ACTIVE LEARNING AND INTERACTIVE LECTURES

Eric Mazur
Harvard University

AAPT New Faculty Meeting
College Park, MD, 8 November 2002

Quick Poll

- heard me speak on Peer Instruction

1 = yes, 0 = no

Quick Poll

- heard me speak on Peer Instruction
- know about/familiar with PI

1 = yes, 0 = no

Quick Poll

- heard me speak on Peer Instruction
- know about/familiar with PI
- **use PI**

1 = yes, 0 = no

Quick Poll

- heard me speak on Peer Instruction
- know about/familiar with PI
- use PI
- **colleague uses PI**

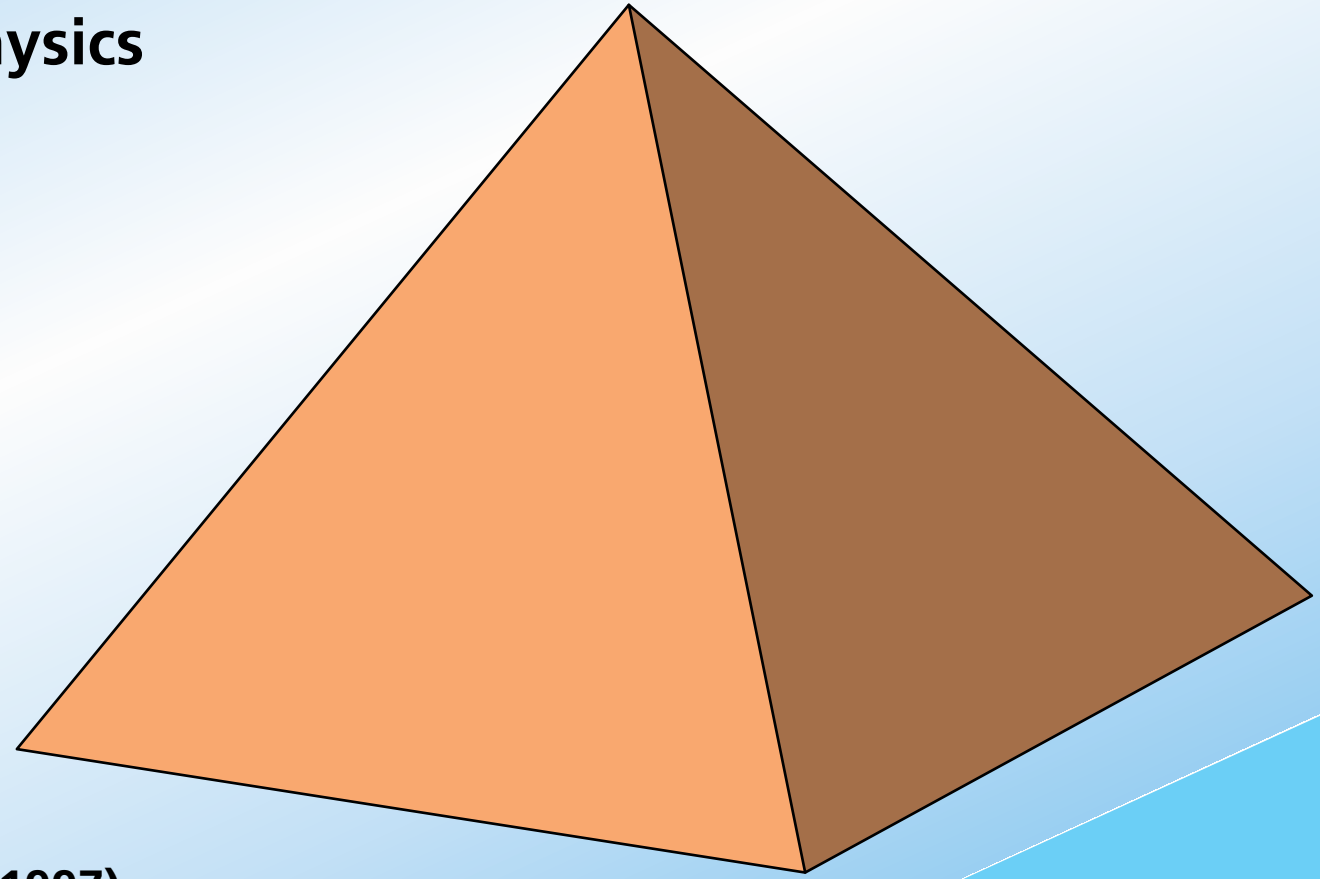
1 = yes, 0 = no

Menu

- motivational material
- implementation details/data
- related research
- web-based resources

We have a problem

380,000 students take introductory physics each year…



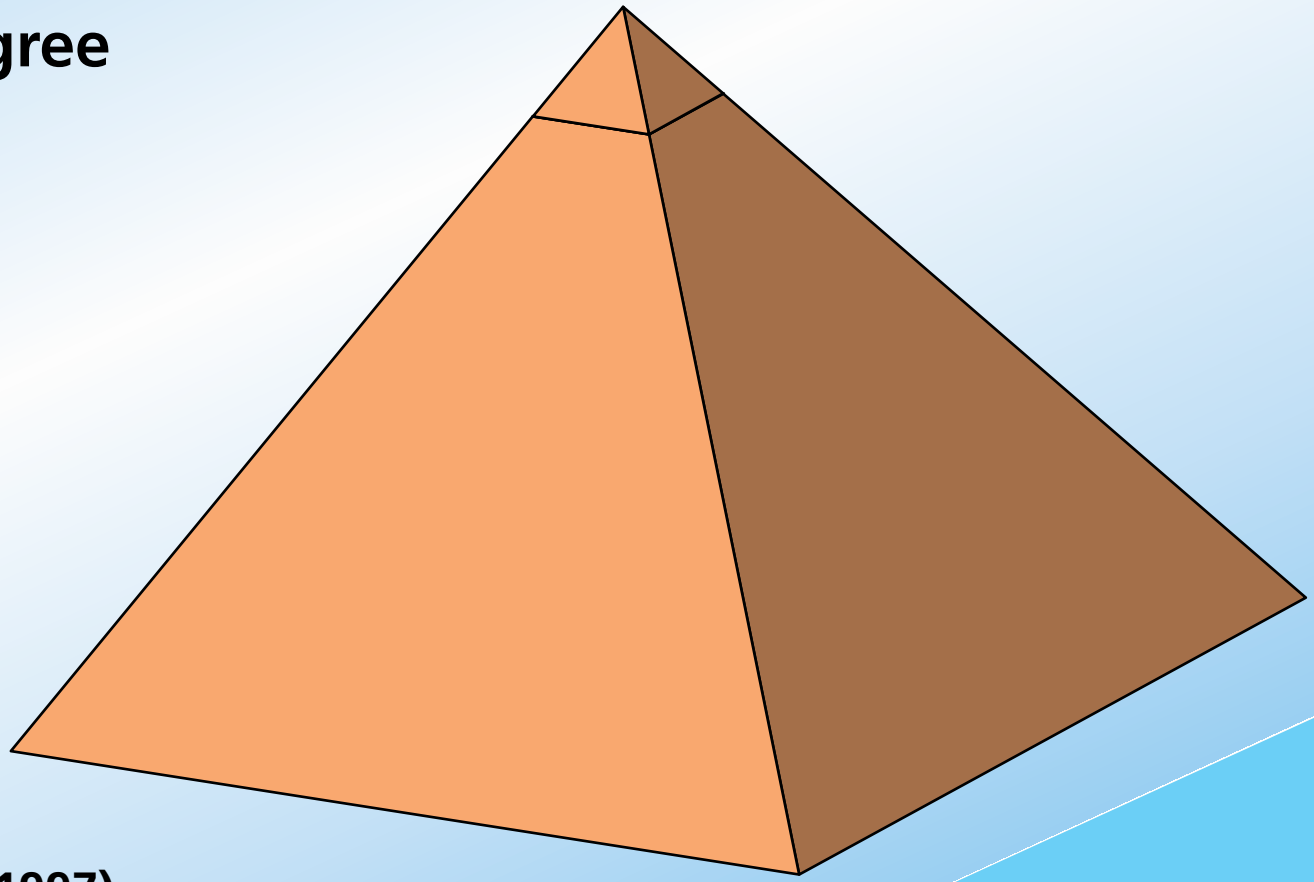
AIP Report R-151.33 **(1997)**

We have a problem

about 1% of these get

a bachelor's degree

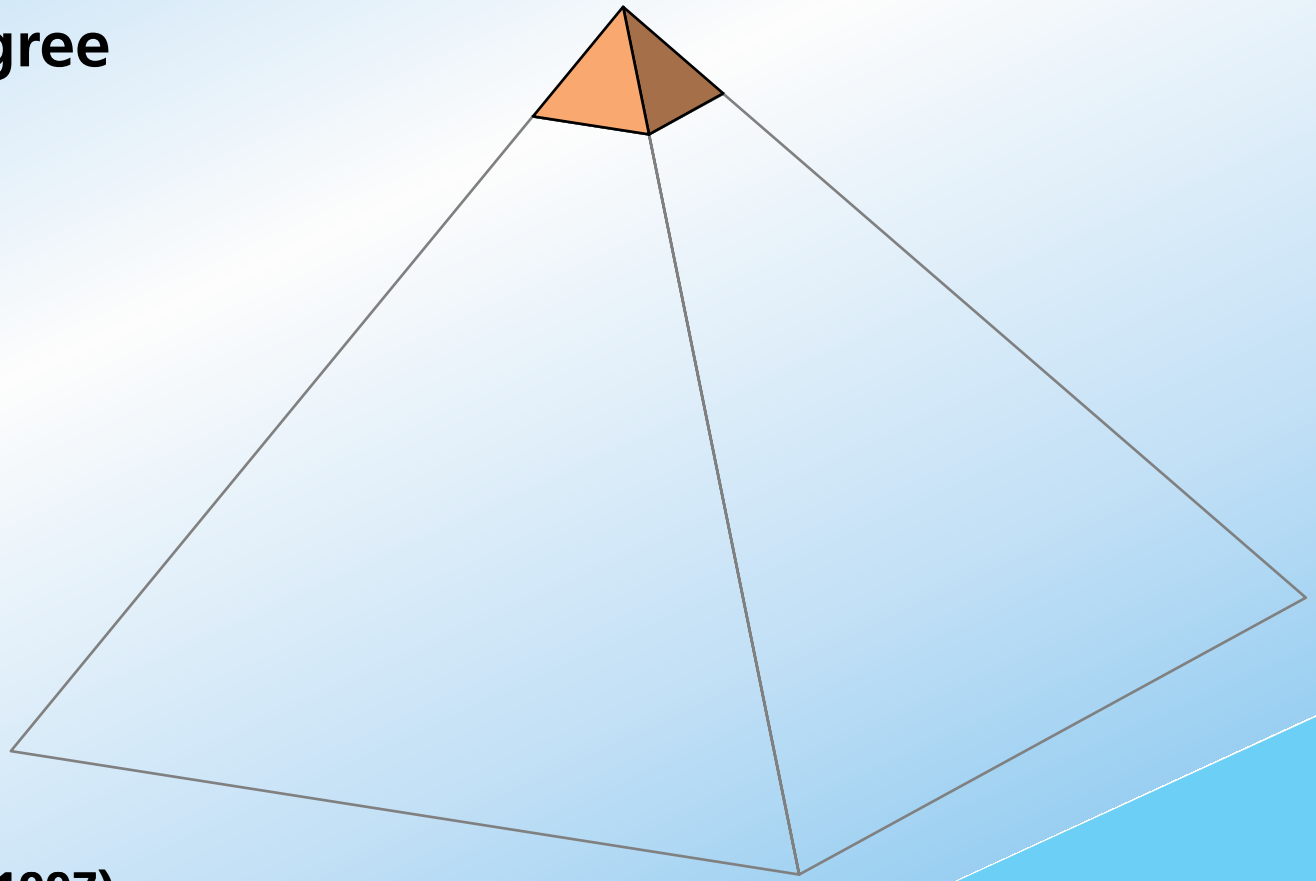
in physics



***AIP Report R-151.33* (1997)**

We have a problem

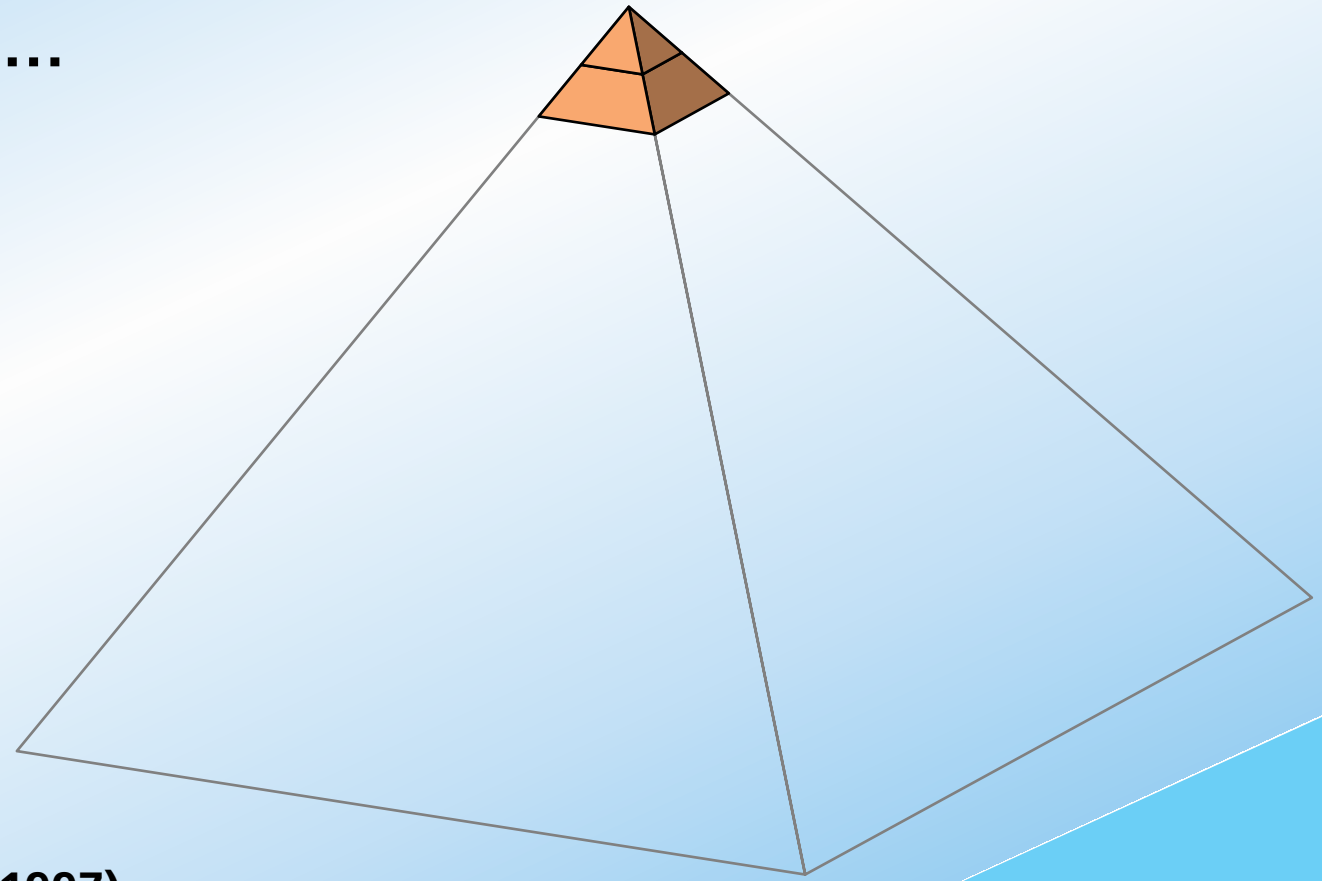
Of the 4,300 students with a bachelor's degree in physics…



***AIP Report R-151.33* (1997)**

We have a problem

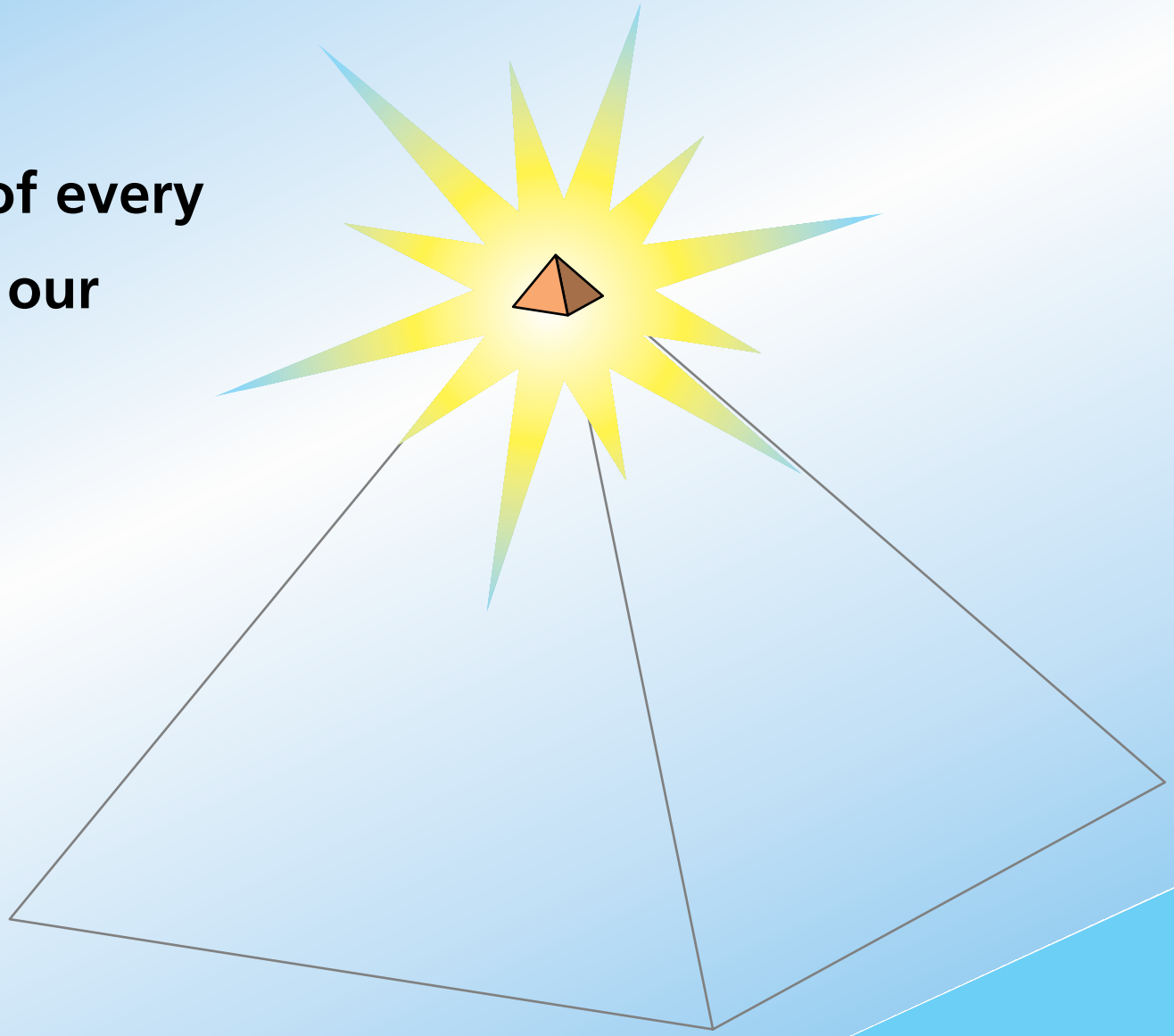
about 35% go on to get a Ph.D. in physics…



***AIP Report R-151.33* (1997)**

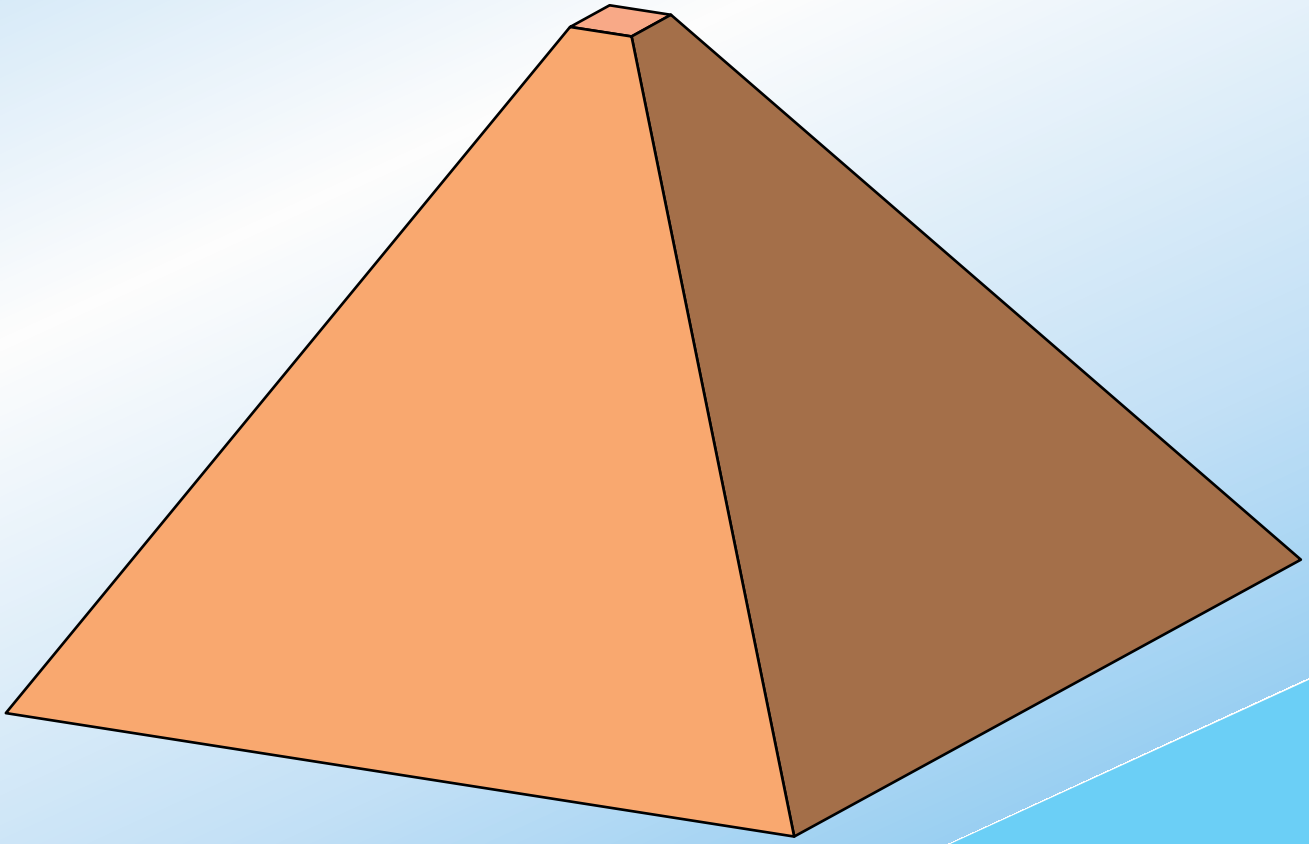
We have a problem

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



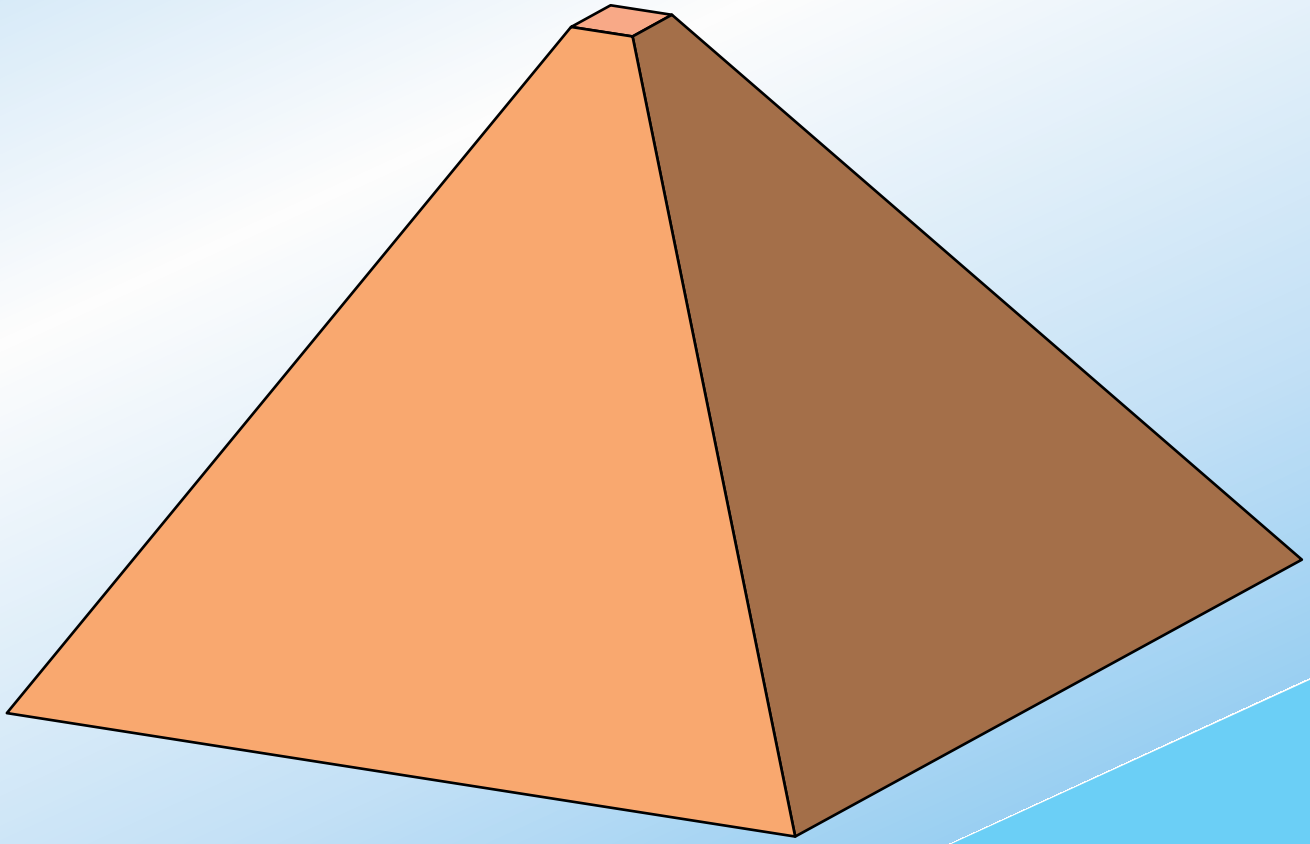
We have a problem

What about the other 259…?



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?

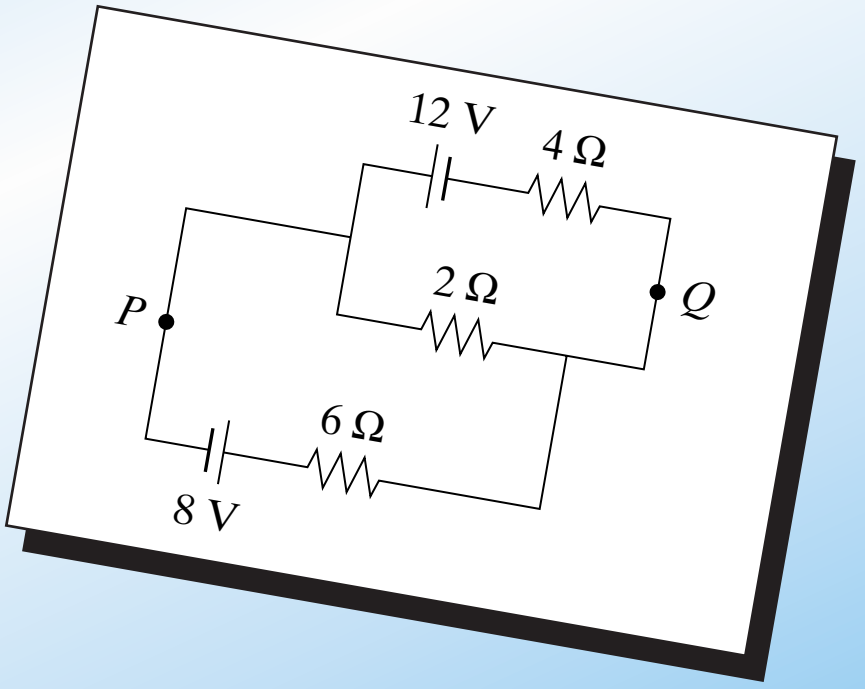
Lectures focus on transfer of information…

Why do we have this problem?

Conventional problems reinforce bad study habits

Why do we have this problem?

Conventional problems reinforce bad study habits



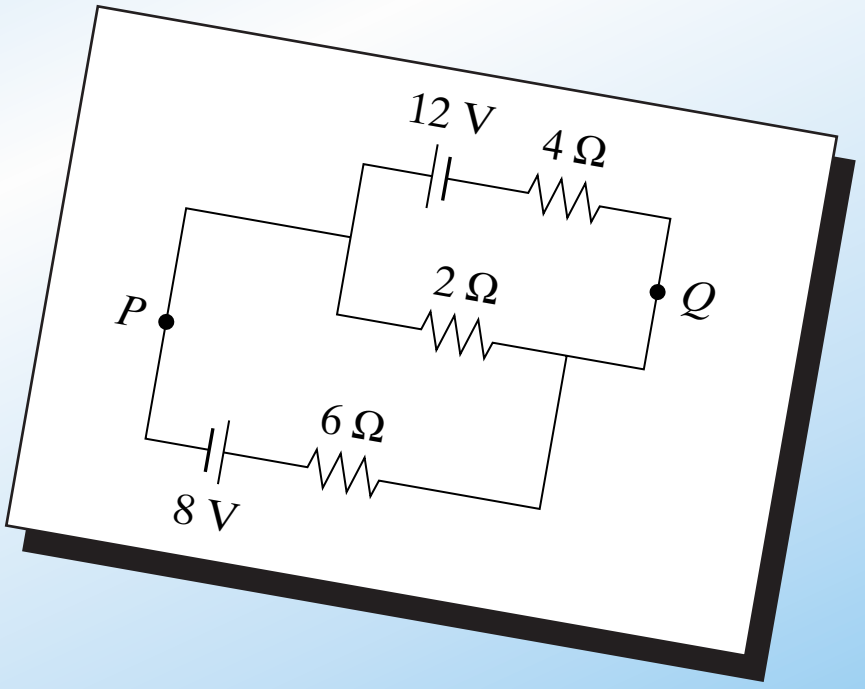
Why do we have this problem?

Conventional problems reinforce bad study habits

Calculate:

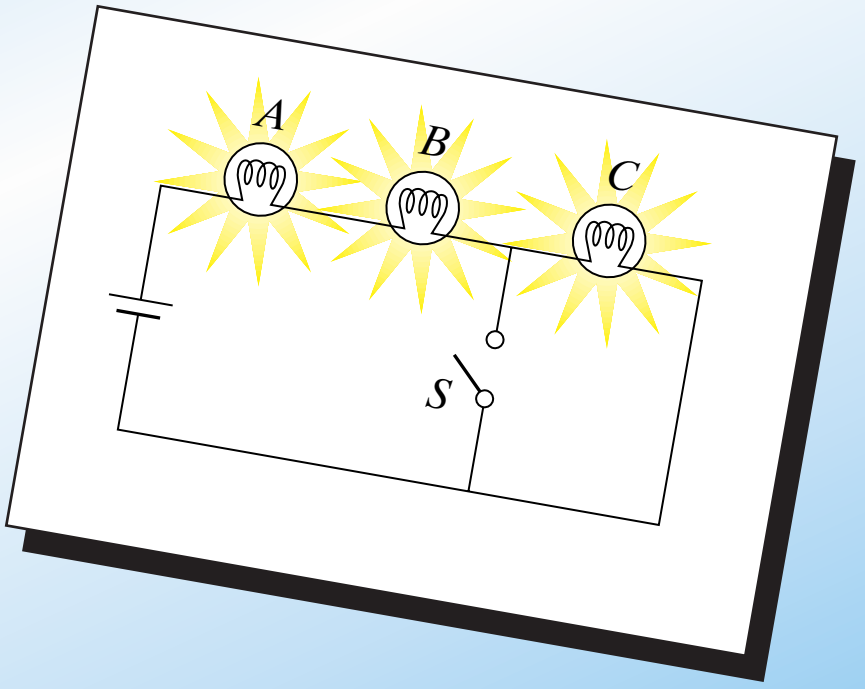
(*a*) the current in the 2-Ω resistor, and

(*b*) the potential difference between points *P* and *Q*



Why do we have this problem?

Are basic principles understood?

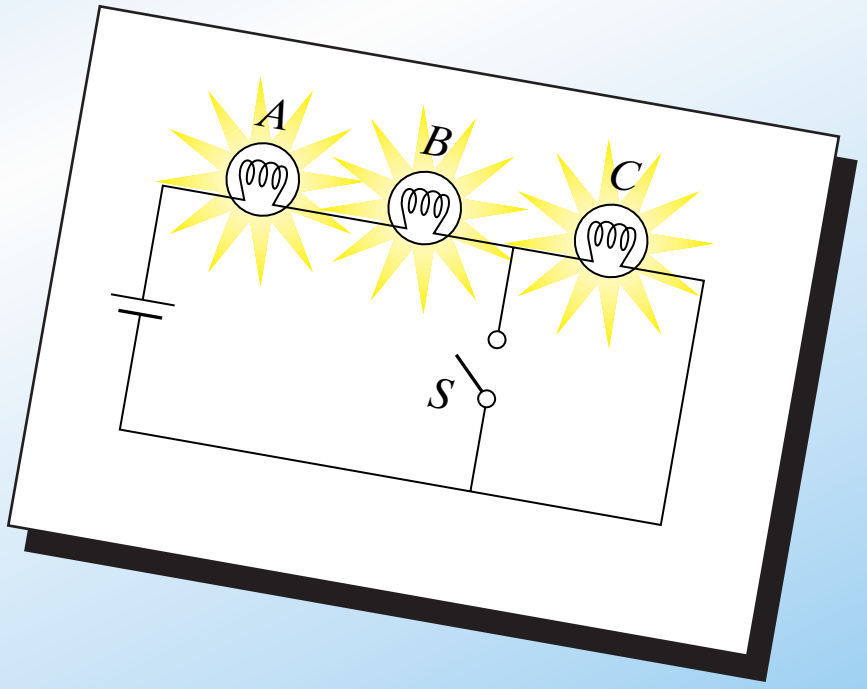


Why do we have this problem?

Are basic principles understood?

When *S* is closed, what happens to the:

(*a*) intensities of *A* and *B*?
(*b*) intensity of *C*?
(*c*) current through battery?
(*d*) voltage drop across *A*, *B*, and *C*?
(*e*) total power dissipated?



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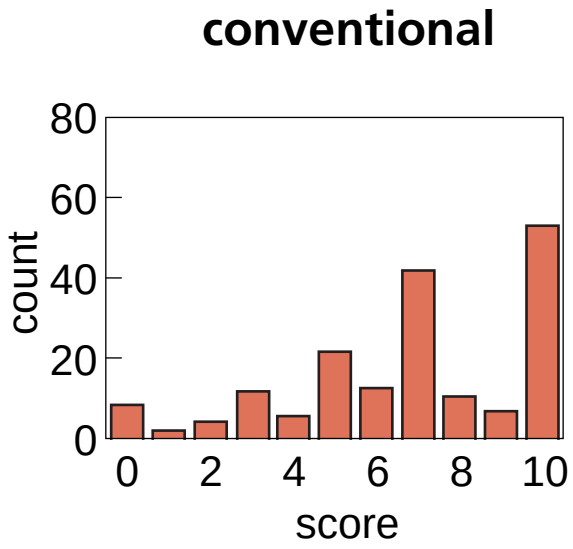

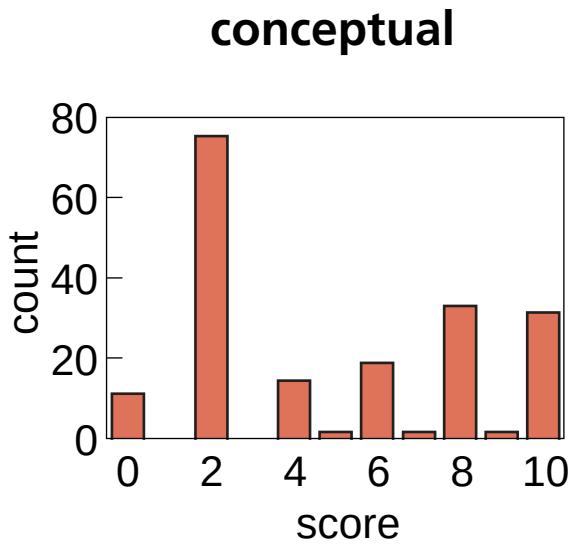

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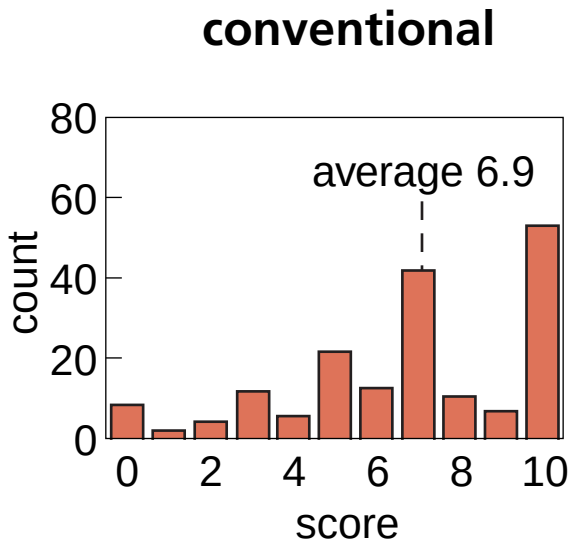

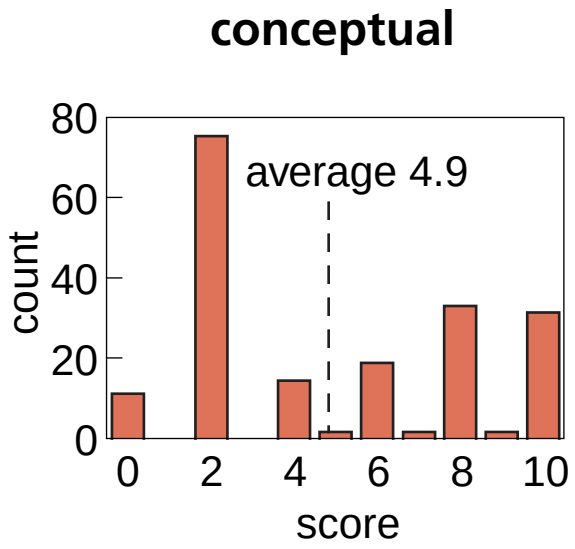

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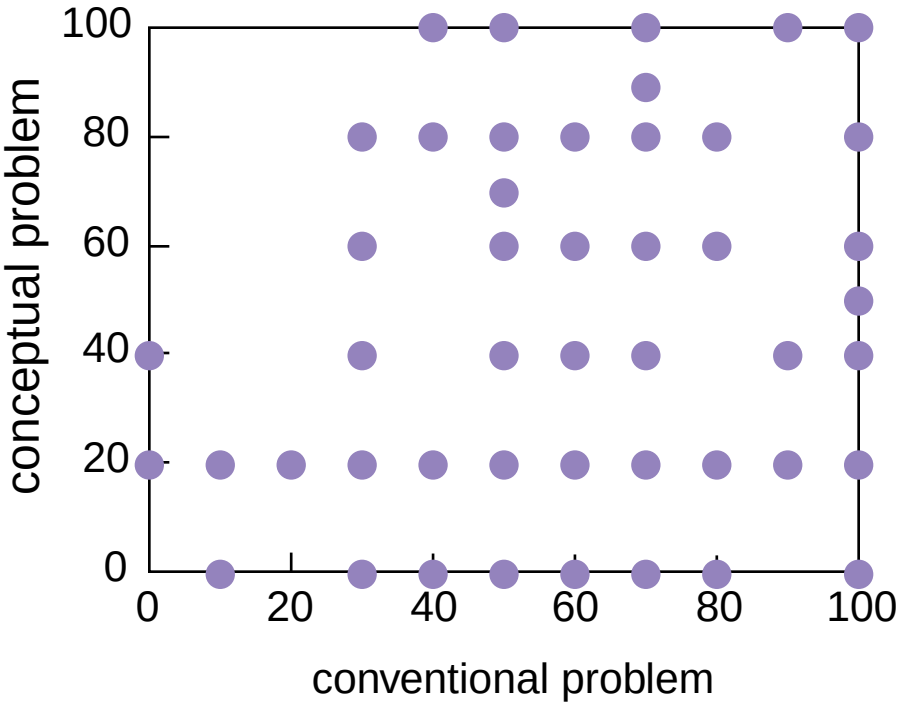

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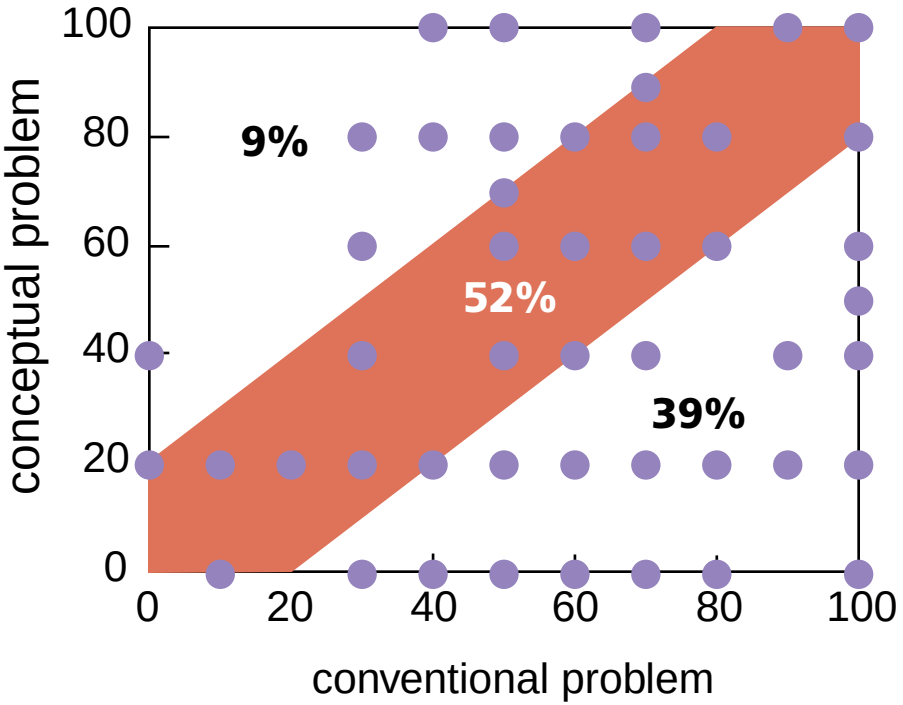


So what should we do?

Peer Instruction

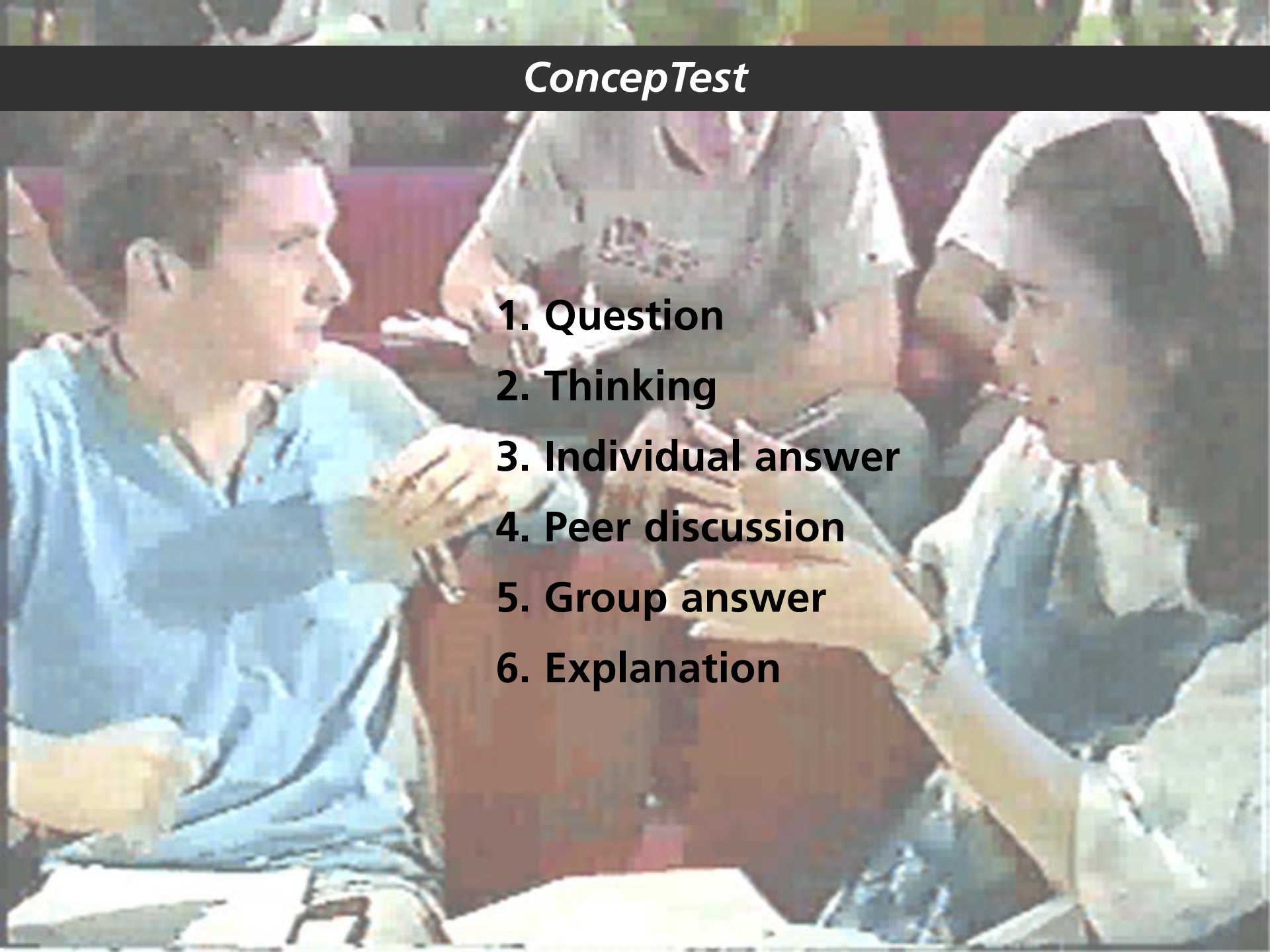
Help students take more responsibility for learning!

Peer Instruction

Main features:

- **Pre-class reading**
- **In class: depth, not coverage**
- **ConcepTests**

ConcepTest

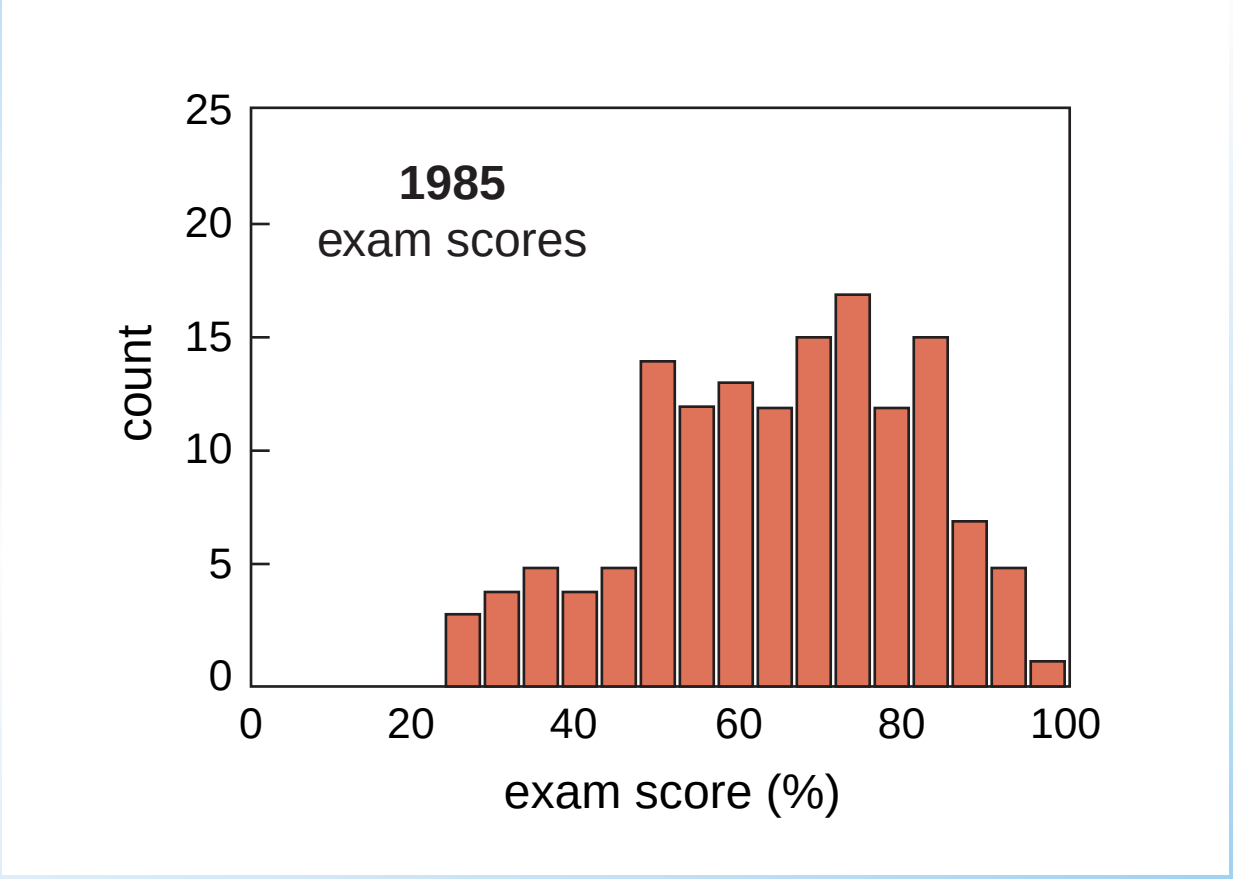


1. Question
2. Thinking
3. Individual answer
4. Peer discussion
5. Group answer
6. Explanation

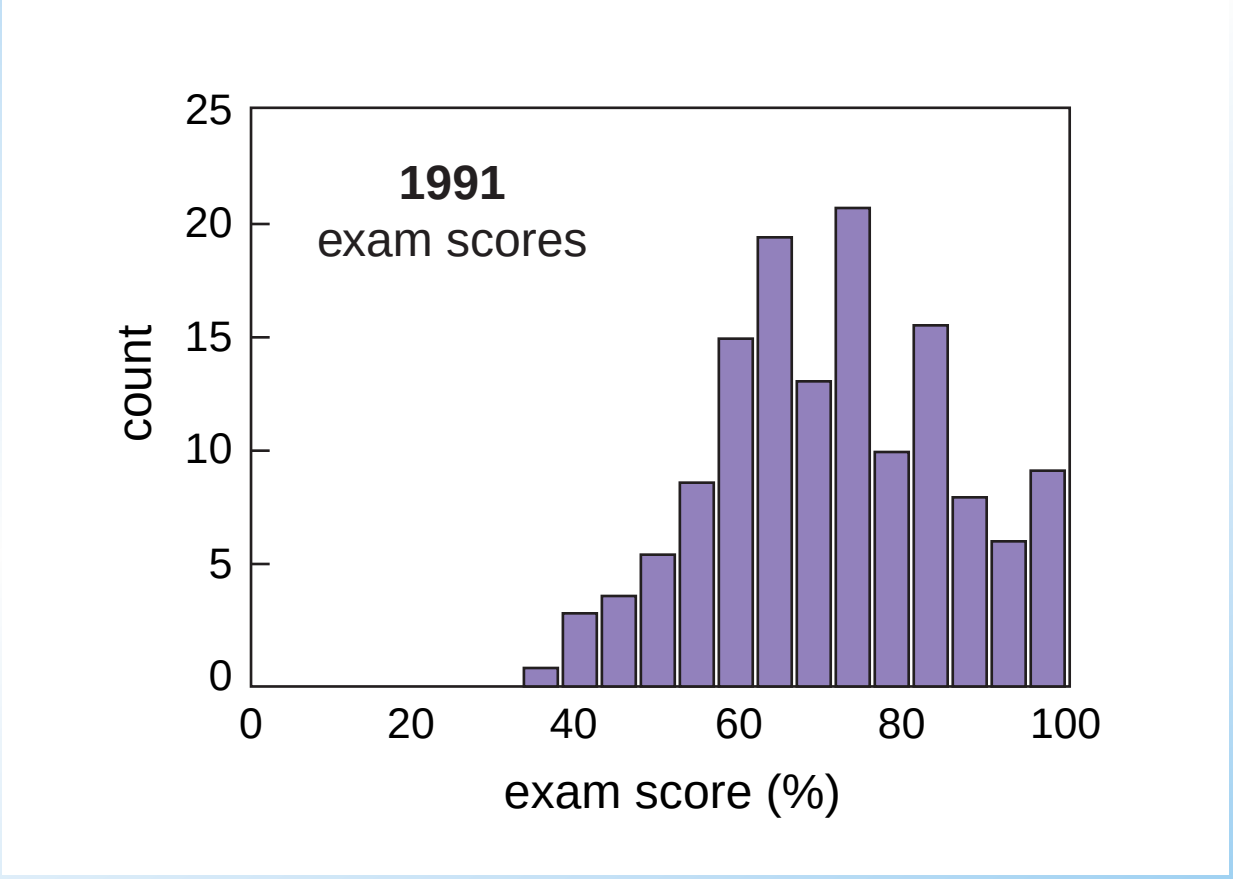
Results

What about problem solving…?

Results


1985
exam scores
count
25
20
15
10
5
0
0
20
40
60
80
100
exam score (%)

Results


1991
exam scores
count
25
20
15
10
5
0
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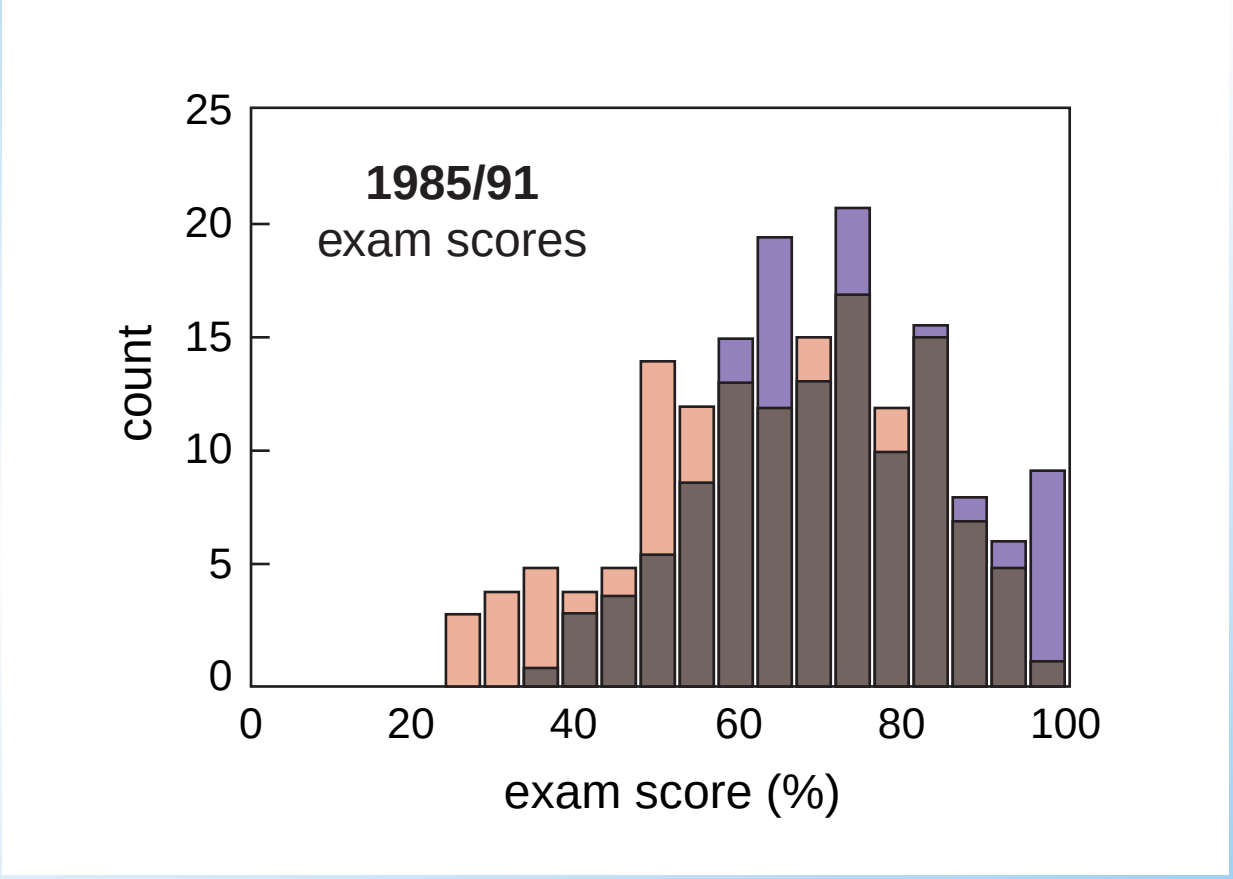
20
40
60
80
100
exam score (%)

Results


1985/91
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count
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0
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10
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100

Results

So better understanding leads to better problem solving!

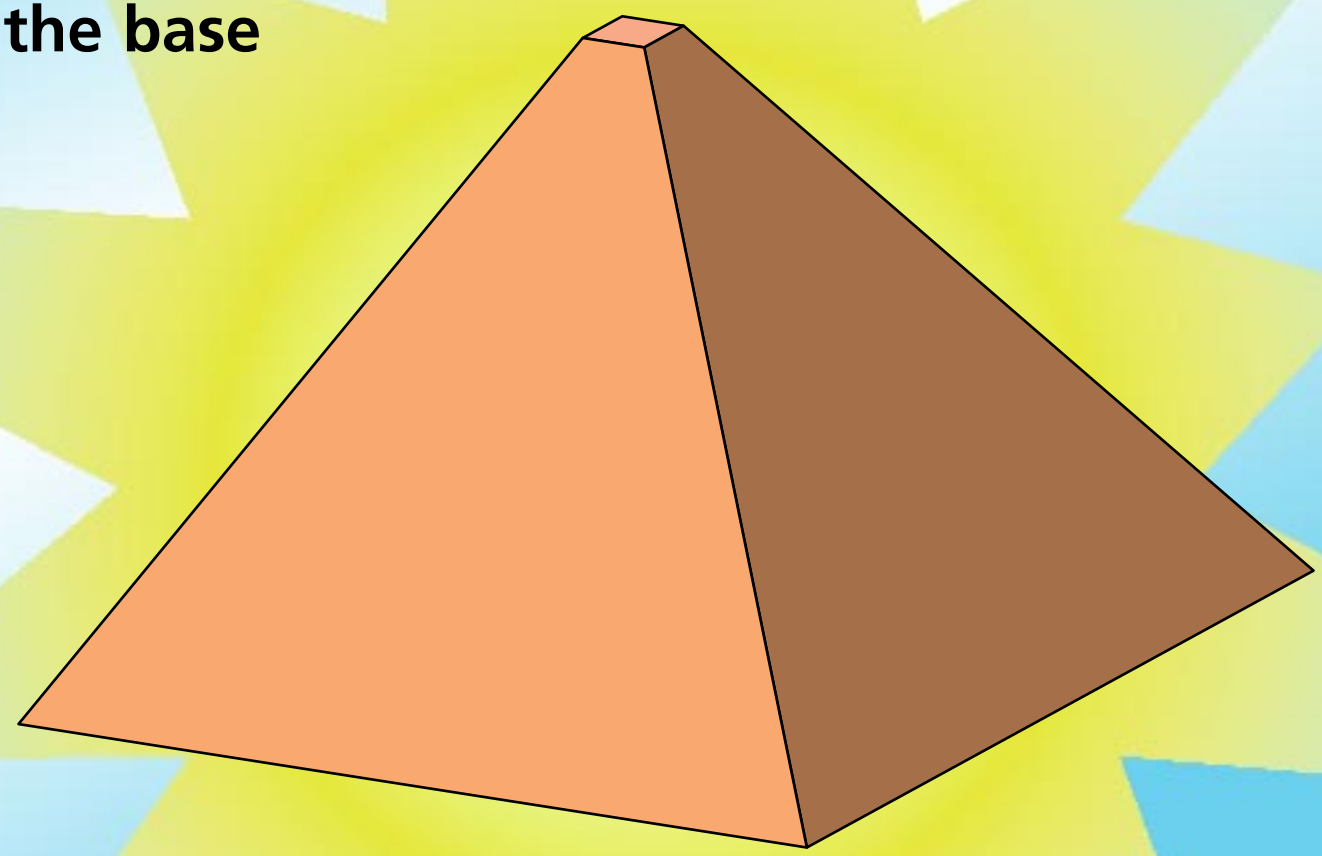
Results

So better understanding leads to better problem solving!

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

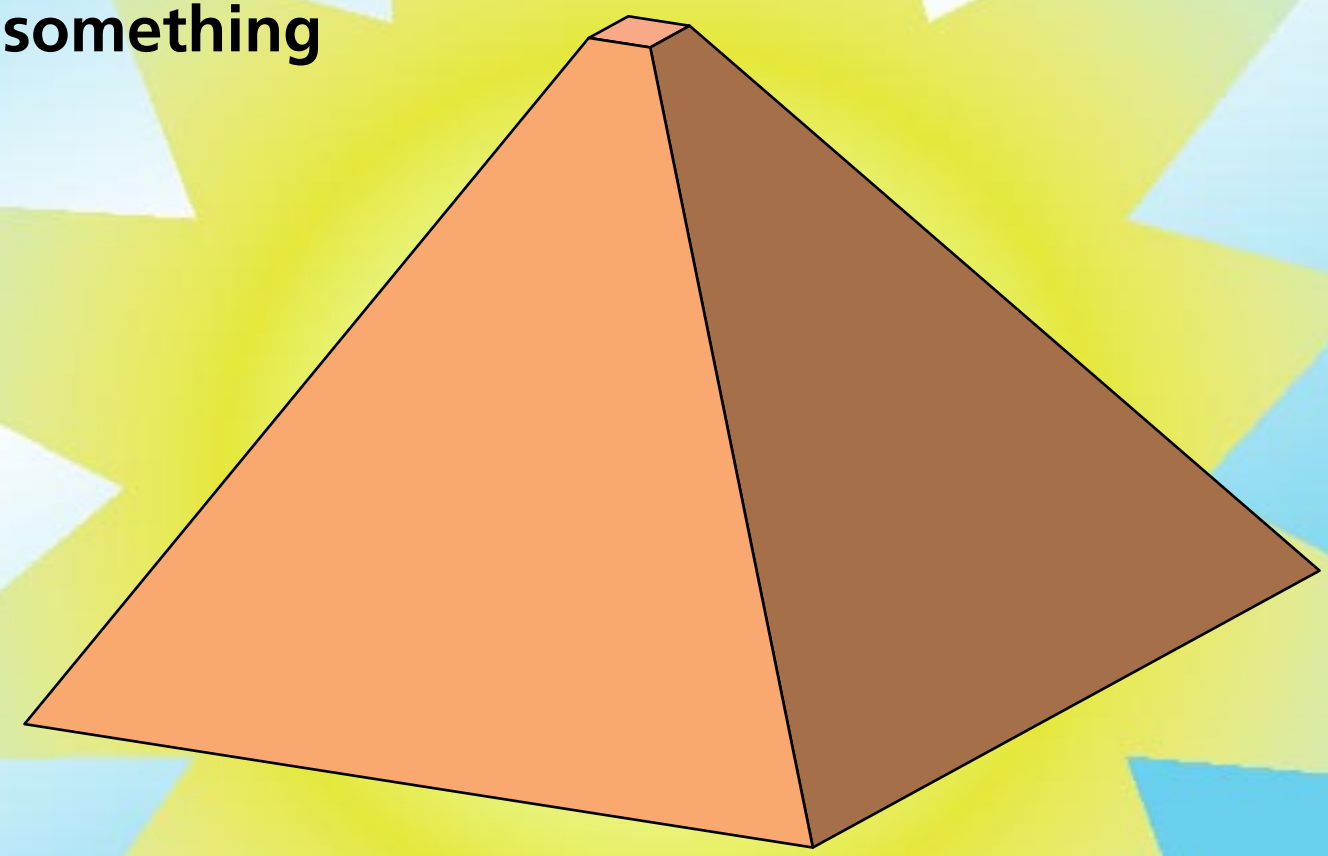
Conclusion

Let's not forget the base of the pyramid!



Conclusion

Let's give them something of value!



Conclusion

Challenges:

- internal skepticism
- growing pains
- limited circle of influence

Conclusion

Rewards:

- **engagement**
- **improved understanding**
- **class is fun!**

Funding

National Science Foundation

For a copy of this talk and additional information:

http://mazur-www.harvard.edu

PEER INSTRUCTION: FROM THEORY TO PRACTICE

Eric Mazur
Harvard University

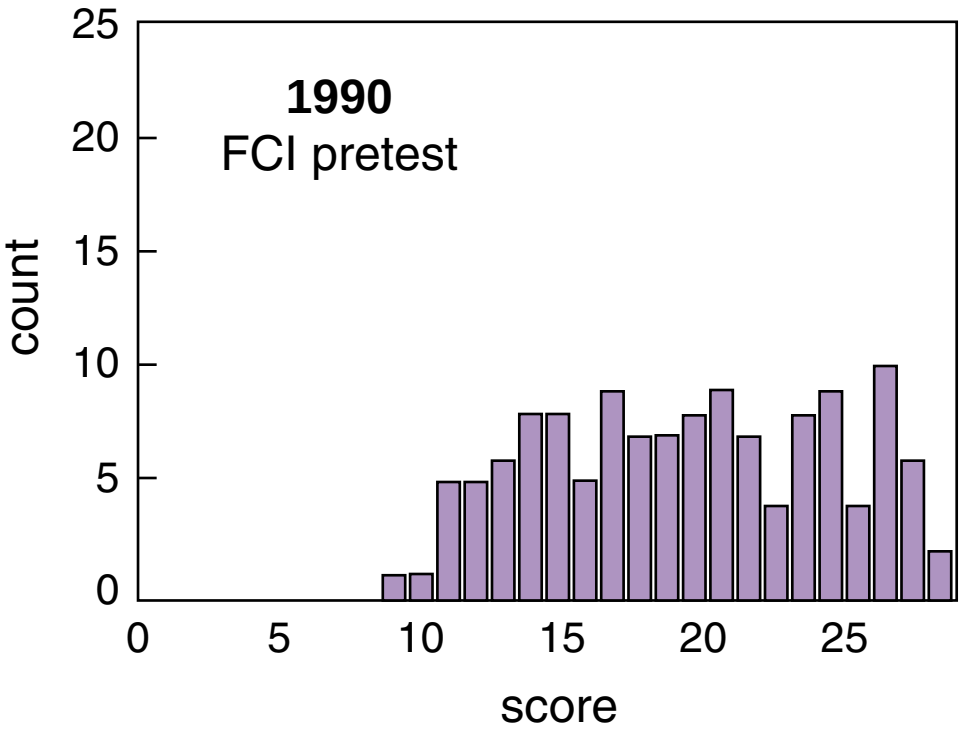
AAPT New Faculty Meeting
9 November 2001

Outline

- **Research: providing the basis for change**
- **ConcepTests: brains-on demo**
- **Problem with Problems**
- **Discussion**

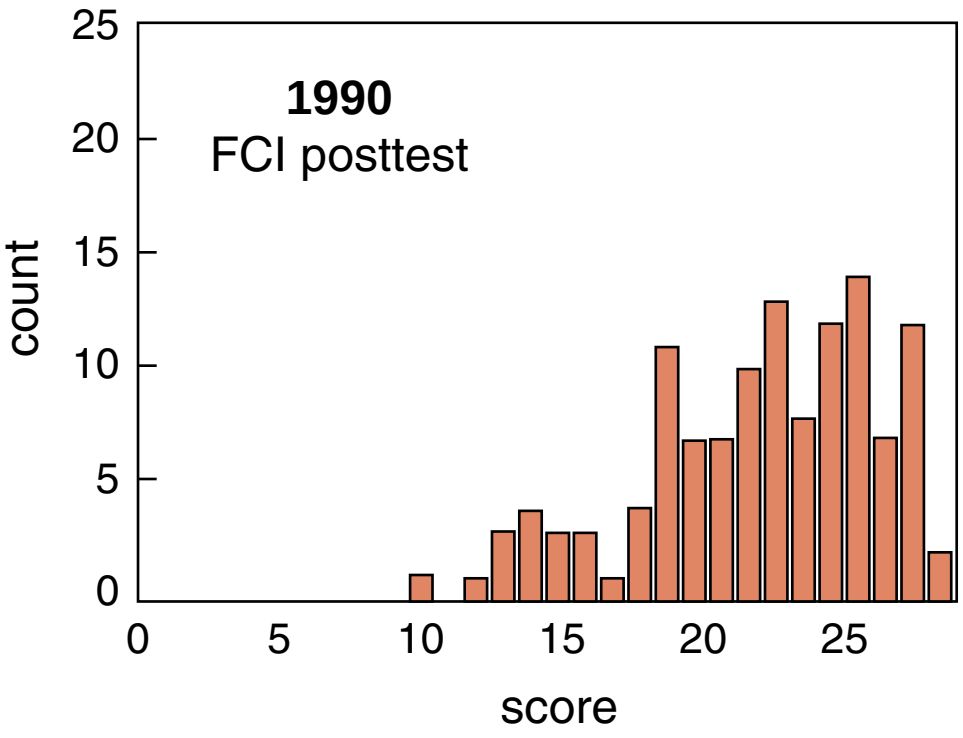
Why use Peer Instruction?

Force Concept Inventory data



Hestenes, *et al.*, *TPT* 30, 141 (1992)

Why use Peer Instruction?



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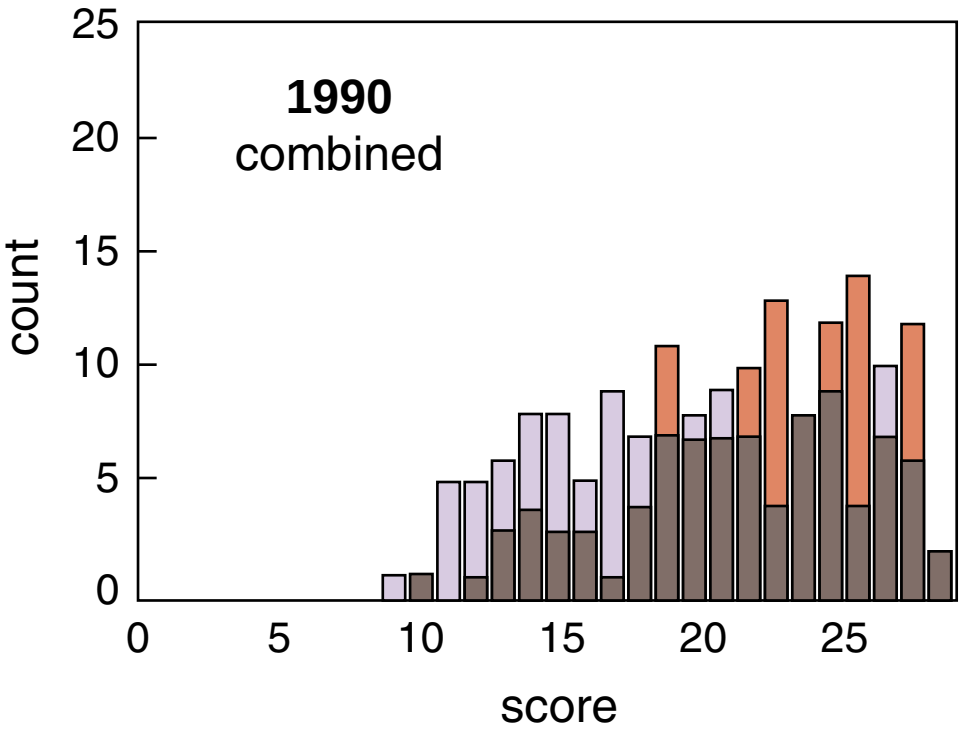

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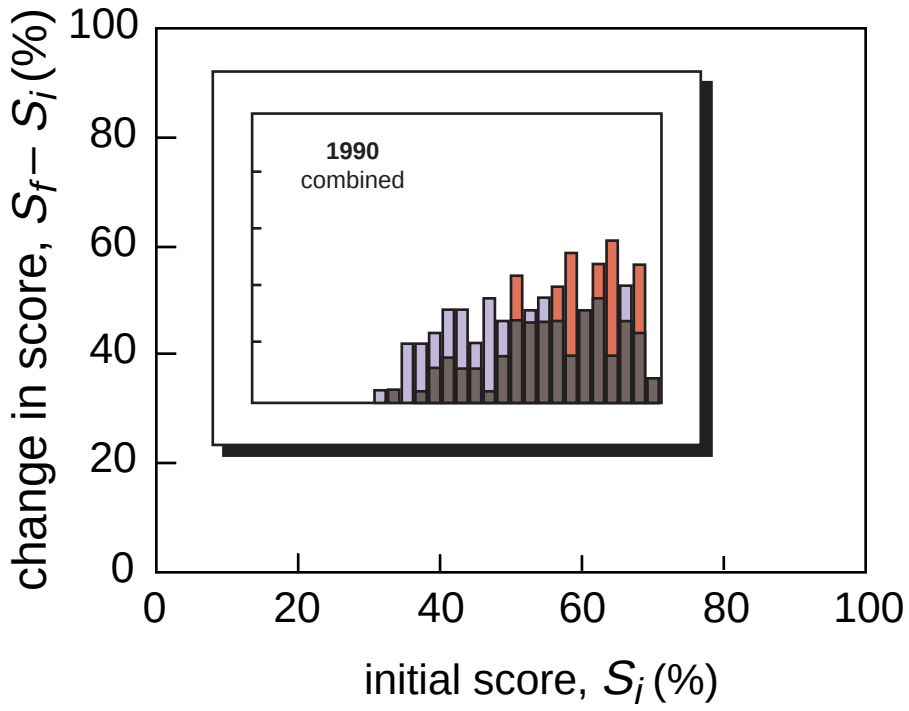

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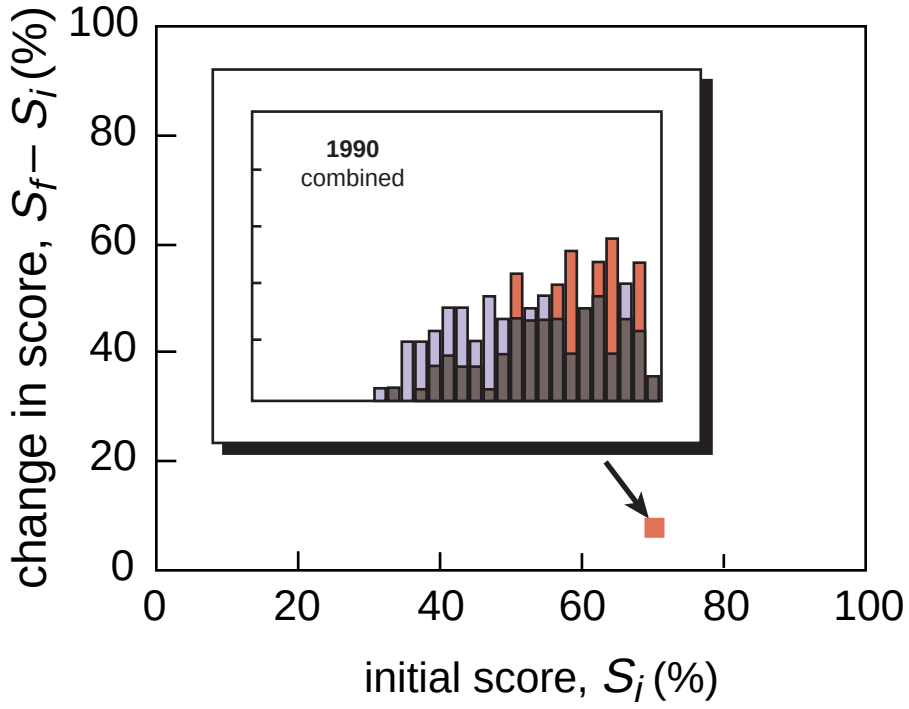

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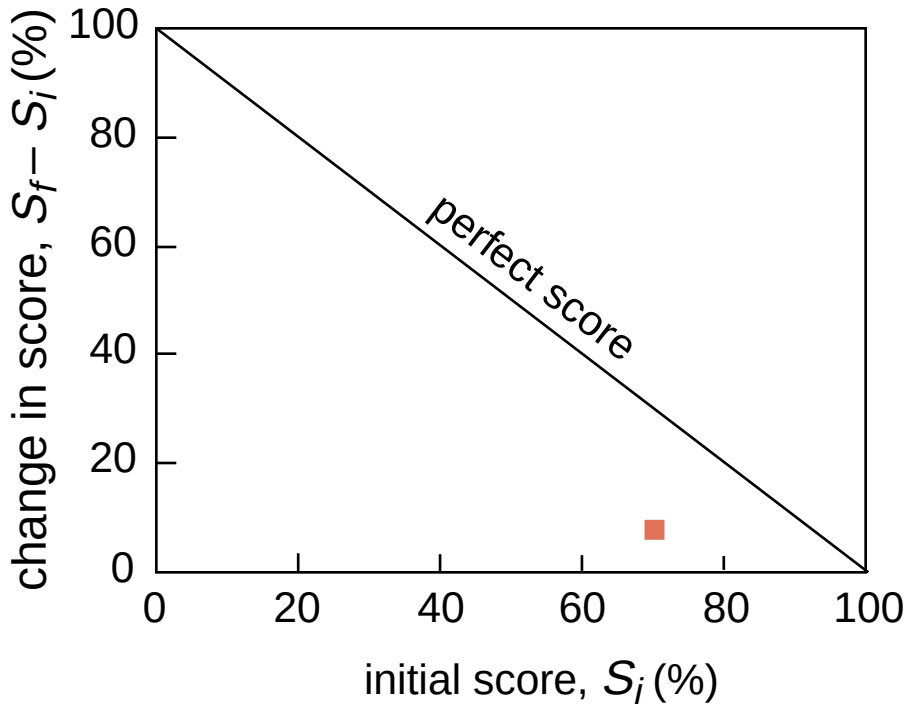

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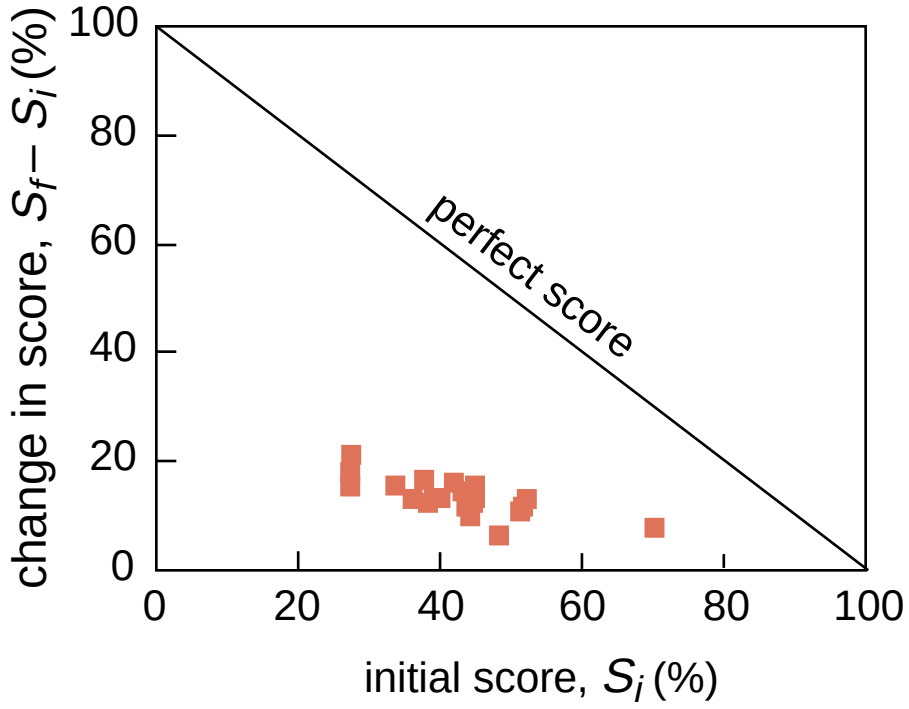

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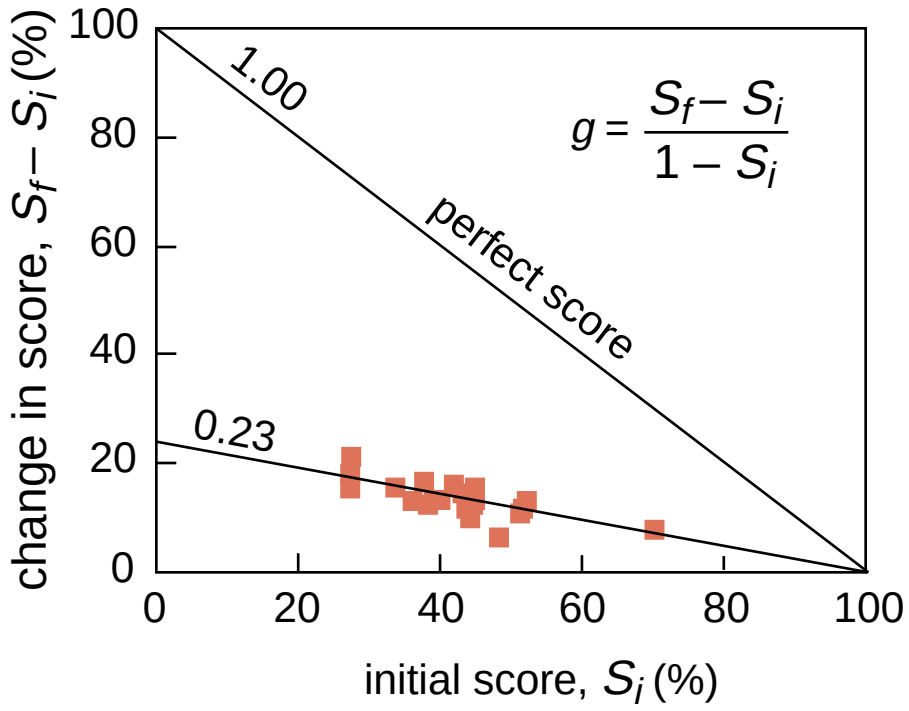
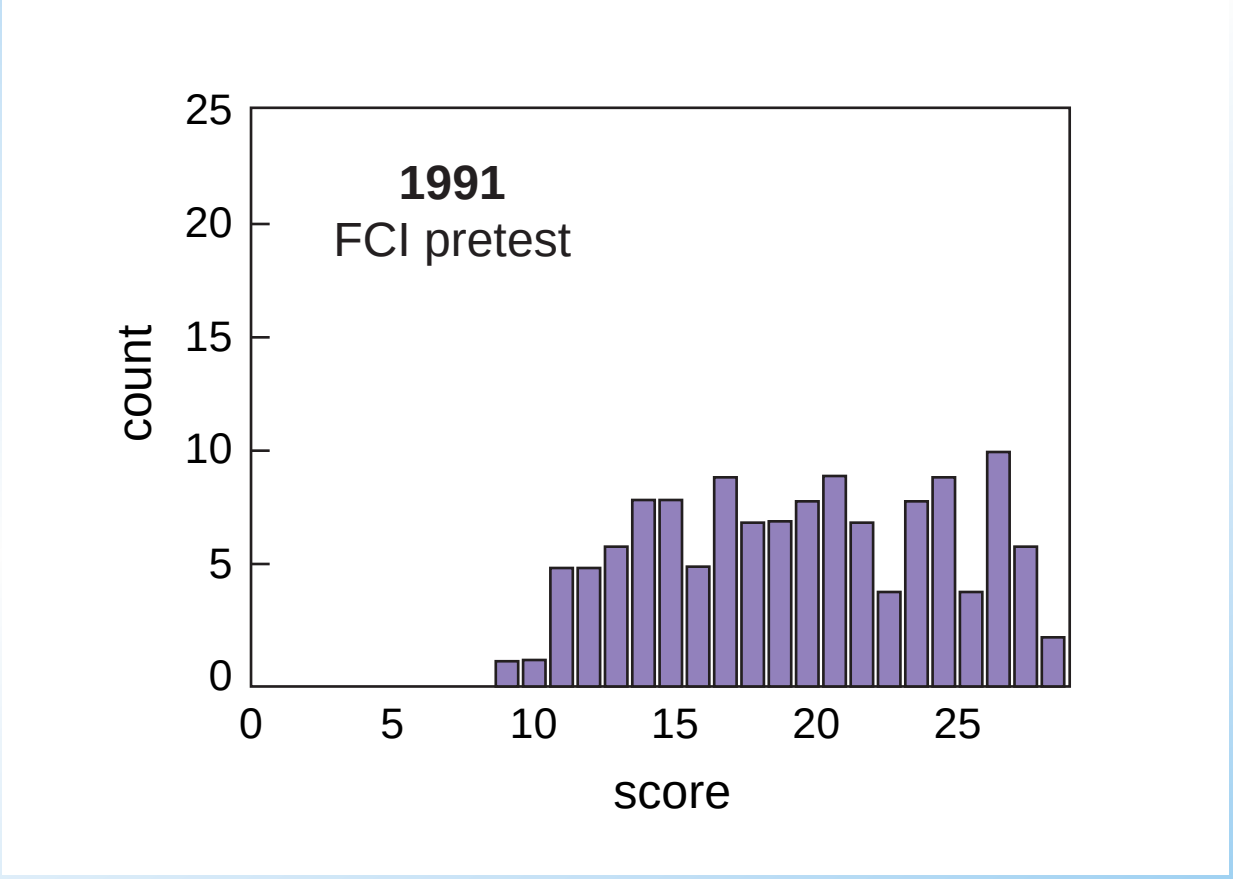


Results



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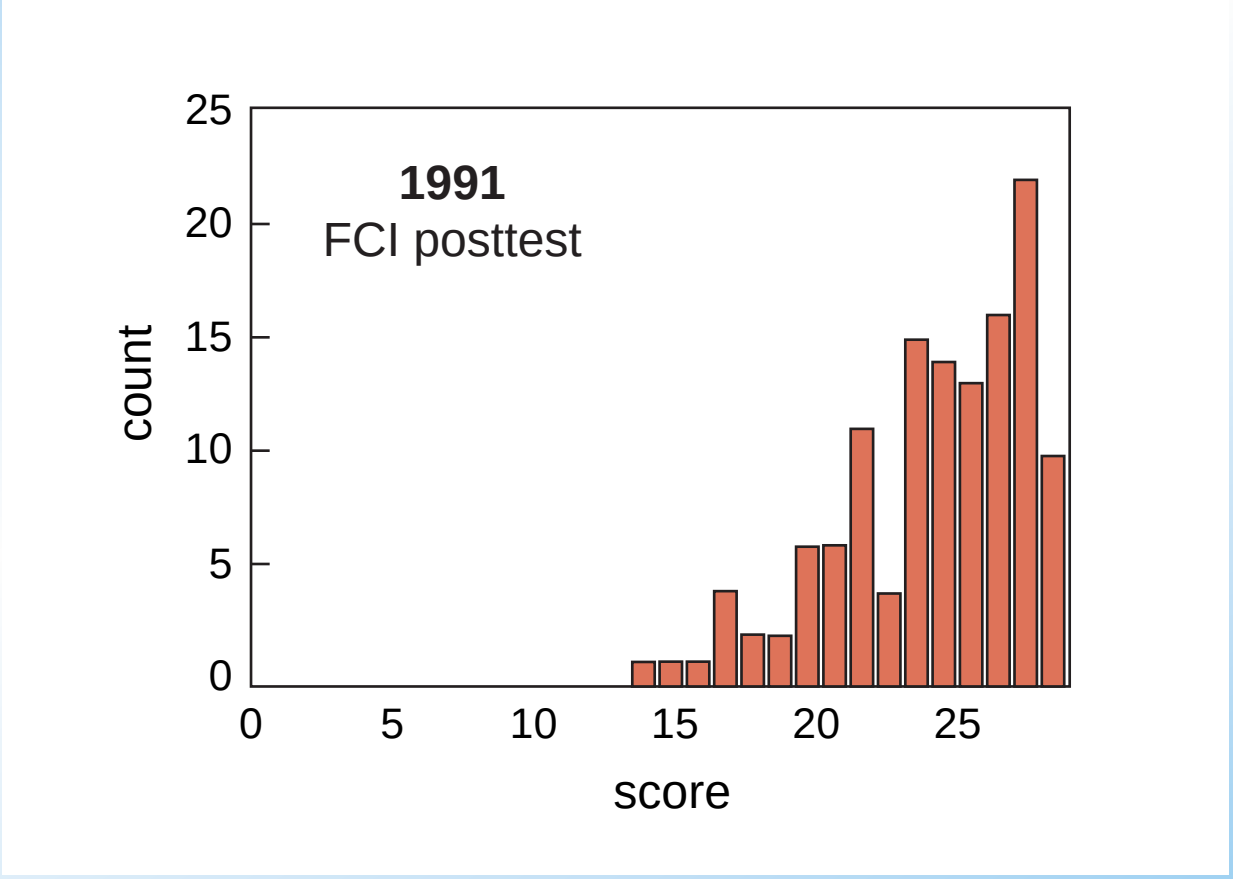

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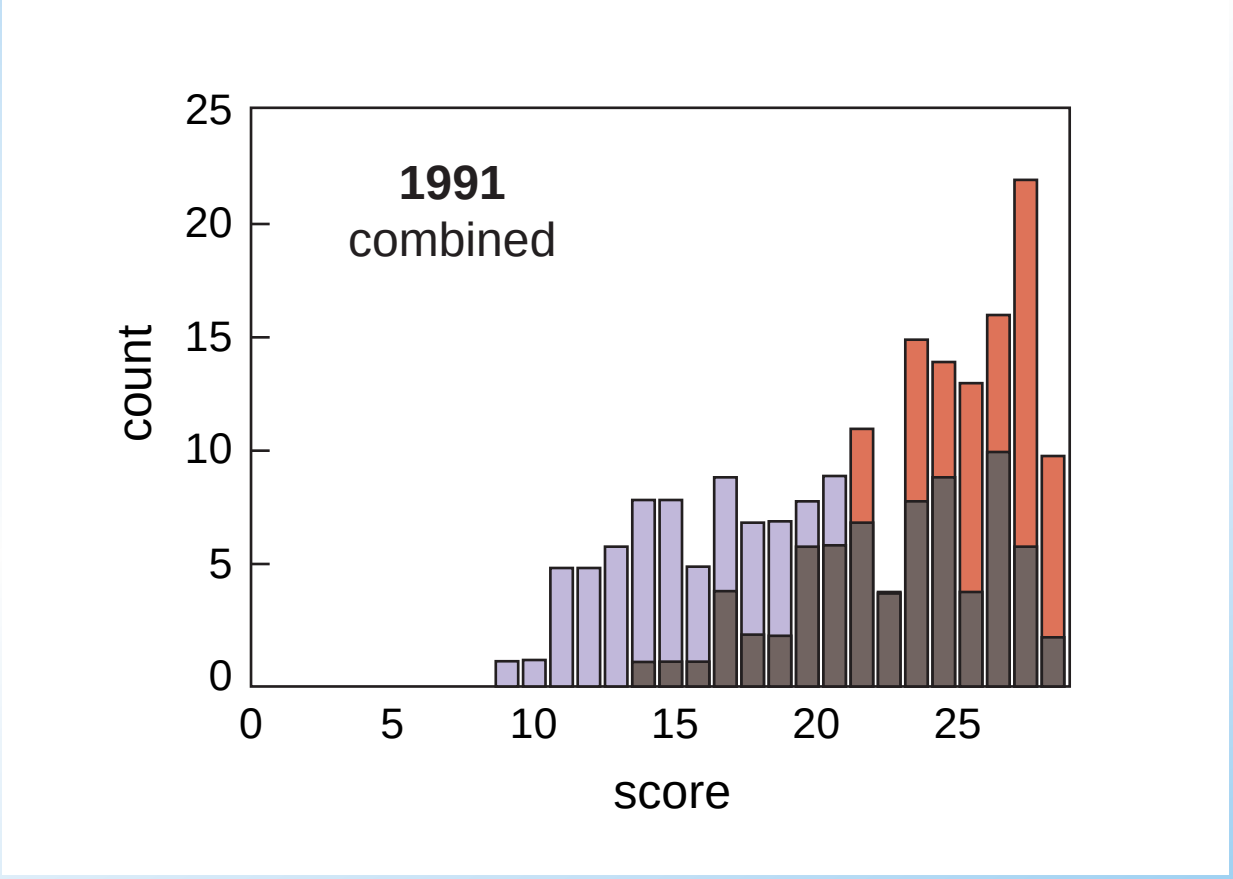

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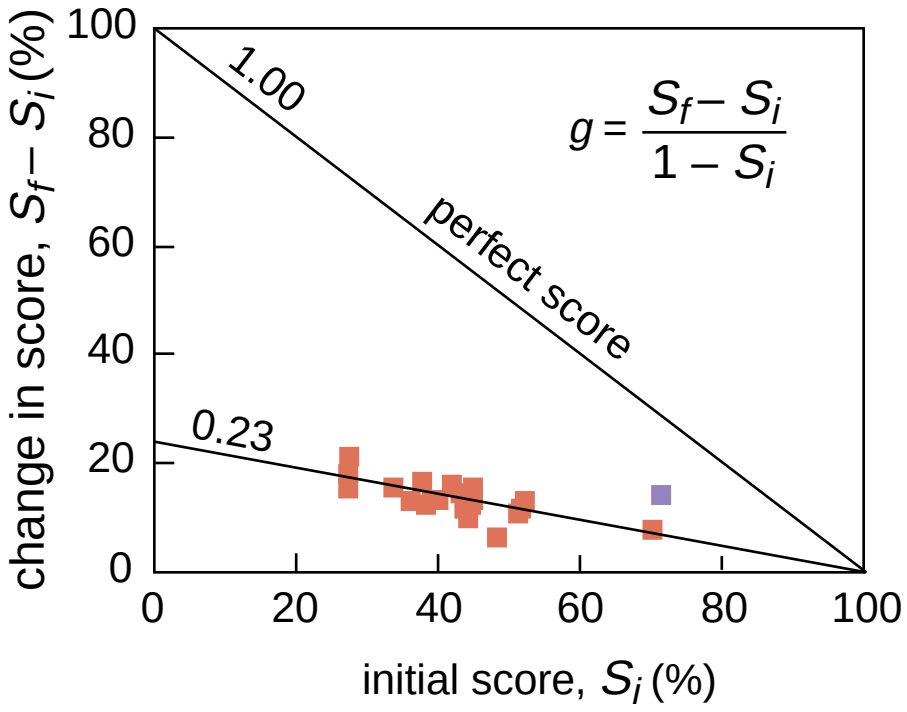
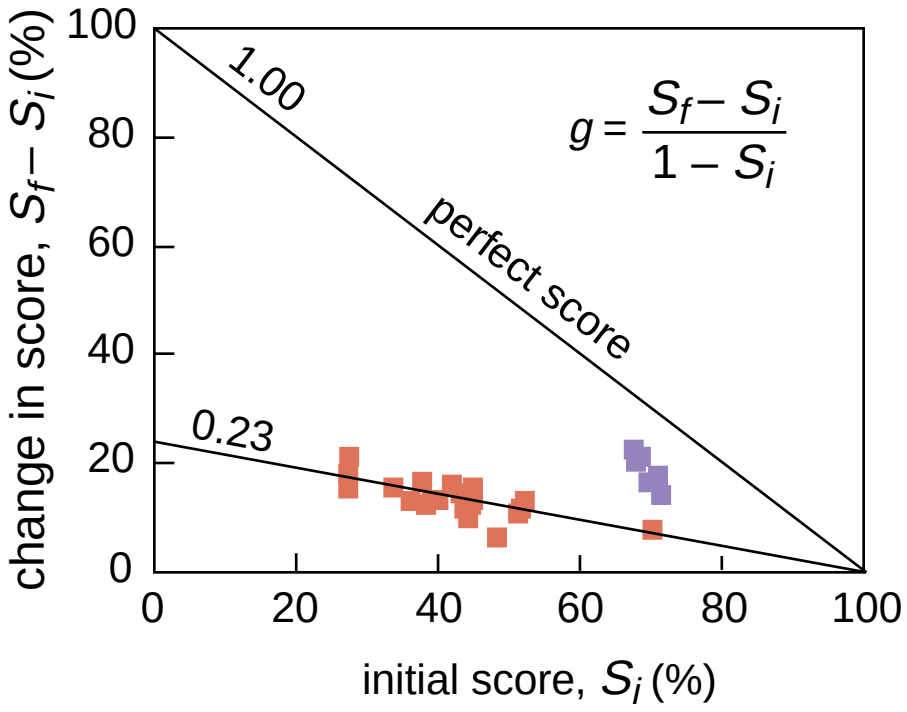

change in score, $S_f - S_i$ (%)
initial score, S_i (%)
0
20
40
60
80
100
1.00
perfect score
0.23
$g = \frac{S_f - S_i}{1 - S_i}$

Results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40
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1.00
perfect score
0.23
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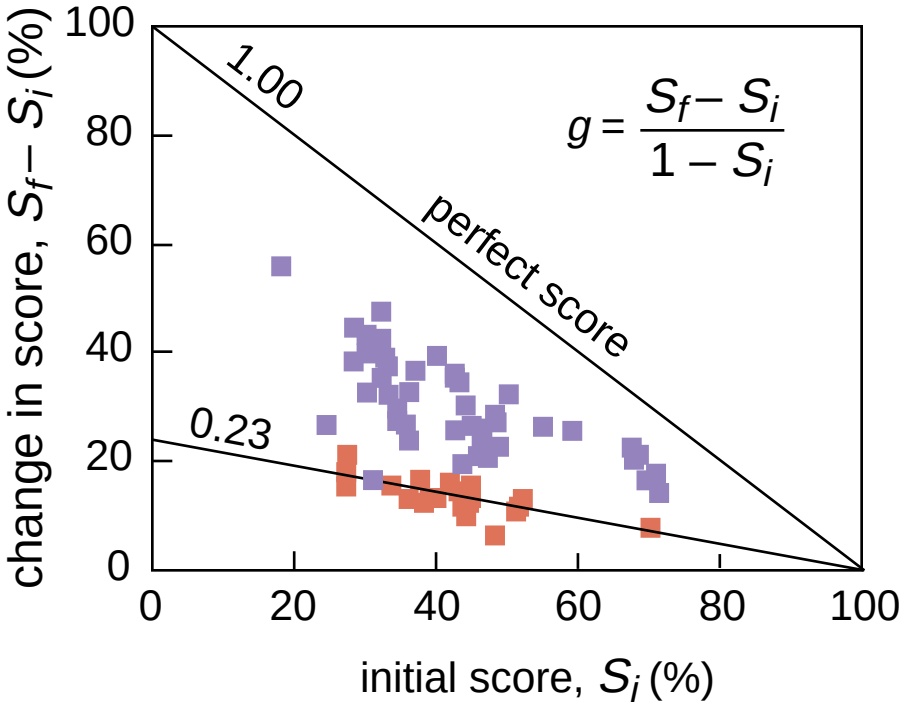
Results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initial score, S_i (%)
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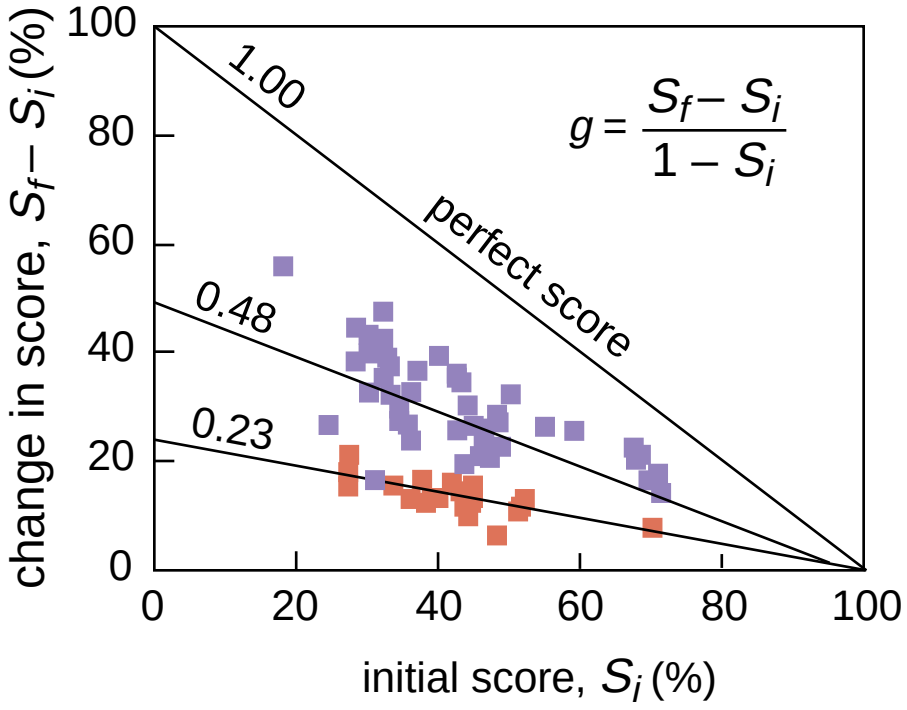
40
60
80
100
1.00
perfect score
0.23
$g = \frac{S_f - S_i}{1 - S_i}$

Results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initial score, S_i (%)
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40
60
80
100
1.00
perfect score
0.48
0.23
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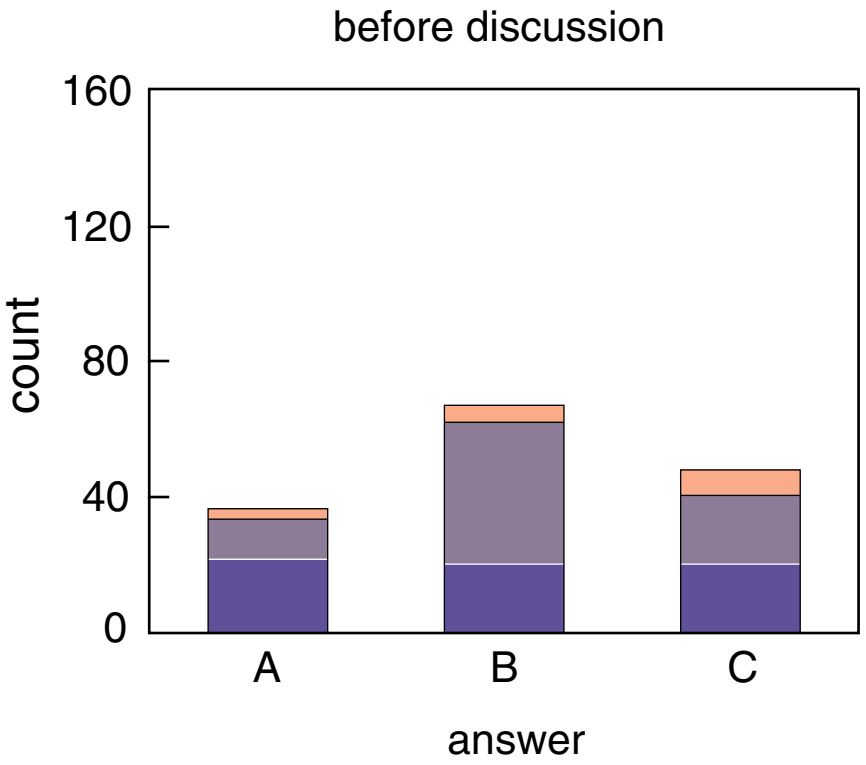
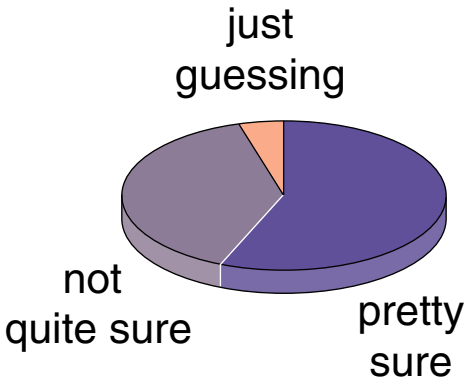
ConcepTest data





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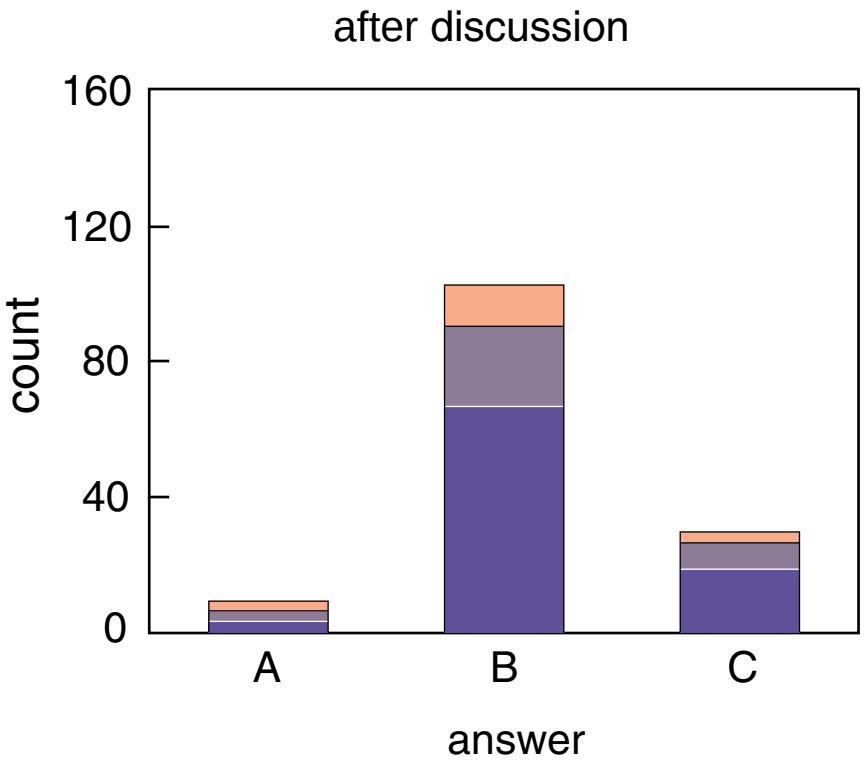

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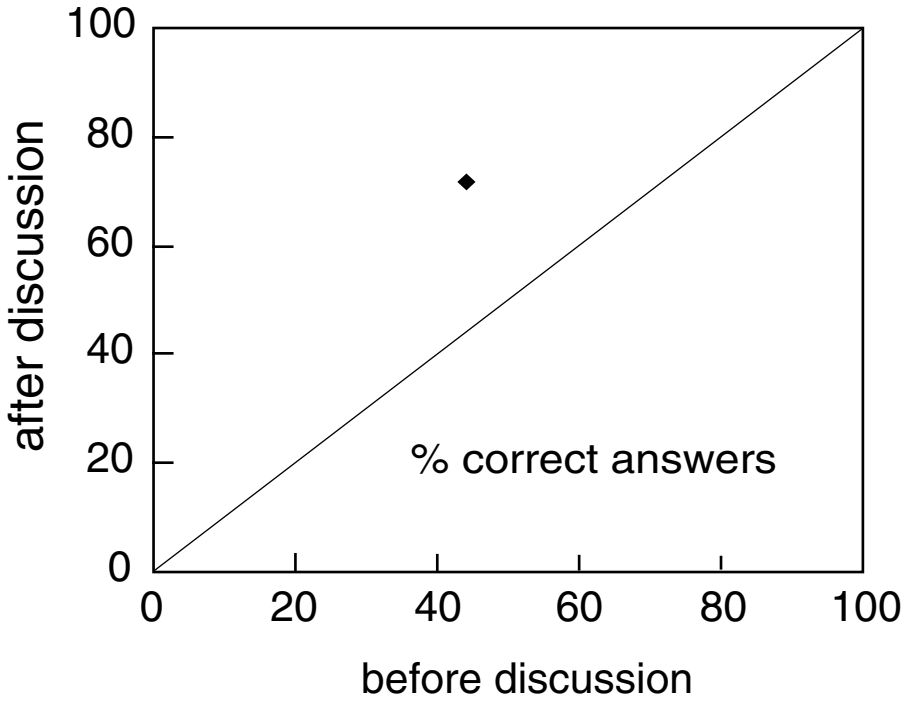

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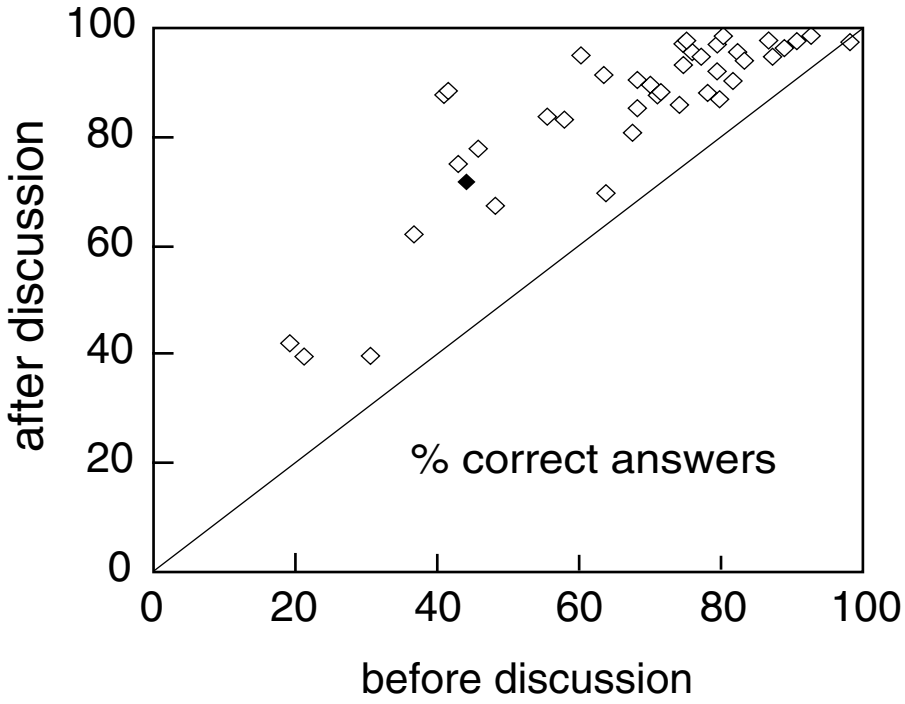

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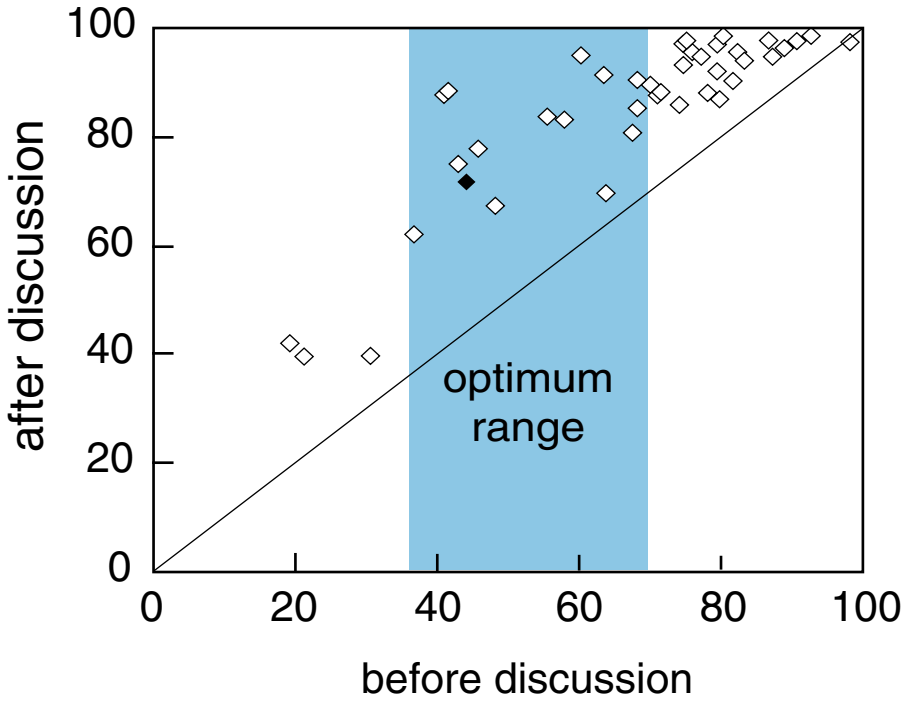
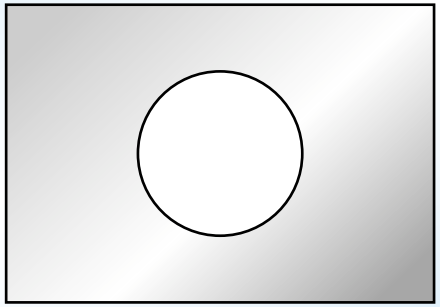


Question 1

Consider a rectangular metal plate with a circular hole in it.



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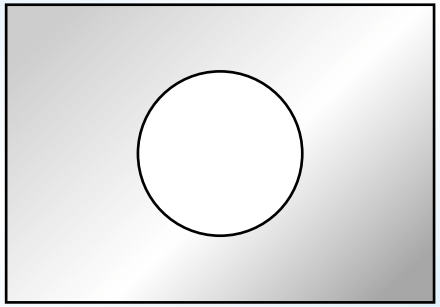

When the plate is uniformly heated, the diameter of the hole

1. increases

2. stays the same

3. decreases

Message 1

It's easy to fire up the audience!

Question 2

A boat carrying a large boulder is floating on a lake. The boulder is thrown overboard and sinks to the bottom of the lake.

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Does the level of the water in the lake (with respect to the shore)

1. go up,

2. go down, or

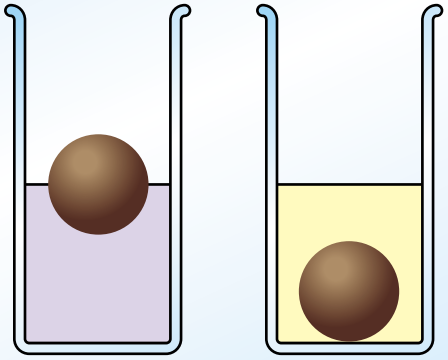
3. stay the same?

Message 2

We all make mistakes!

Question 3

Consider an object that floats in water but sinks in oil. When the object floats in water, half of it is submerged.



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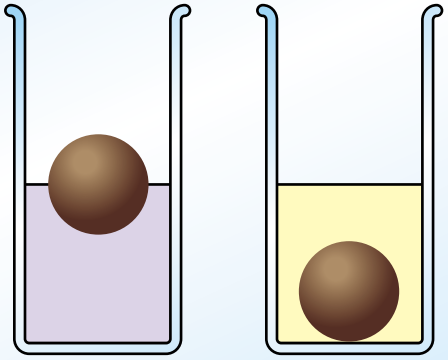
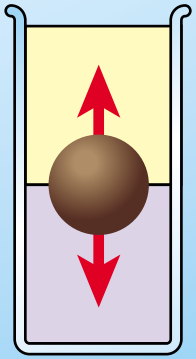


If we slowly pour oil on top of the water so it completely covers the object, the object

1. moves up.

2. stays in the same place.

3. moves down.



Message 3

It's easy to make simple demonstrations fascinating!

Question 4

When we hold a page of printed text in front of a mirror, the text on the image in the mirror runs from right to left:

The New York Times

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Why is it that right and left are interchanged and not top and bottom? Because

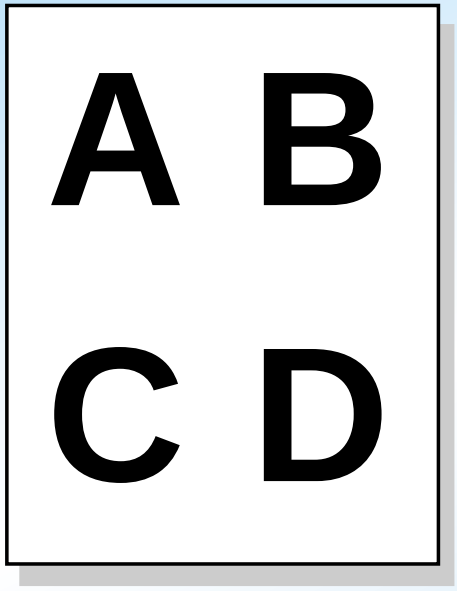
1. **the mirror is oriented vertically,**
2. **we have two eyes in the horizontal plane,**
3. **the Earth's gravitation is directed downward,**
4. **a habit we have when looking at images in a mirror,**
5. **It only *appears* to run from left to right.**

Message 4

It's "simple" only if you know the answer

Feedback

Flashcards: simple and effective!



Feedback

Flashcards: simple and effective!

A B

C D

Problem with problems

On a Saturday afternoon, you pull into a parking lot with unmetered spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

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Requires assumptions
Requires developing a model
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Requires applying a (new) model

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Requires using a calculator

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Essential elements

- **Reading (before class)**
- **Participation (during class)**
- **Problem-solving (after class)**
- **Appropriate testing/assessment**

Coverage

traditional	
coverage	encyclopedic
retention	disappointing

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"What counts is not how much is covered, but how much is uncovered"

Viki Weisskopf

Reading

- **Web-based assignment due before class**

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- **Three questions (content and feedback)**

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- **Graded on effort**

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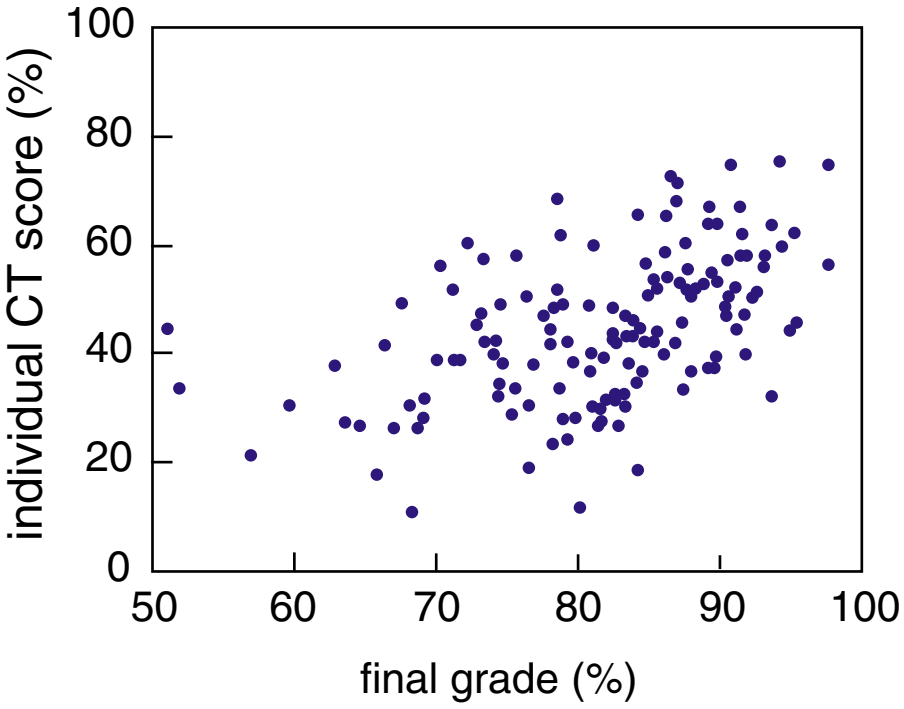
- **Three questions (content and feedback)**
- **Graded on effort**
- **5% of final grade**

Who benefits?



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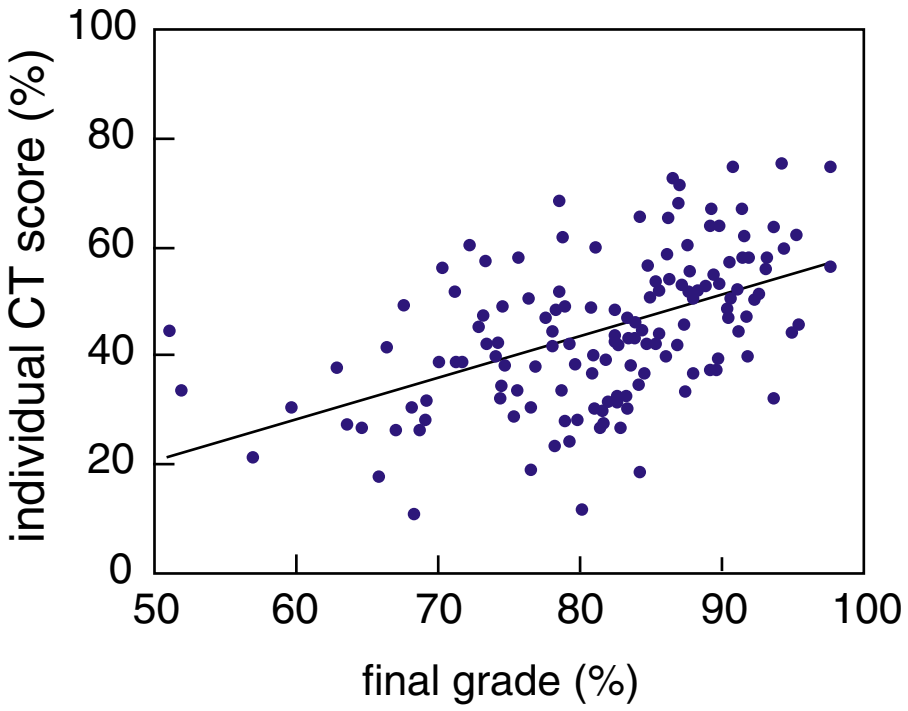

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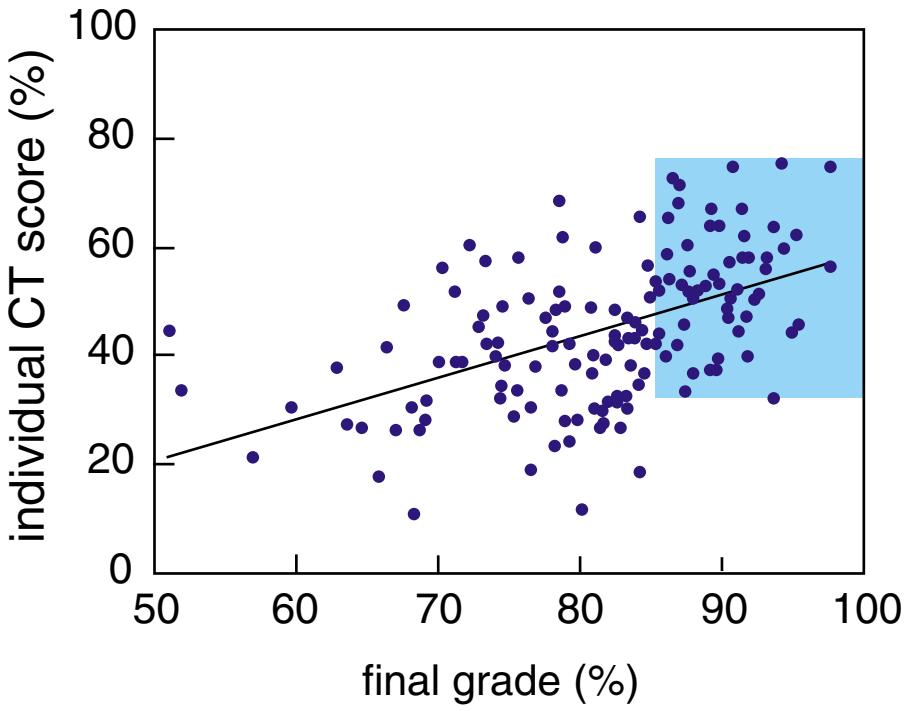
even best students are challenged!



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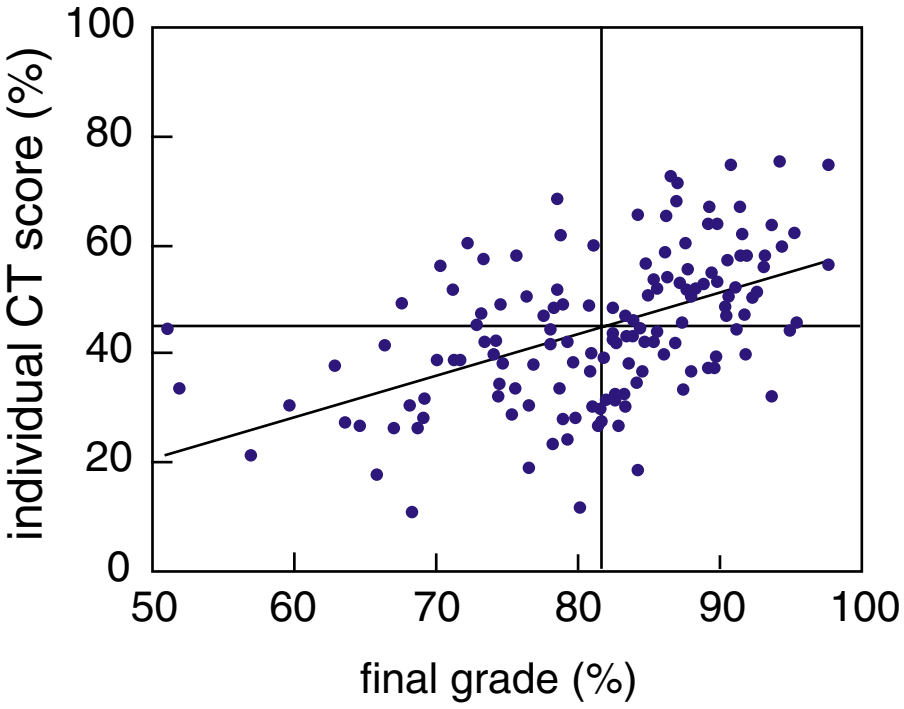

Resources

Peer Instruction: A User's Manual **(Prentice Hall, 1997)**

http://galileo.harvard.edu

Funding

National Science Foundation

For a copy of this talk and additional information:

http://mazur-www.harvard.edu