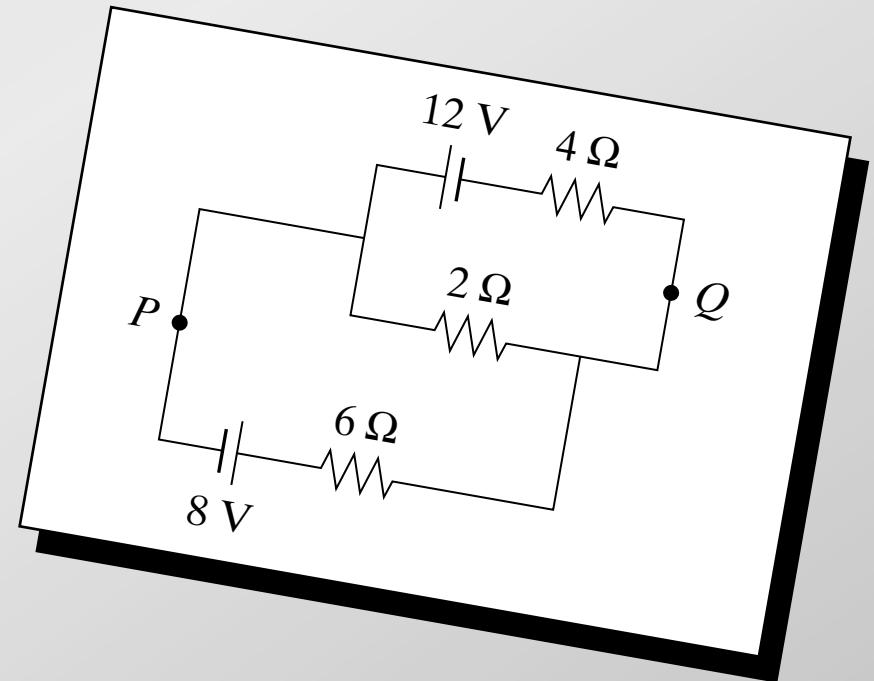
# Why do we have this problem?

**not transfer but assimilation of information is key**



# Why do we have this problem?

conventional problems reinforce bad study habits



# Why do we have this problem?

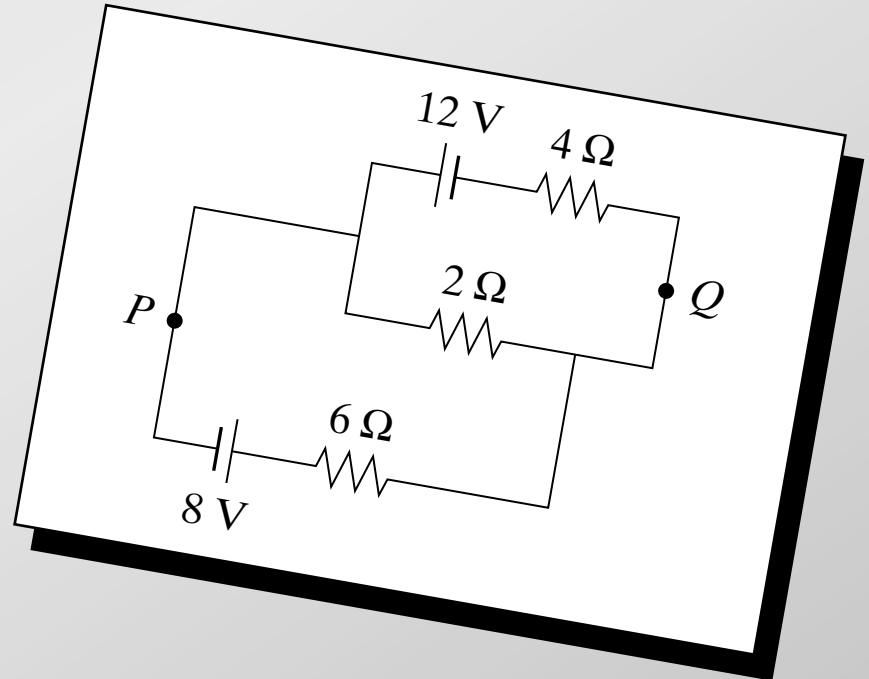
conventional problems reinforce bad study habits

Calculate:

(a) current in  $2\text{-}\Omega$  resistor

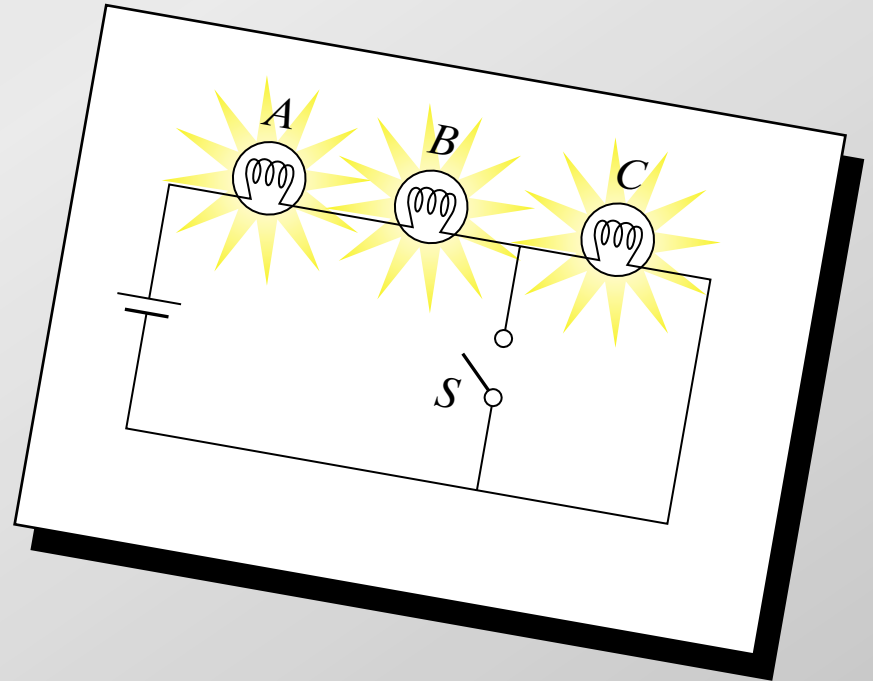
(b) potential difference

between  $P$  and  $Q$



# Why do we have this problem?

are the basic principles understood?

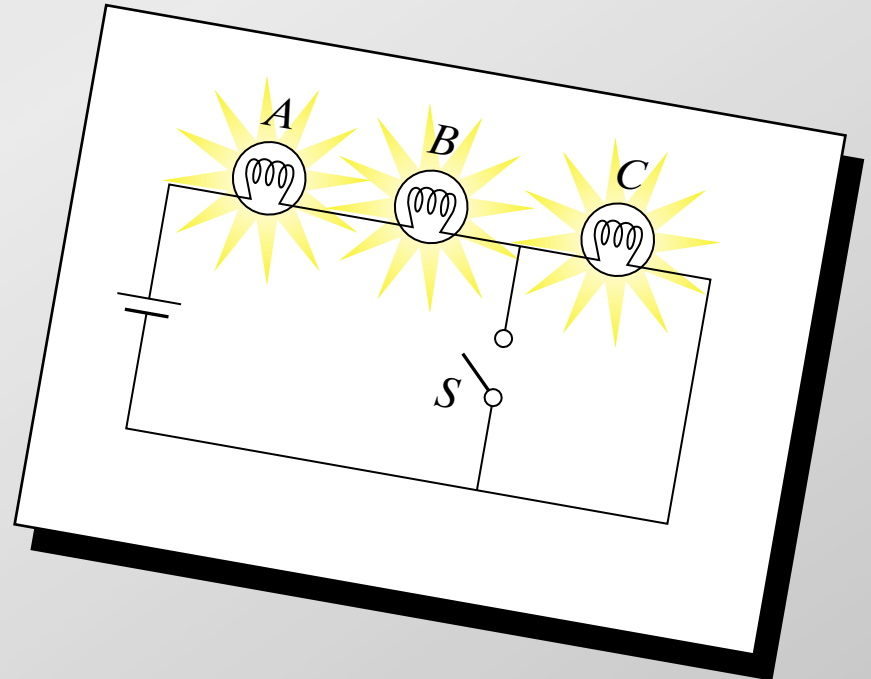


# Why do we have this problem?

are the basic principles understood?

When  $S$  is closed, what happens to:

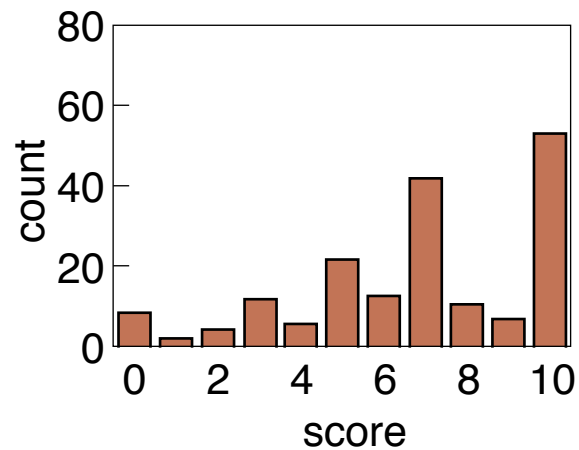
- (a) intensities of  $A$  and  $B$ ?
- (b) intensity of  $C$ ?
- (c) current through battery?
- (d) potential difference across  
 $A$ ,  $B$ , and  $C$ ?
- (e) the total power dissipated?



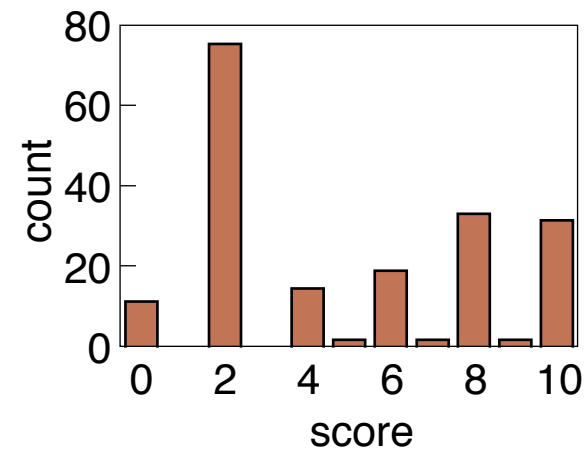


# Why do we have this problem?

conventional

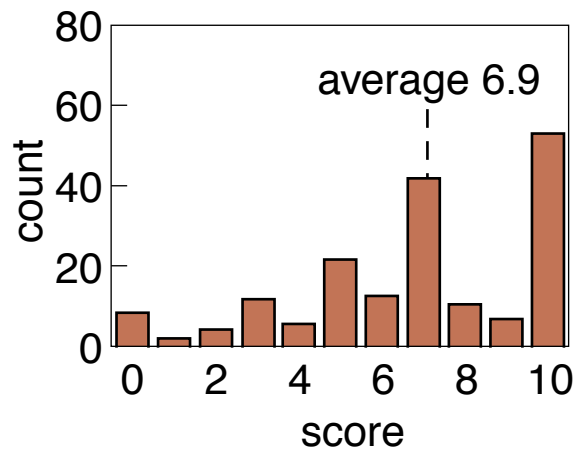


conceptual

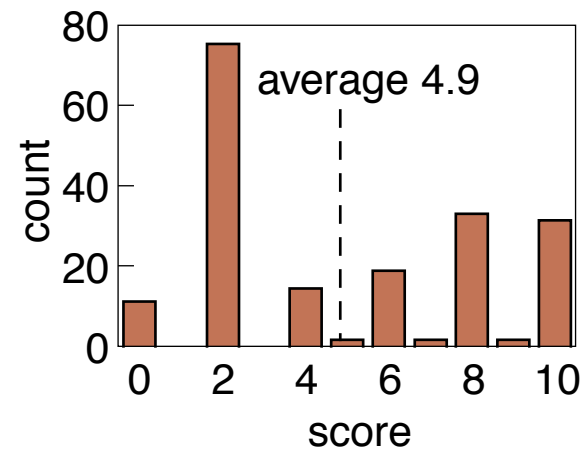


# Why do we have this problem?

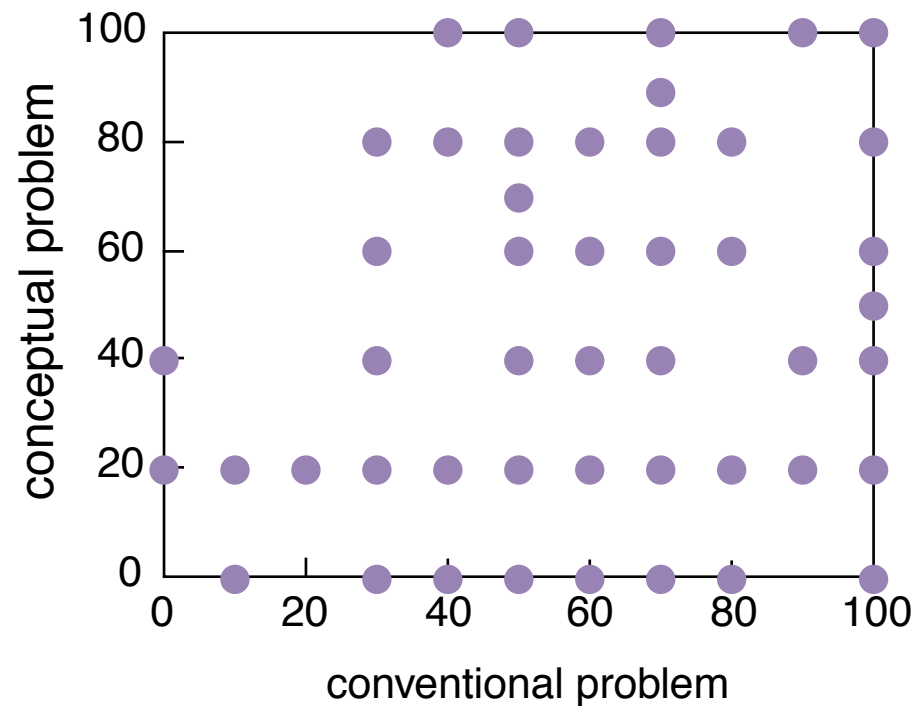
conventional



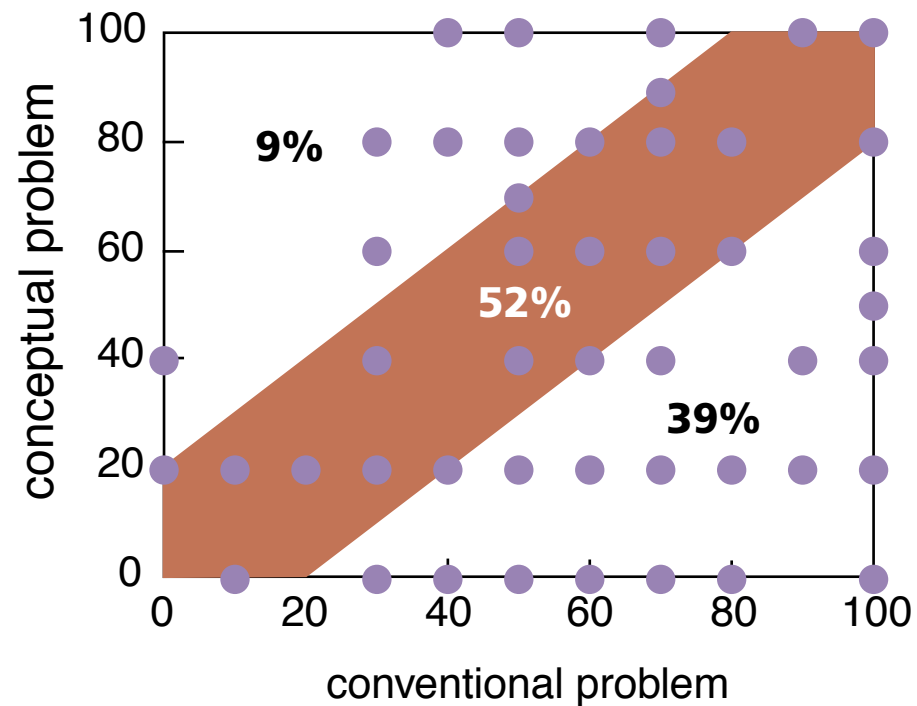
conceptual



# Why do we have this problem?



# Why do we have this problem?



So what should we do?



# Peer Instruction

**Give students more responsibility for gathering information...**

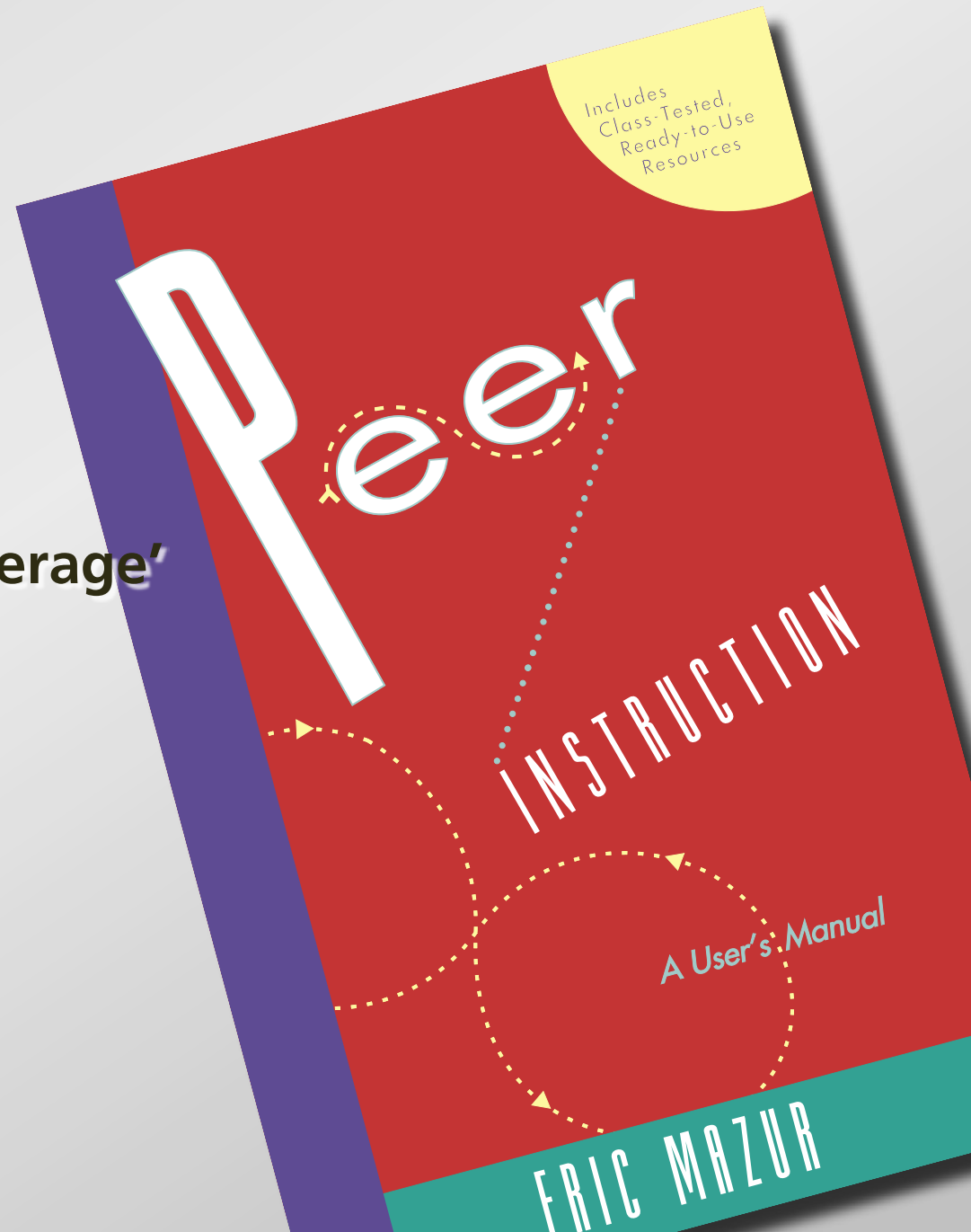
# Peer Instruction

**Give students more responsibility for gathering information...  
so we can better help them assimilate it.**

# Peer Instruction

## Main features:

- pre-class reading
- in-class: depth, not 'coverage'
- ConcepTests





# Peer Instruction

**ConcepTest:**

- 1. Question**
- 2. Thinking**
- 3. Individual answer**
- 4. Peer discussion**
- 5. Revised/Group answer**
- 6. Explanation**

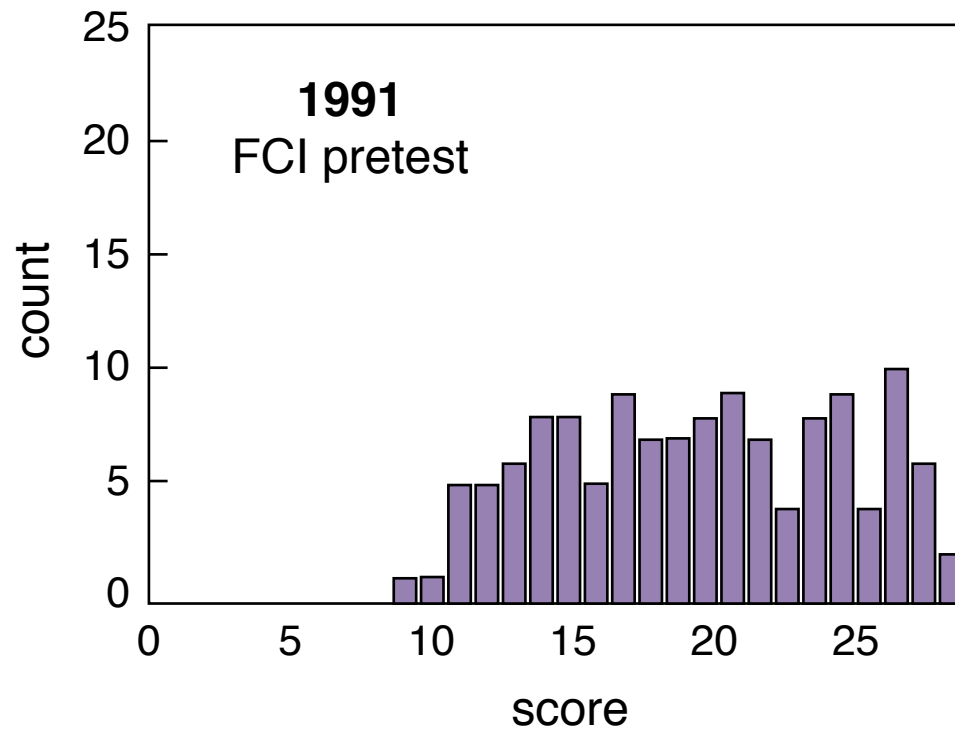


# Peer Instruction

is it any good?

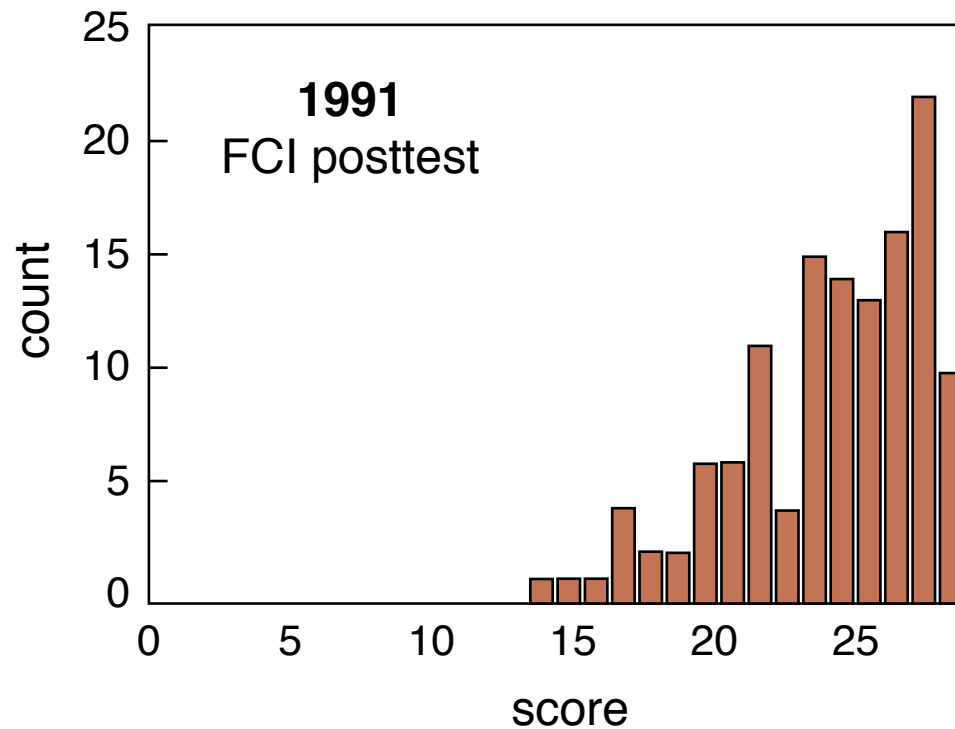
# Peer Instruction

first year of implementing PI



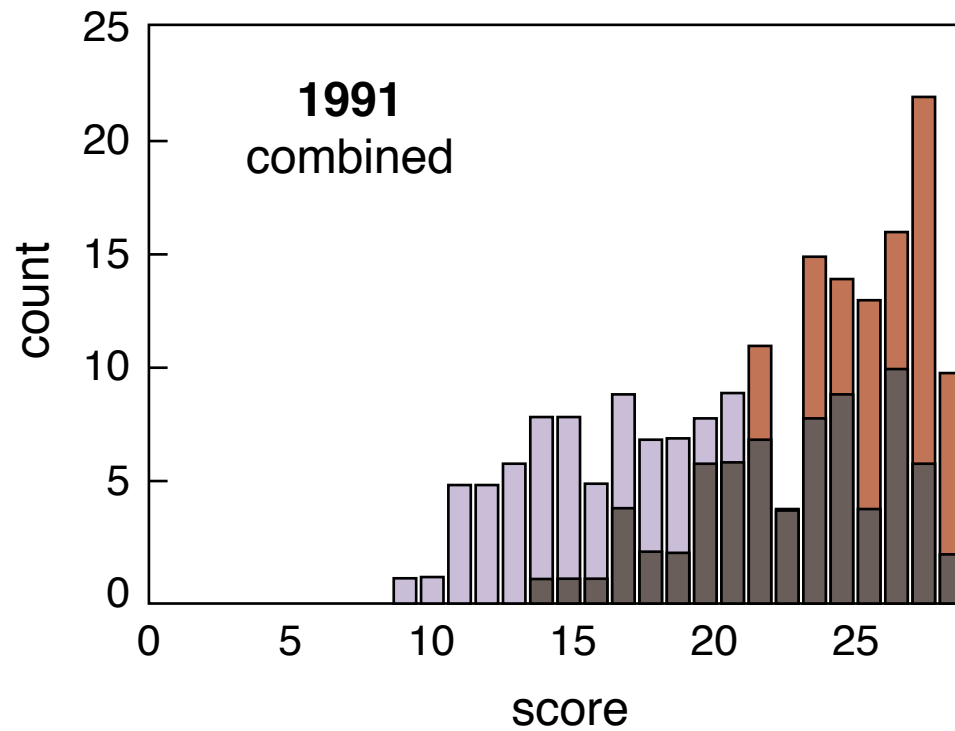
# Peer Instruction

first year of implementing PI

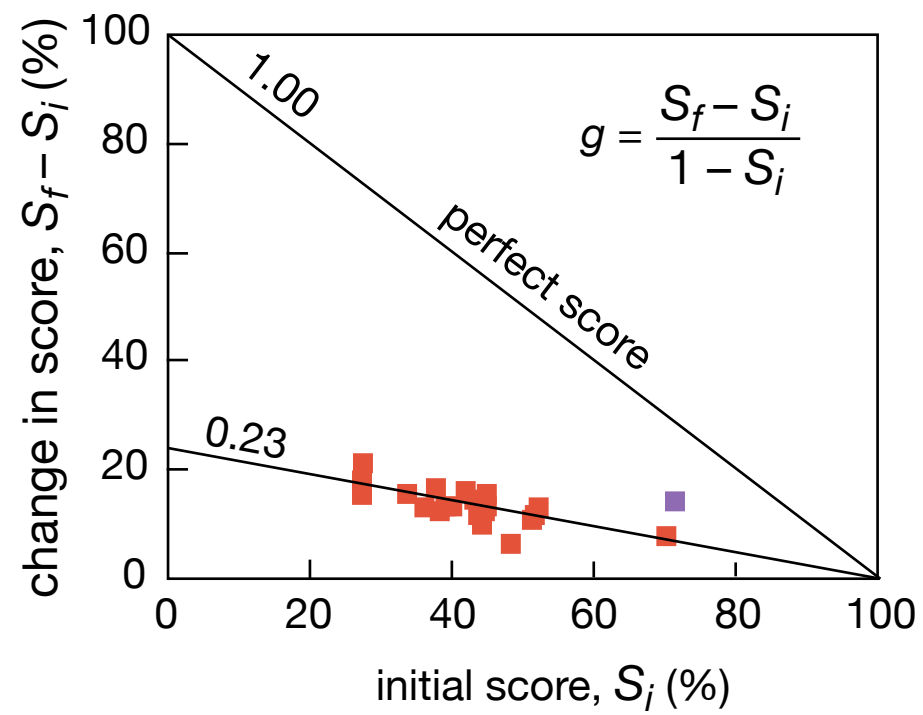


# Peer Instruction

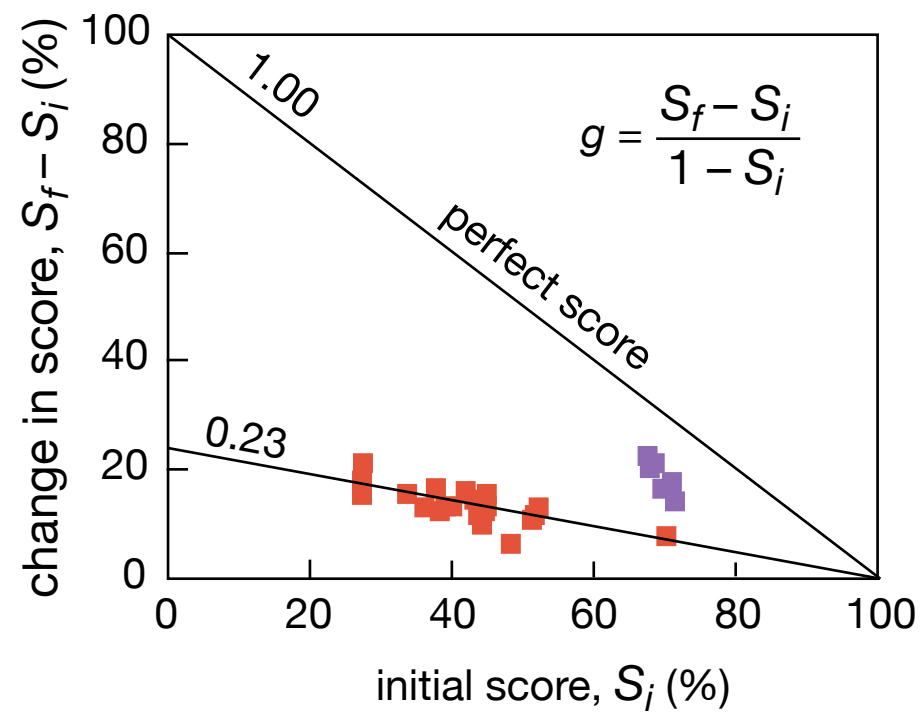
first year of implementing PI



# Peer Instruction

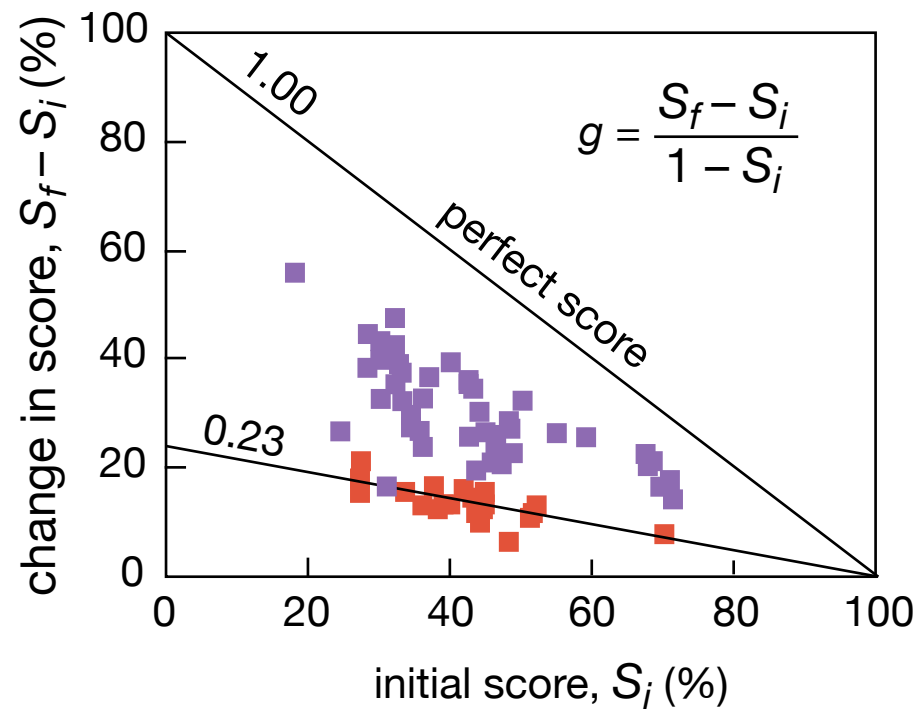


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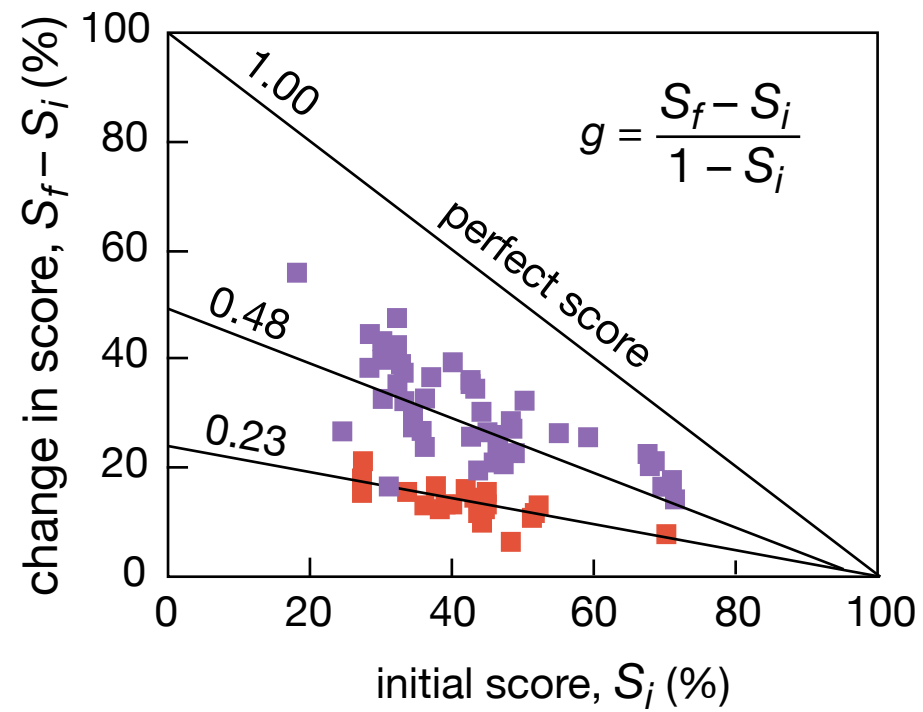




# Peer Instruction



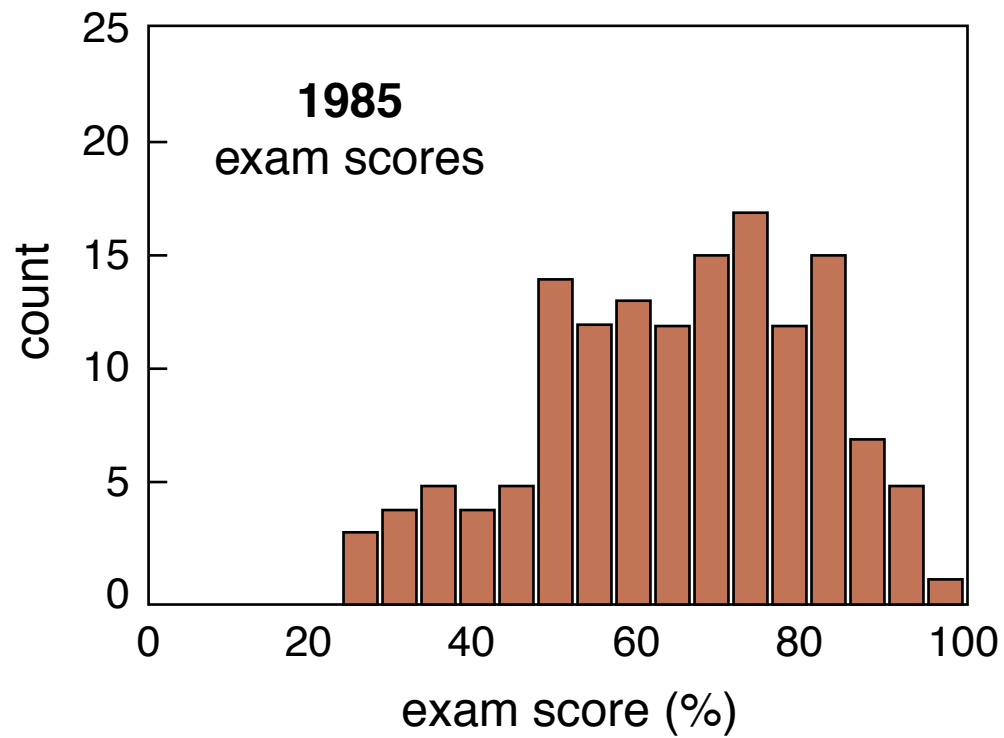
# Peer Instruction



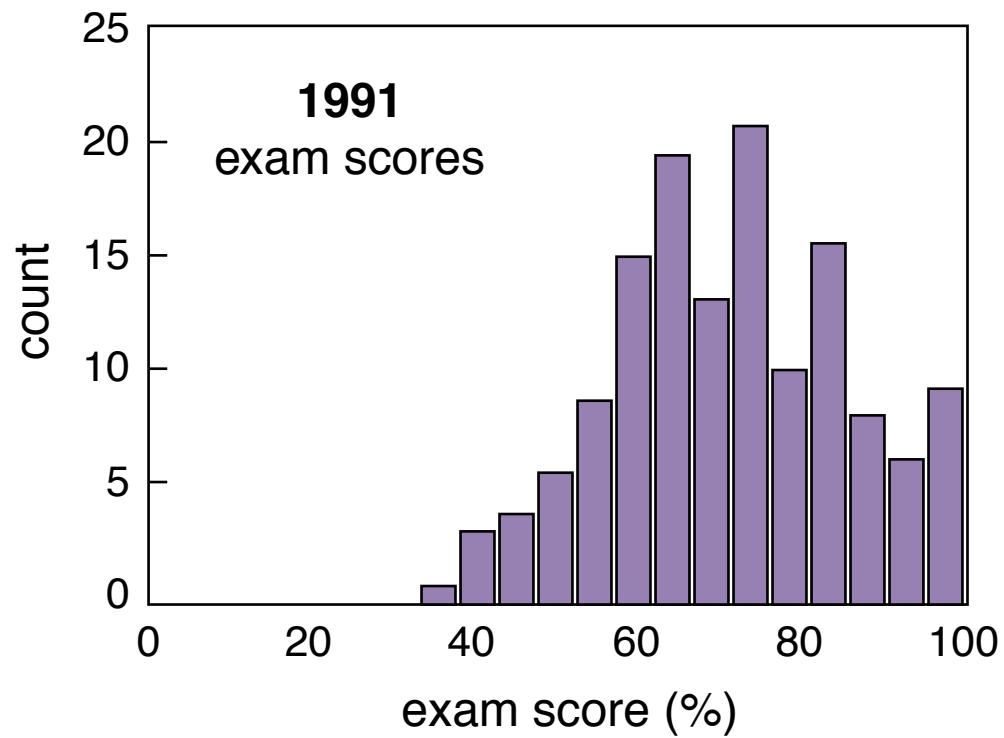
# Peer Instruction

**what about problem solving?**

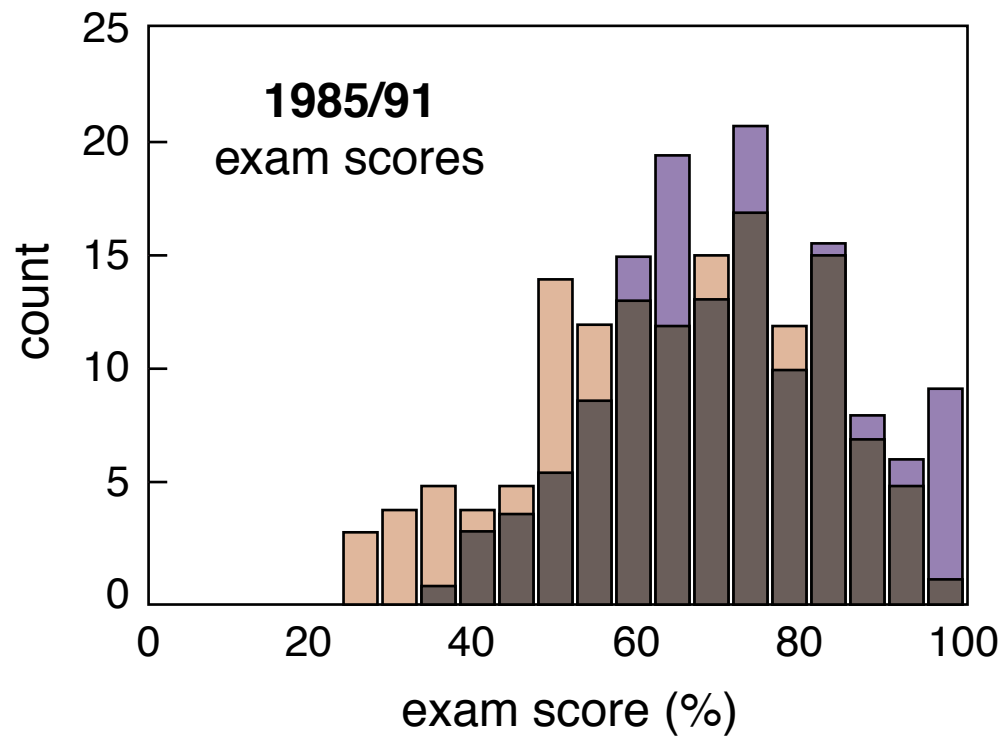
# Peer Instruction



# Peer Instruction



# Peer Instruction



# Peer Instruction

**So better understanding leads to better problem solving!**

# Peer Instruction

**So better understanding leads to better problem solving!**

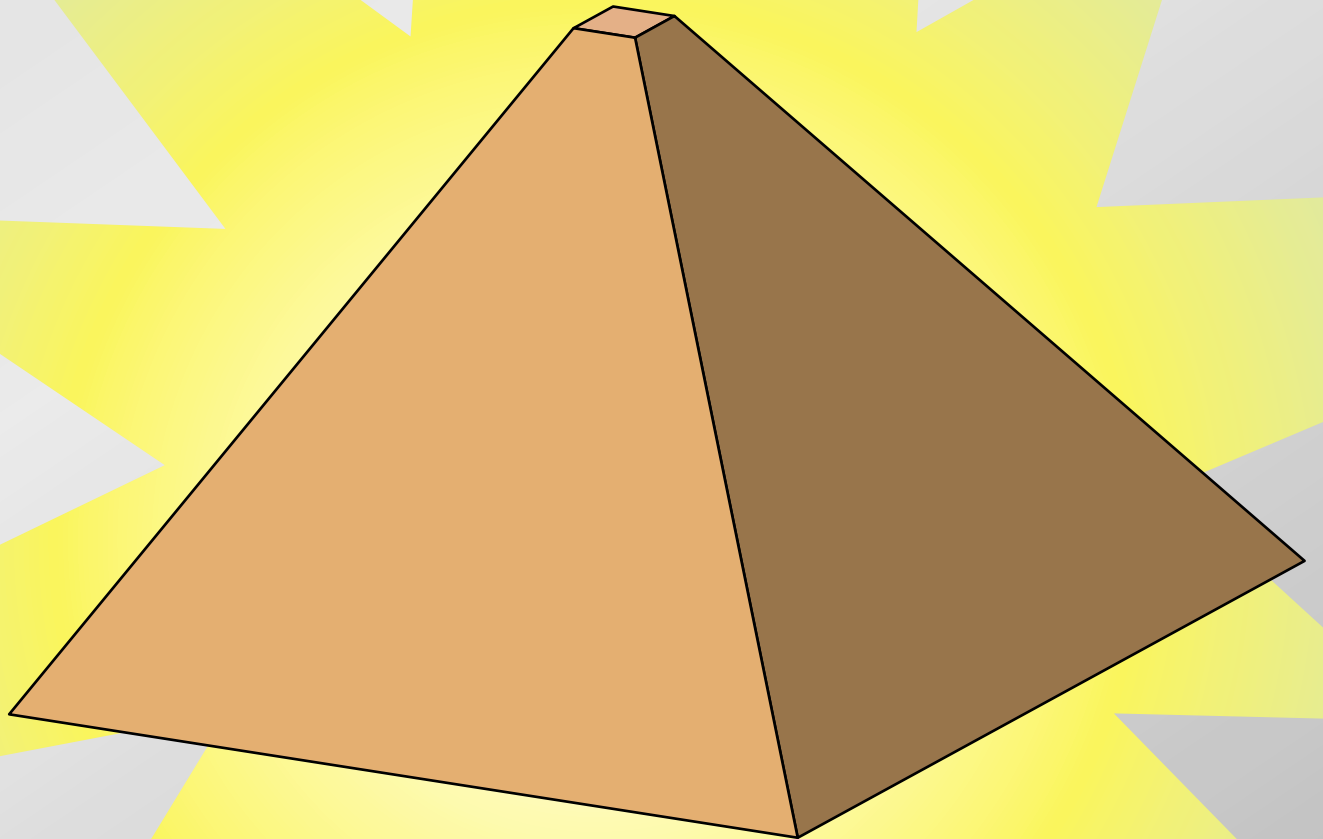
**(but “good” problem solving doesn’t always indicate understanding!)**





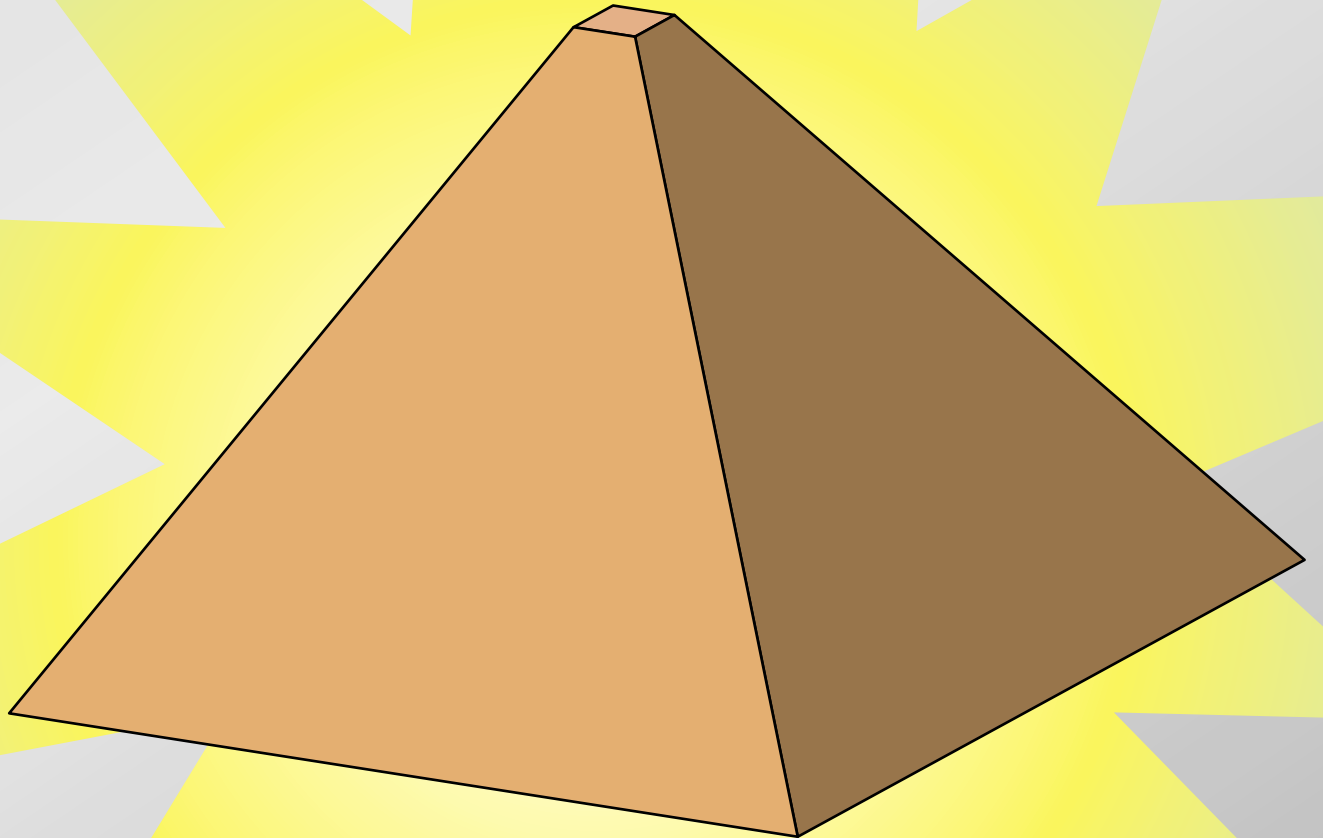
# Conclusion

Let's not forget the base  
of the pyramid



# Conclusion

Let's given them something  
of value!



**Funding:**

**National Science Foundation**

**for a copy of this presentation:**

**<http://mazur-www.harvard.edu>**