Peer Instruction
in Large (and small!) Lectures

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Studiedag Onderwijsvernieuwing
Leuven, 4 June 2002

Outline

- **Problem**

Outline

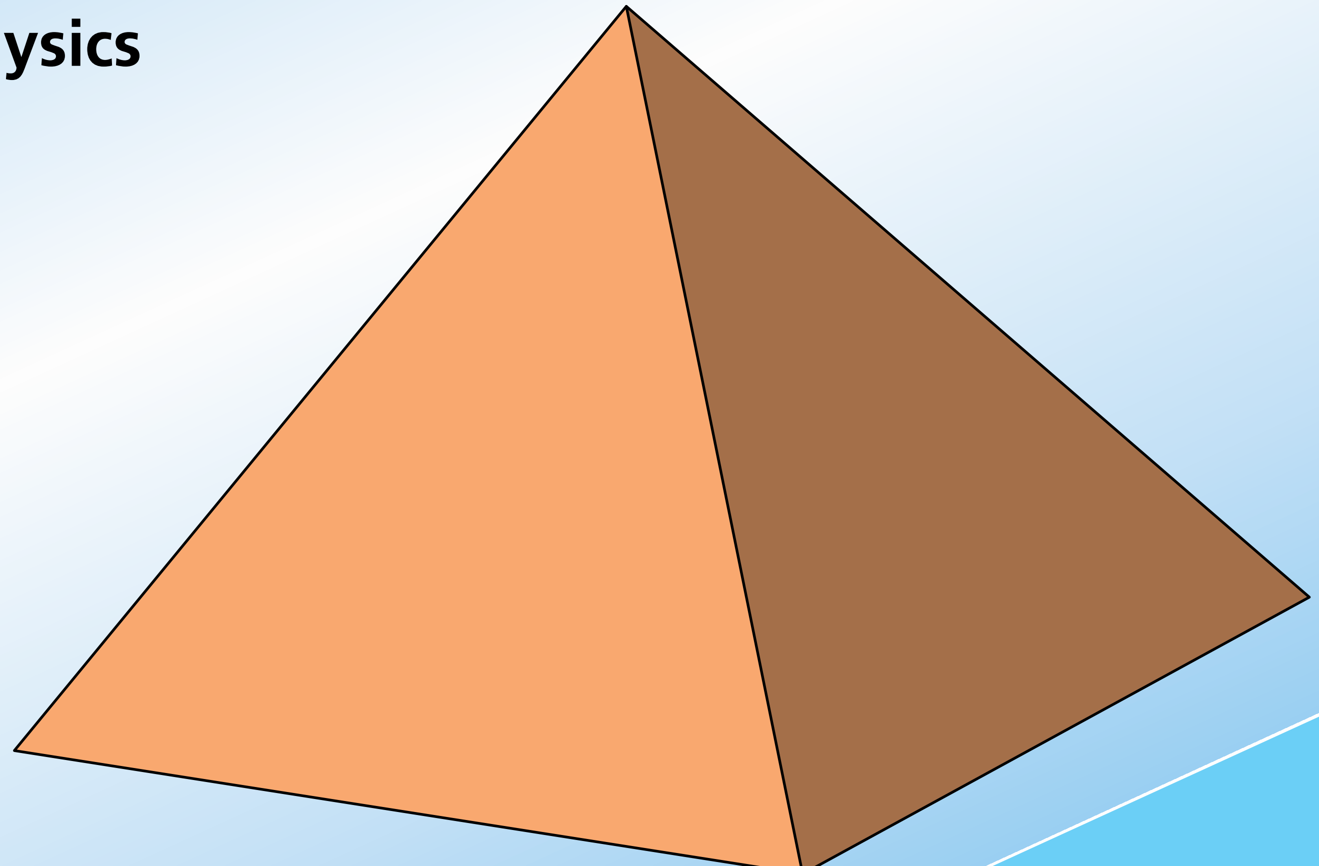
- **Problem**
- **Cause**

Outline

- **Problem**
- **Cause**
- **Remedy**

We have a problem

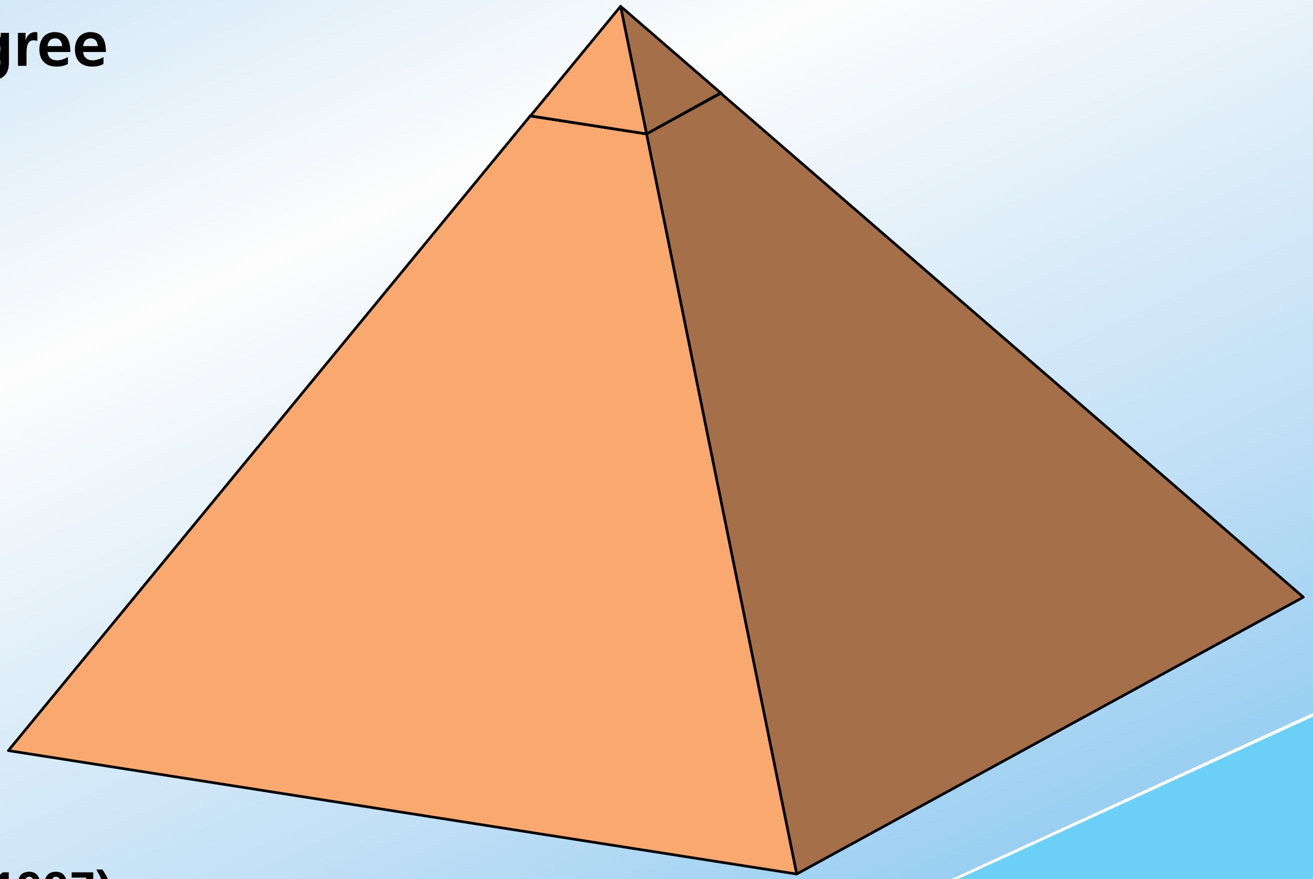
380,000 students take introductory physics each year…



AIP Report R-151.33 (1997)

We have a problem

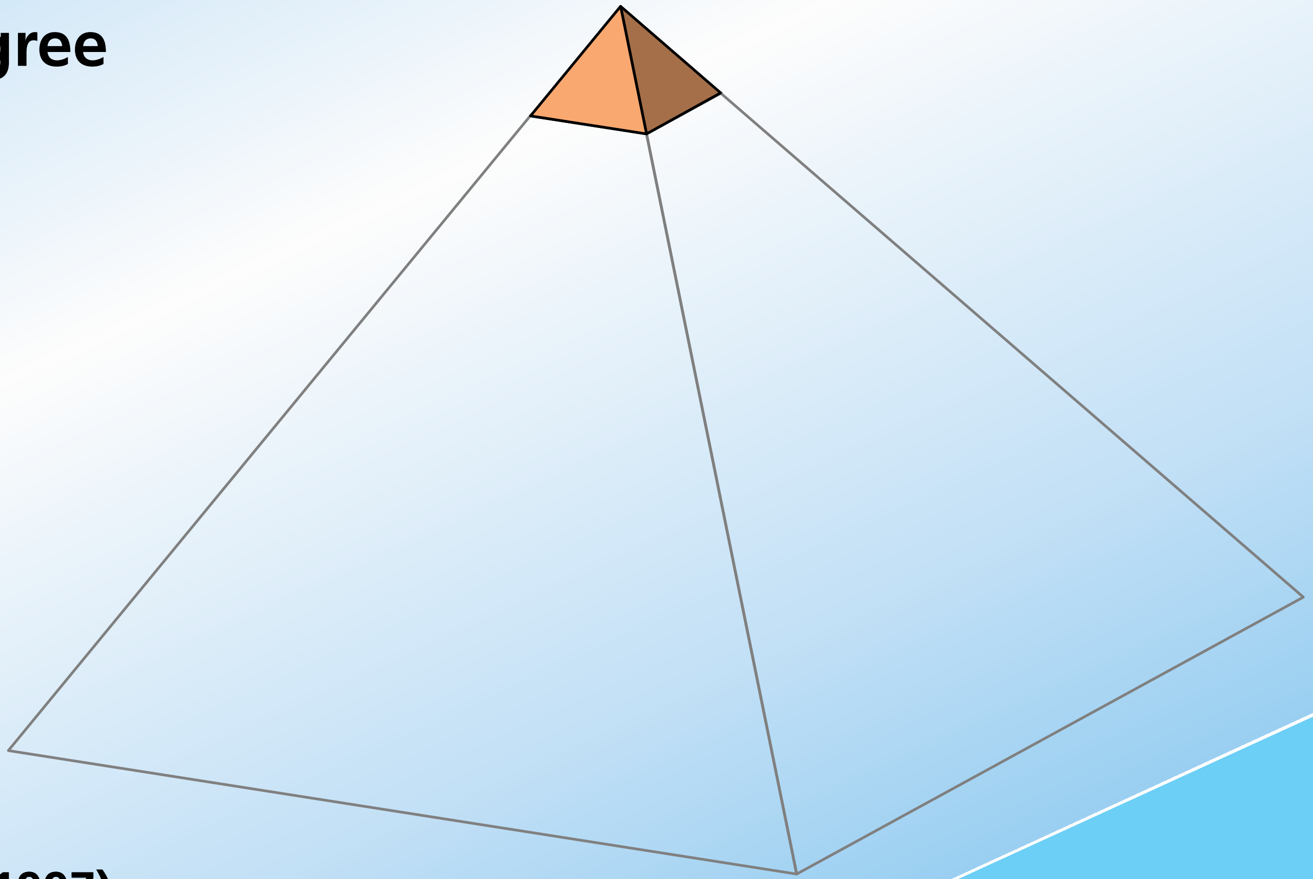
about 1% of these get
a bachelor's degree
in physics



AIP Report R-151.33 (1997)

We have a problem

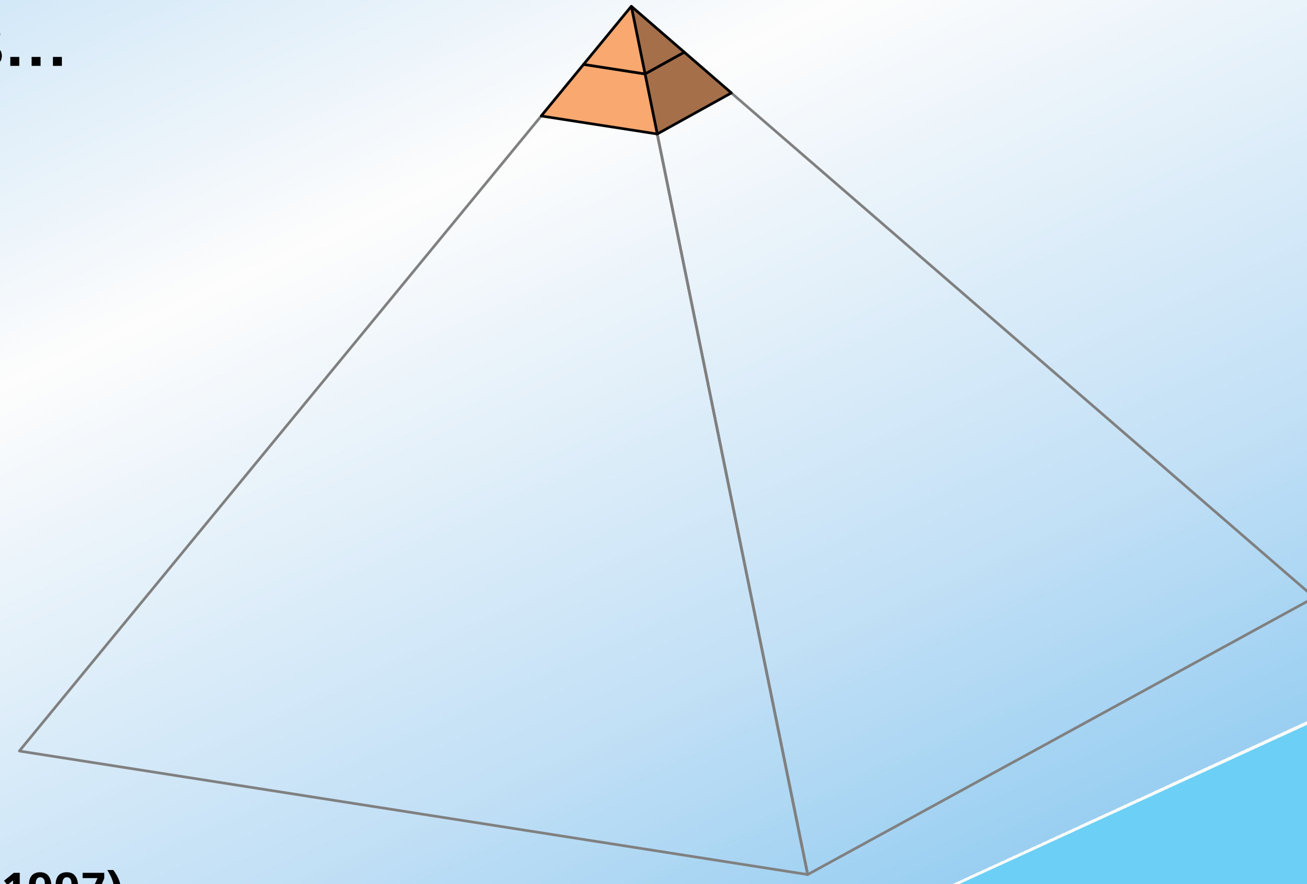
Of the 4,300 students with a bachelor's degree in physics…



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

We have a problem

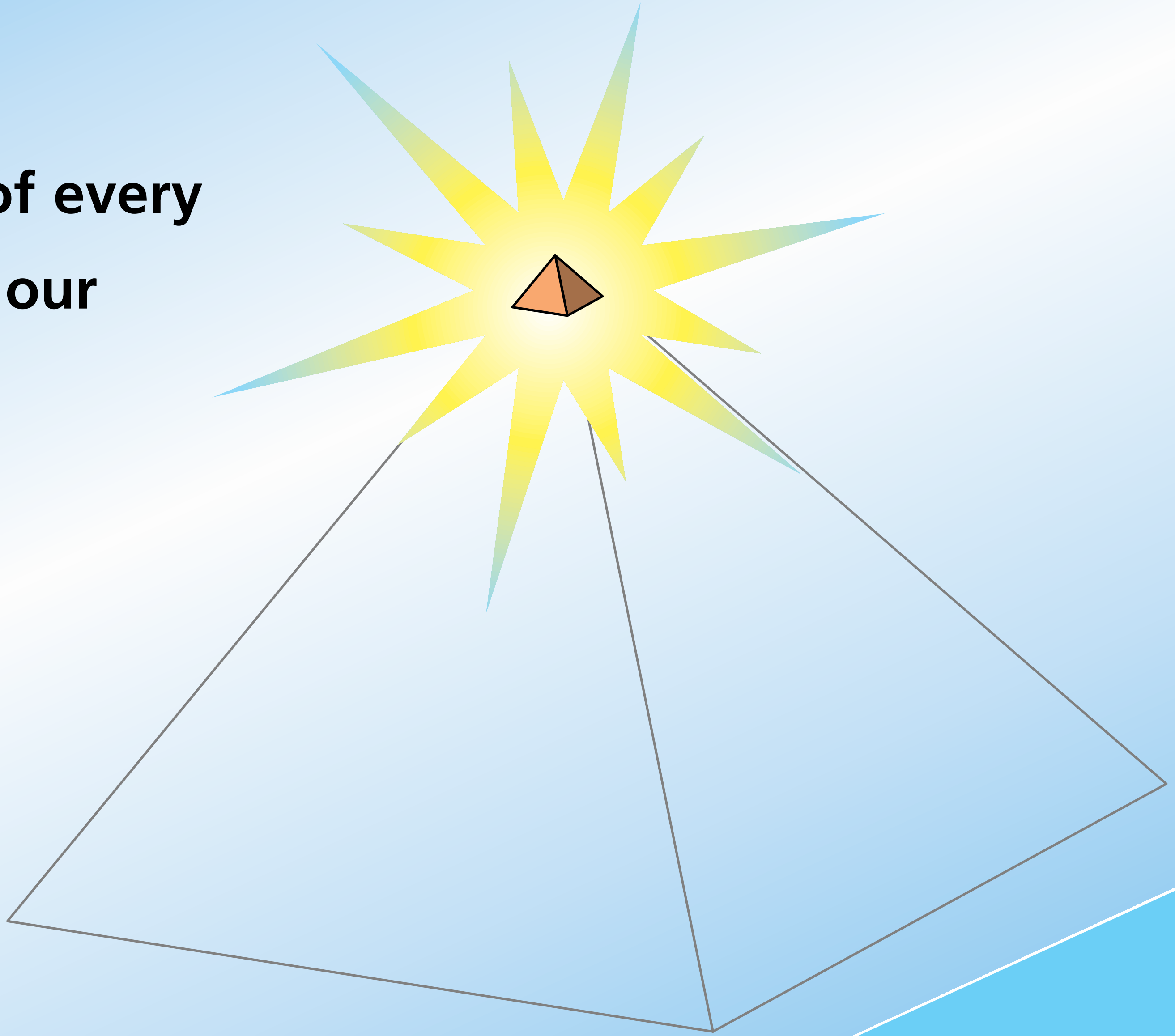
about 35% go on to get a Ph.D. in physics…



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

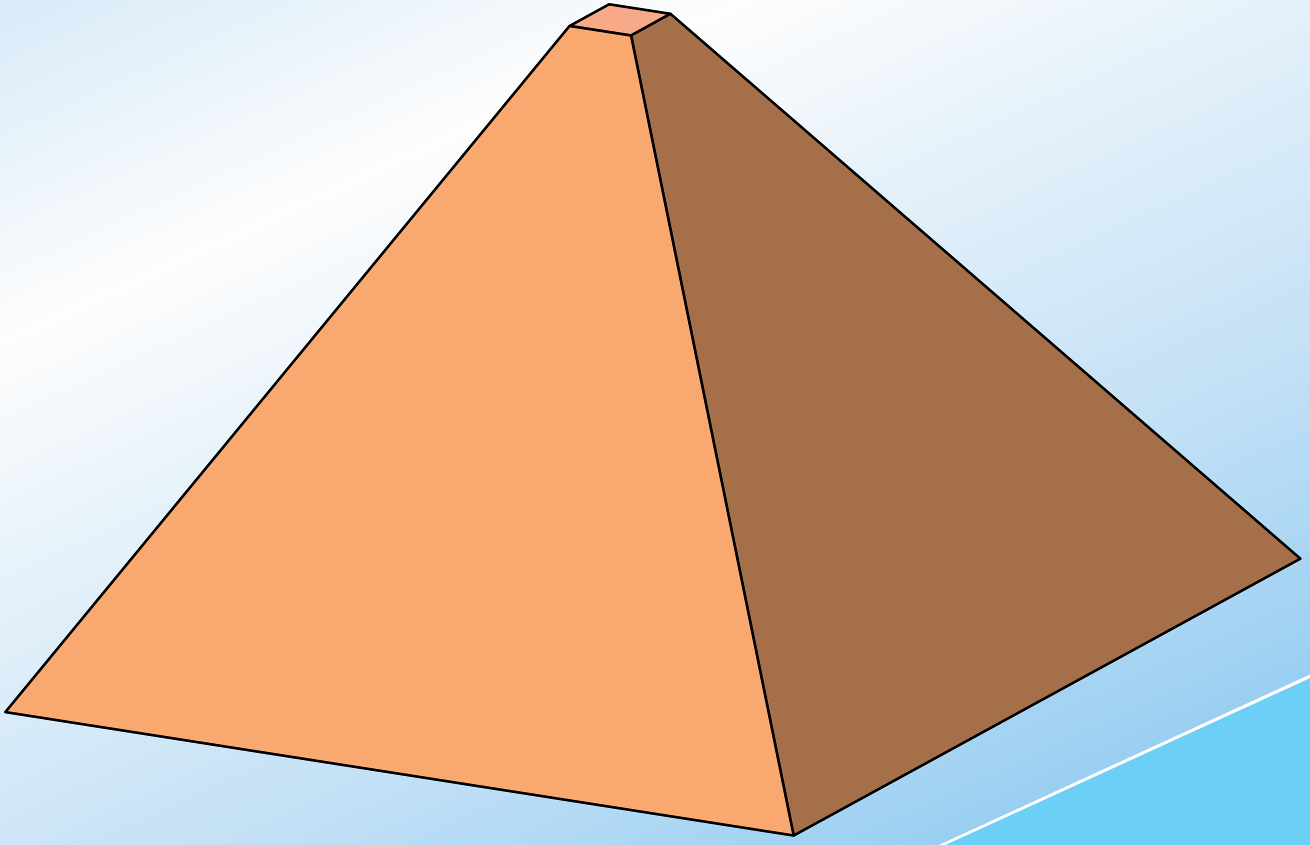
We have a problem

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



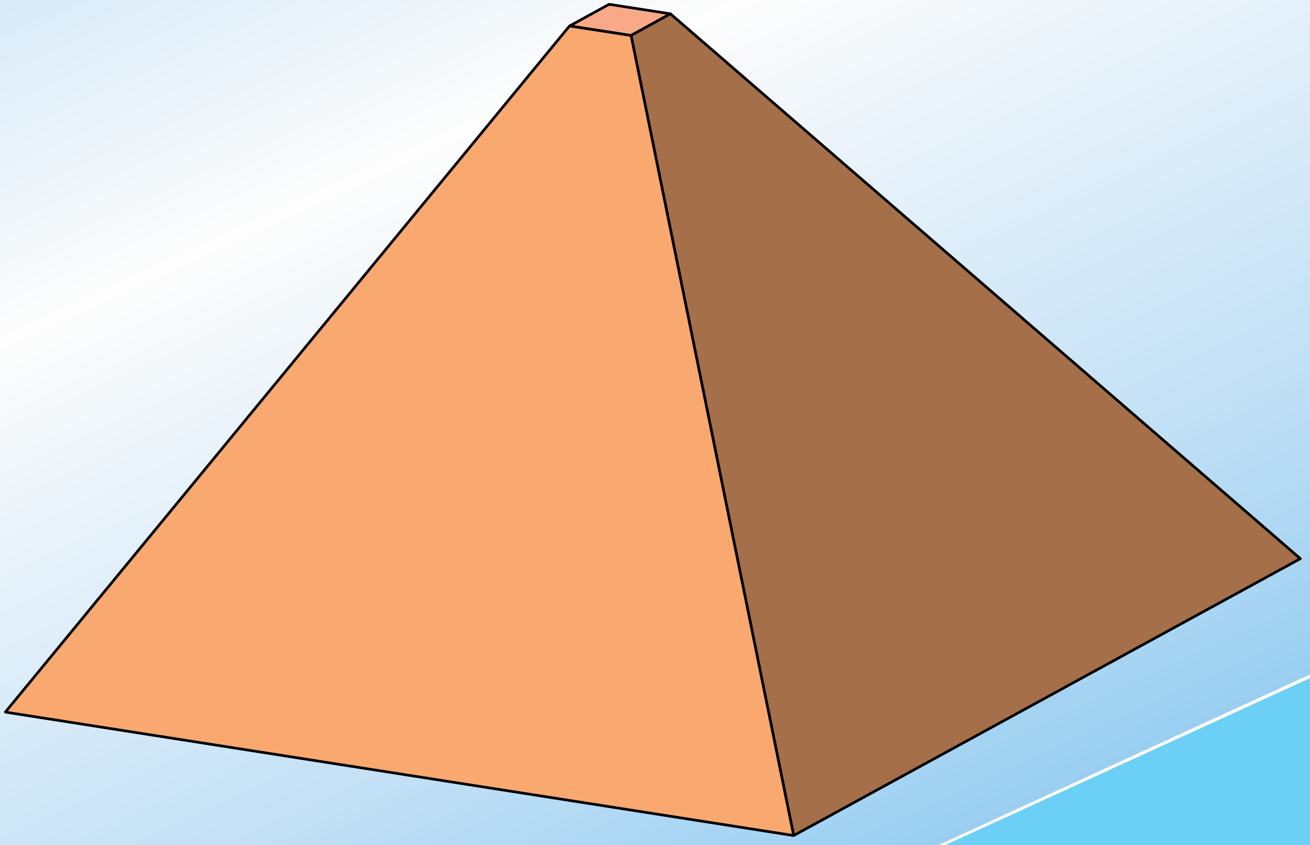
We have a problem

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

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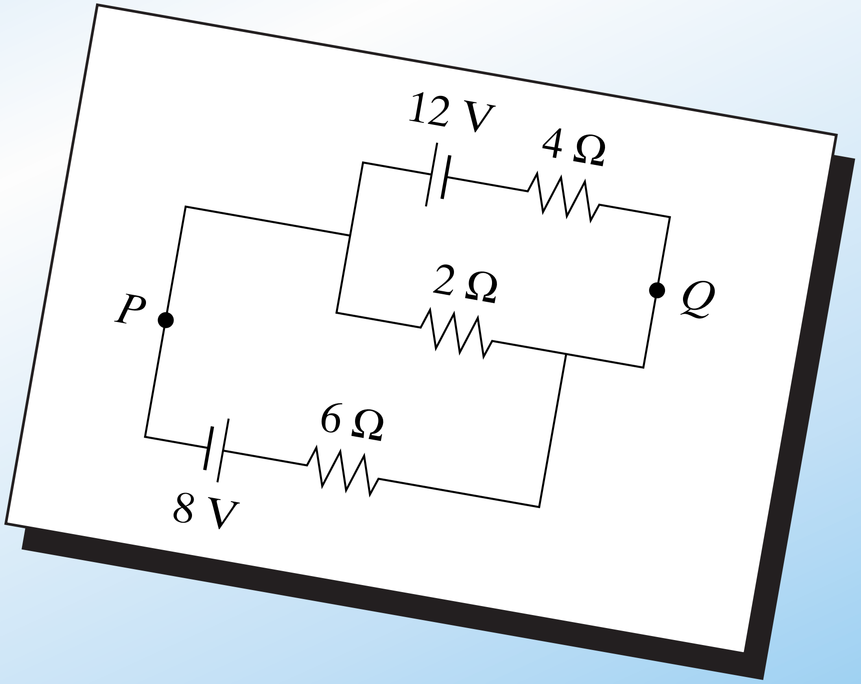


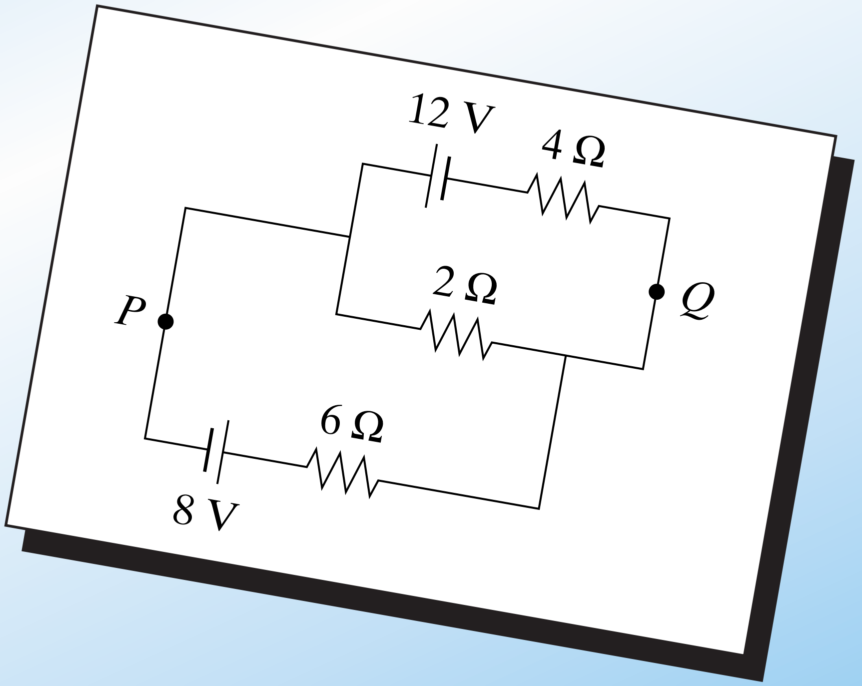
Why do we have this problem?

Conventional problems reinforce bad study habits

Calculate:

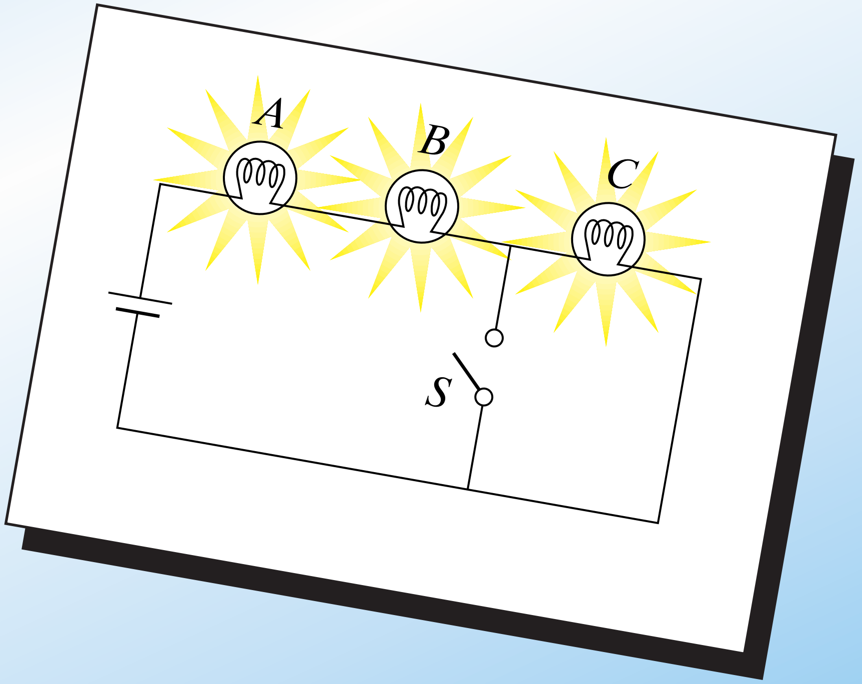
(*a*) the current in the 2-Ω resistor, and

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



Why do we have this problem?

Are basic principles understood?

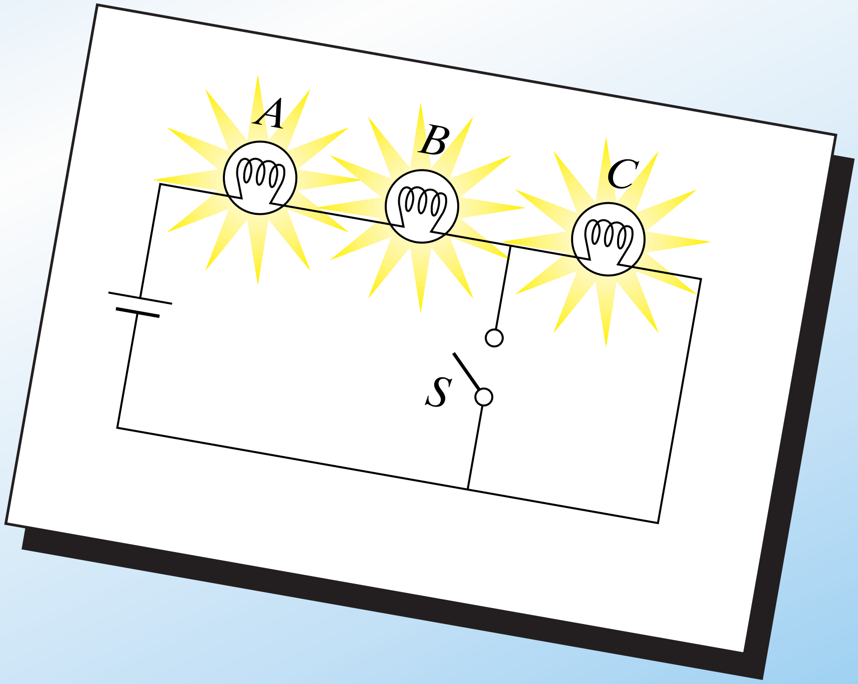


Why do we have this problem?

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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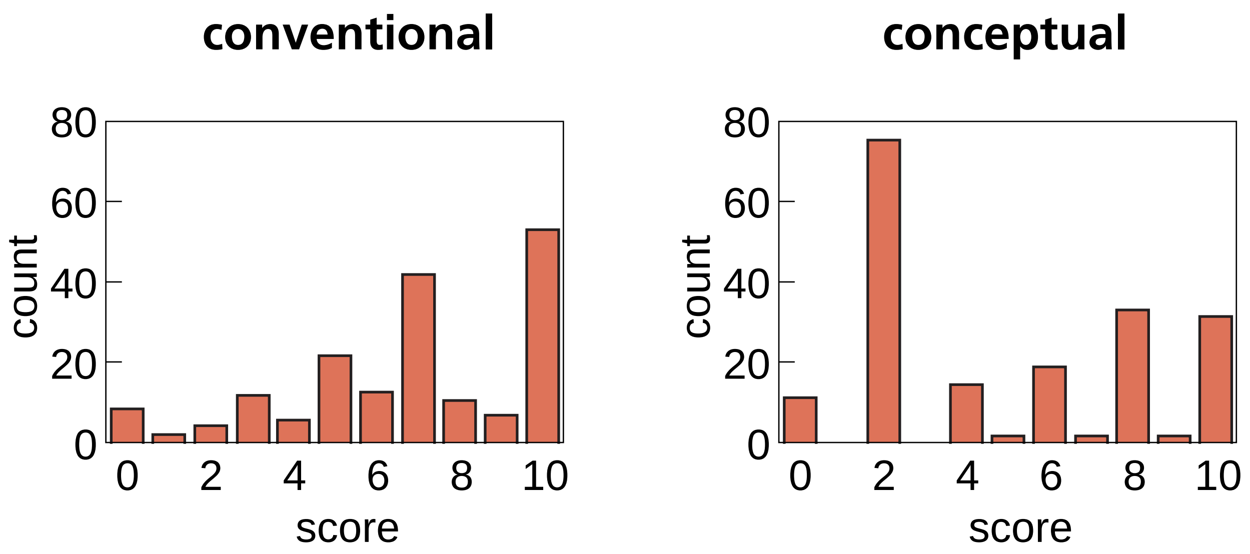

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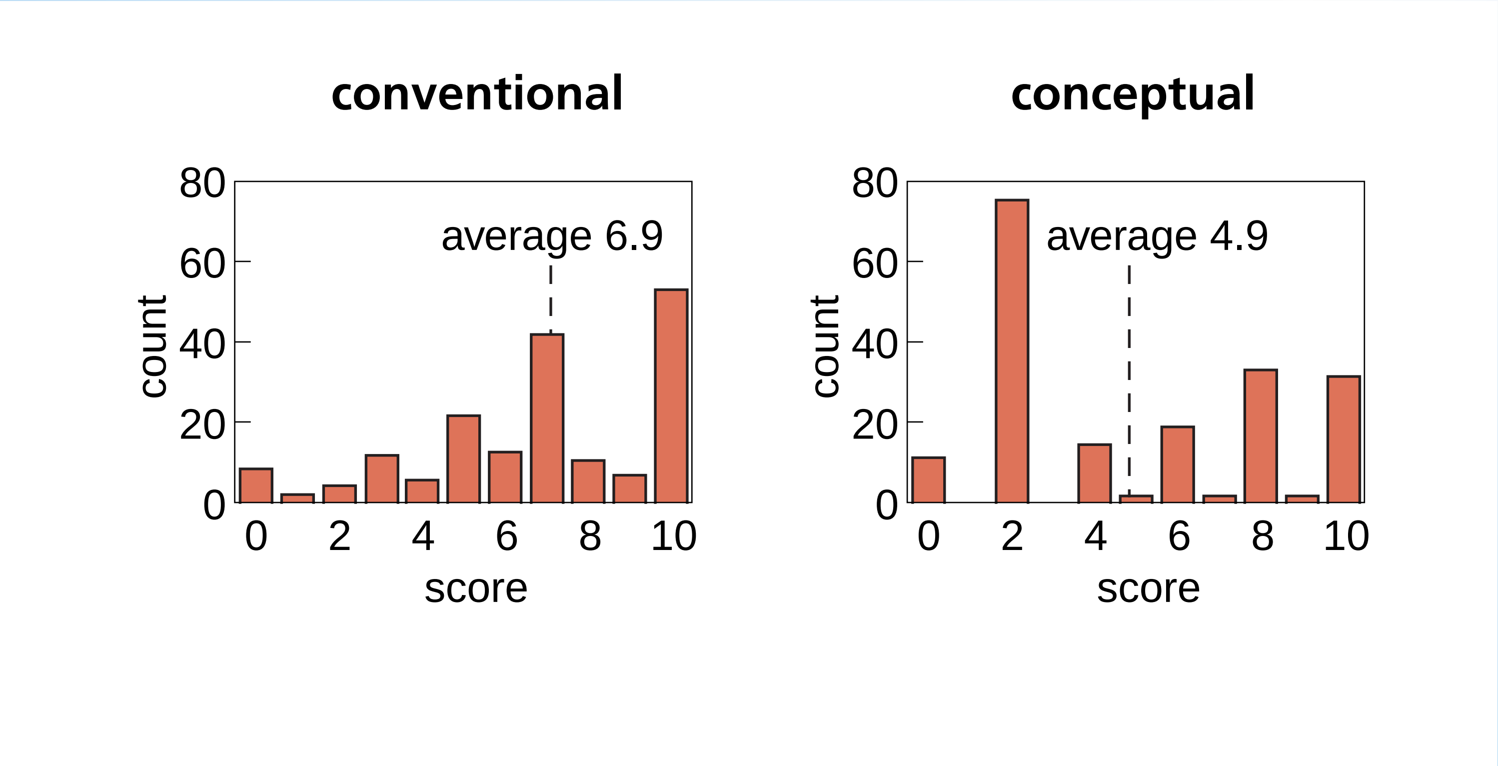

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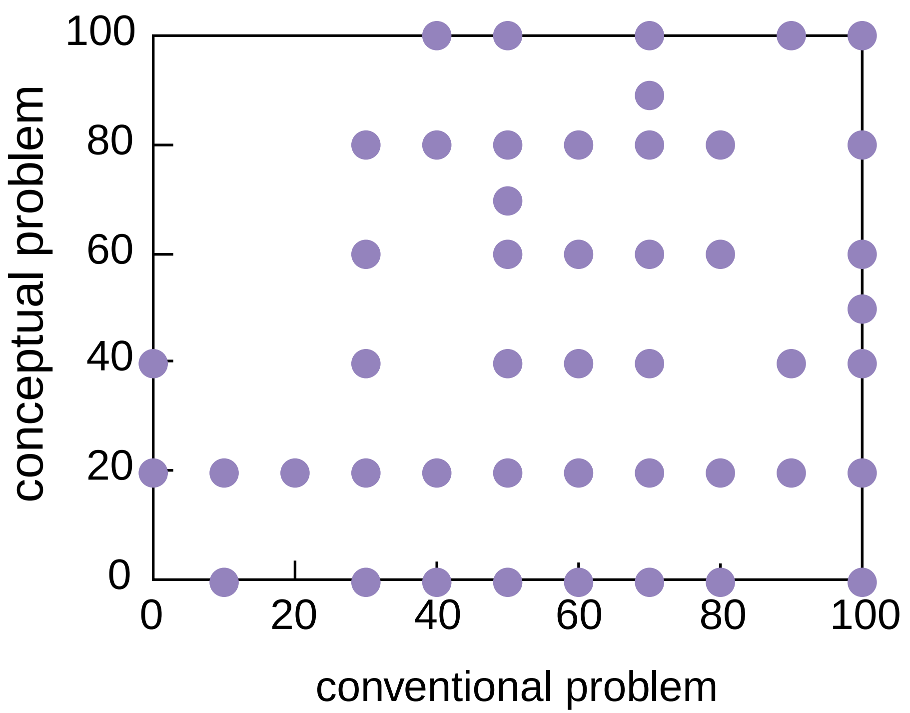

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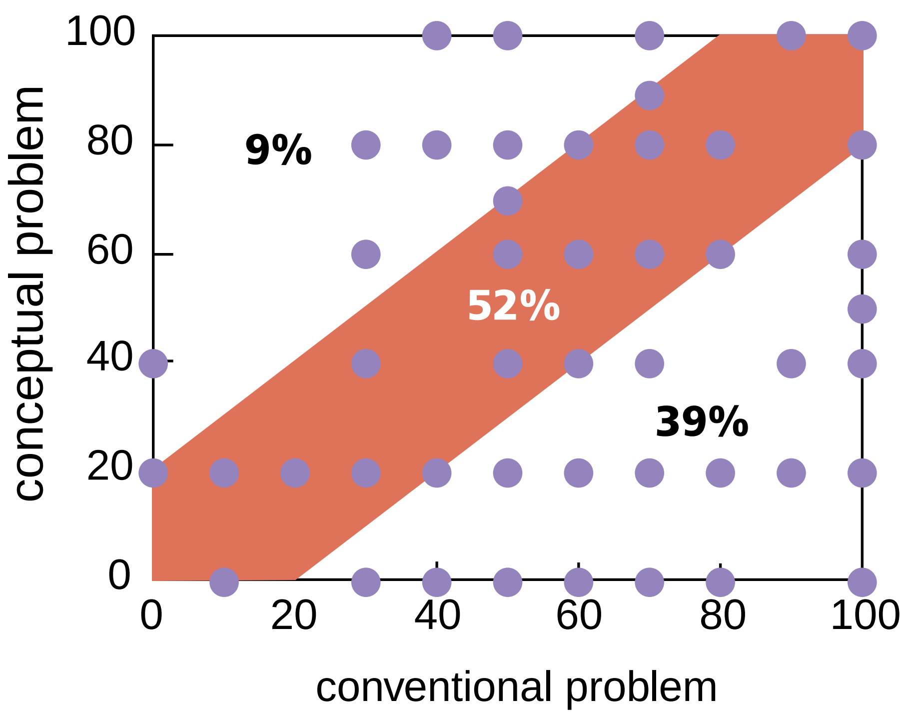


So what should we do?

Peer Instruction

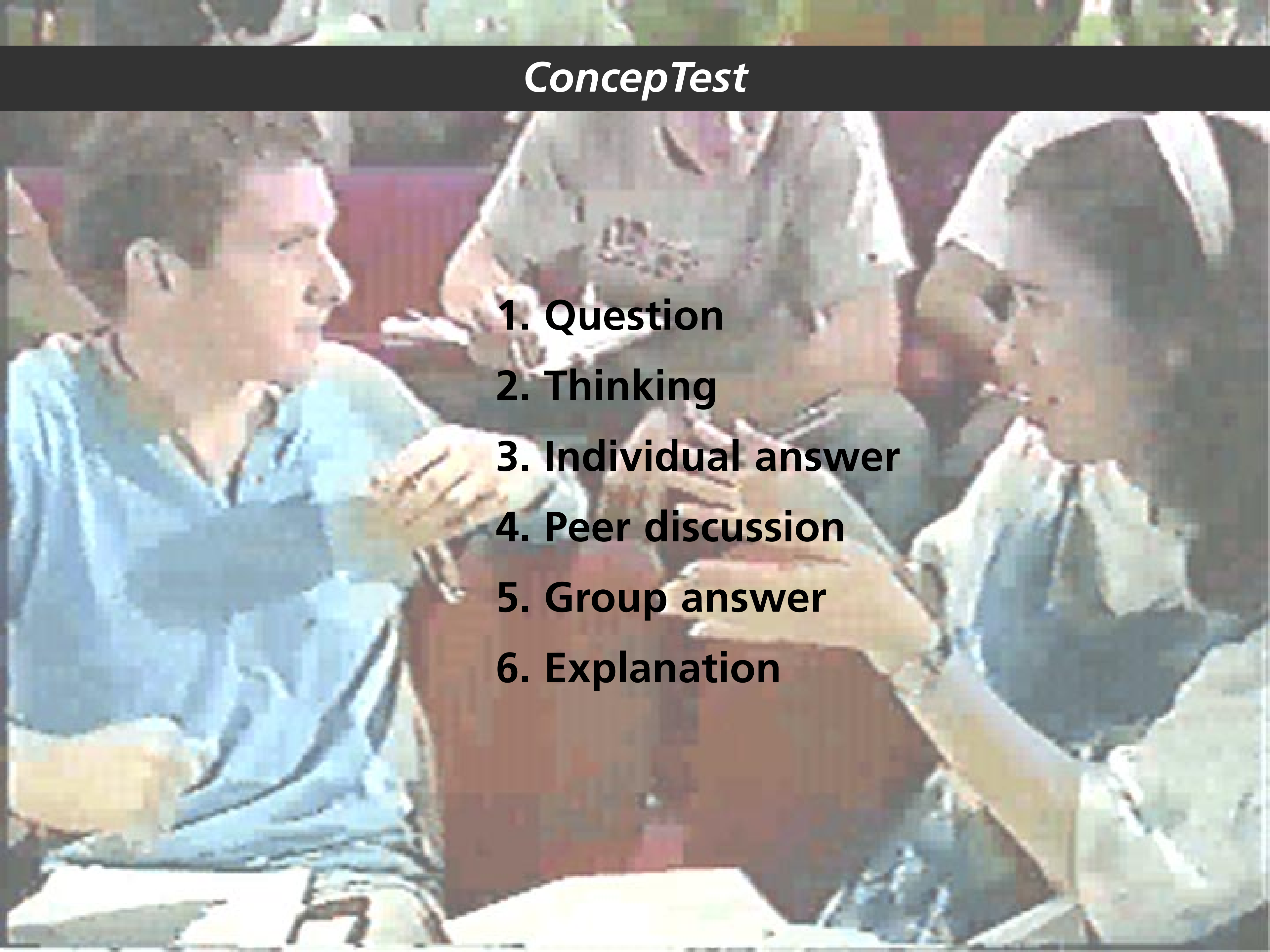
Help students take more responsibility for learning!

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

Is it any good?

Is it any good?

- **Results**

Results

Better understanding leads to better problem solving!

Results

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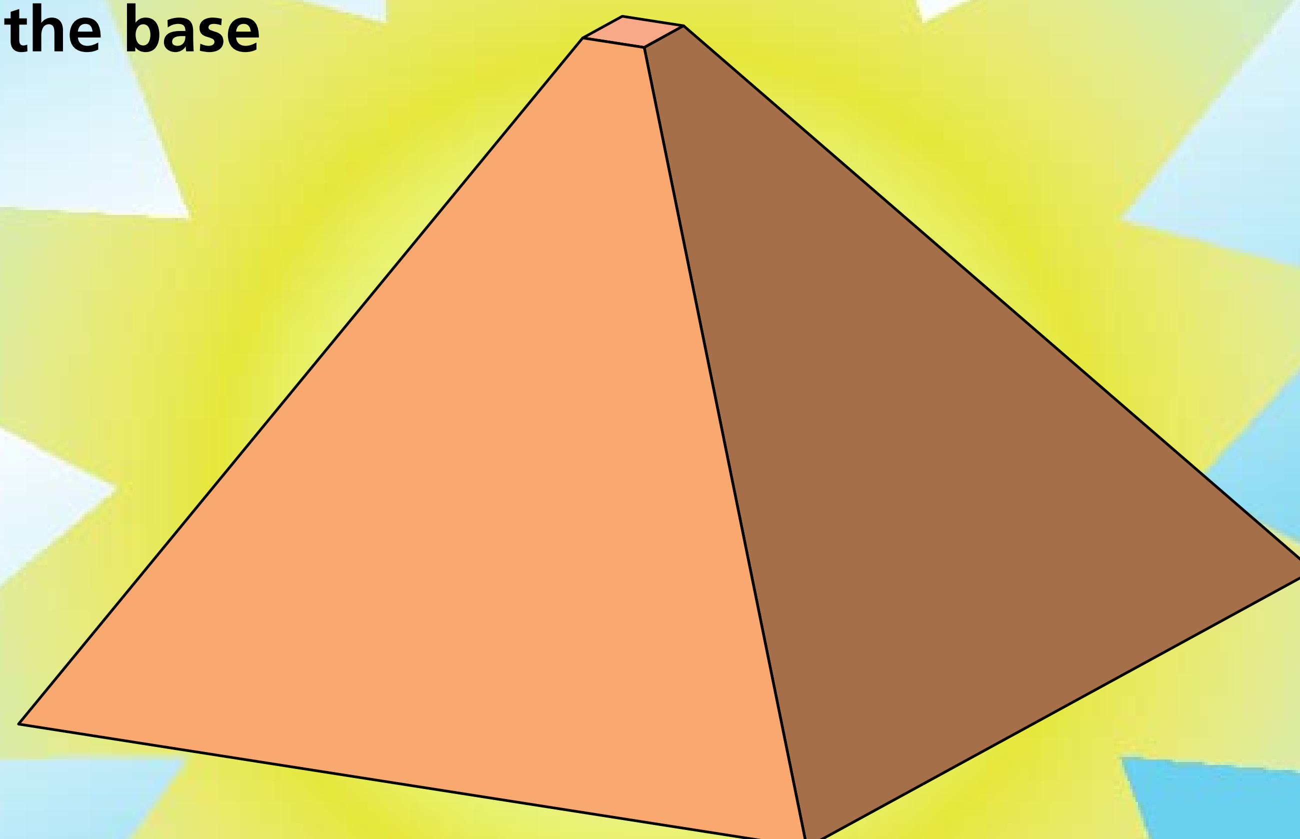
(but "good" problem solving doesn't always indicate understanding!)

Is it any good?

- Results
- Student Reactions

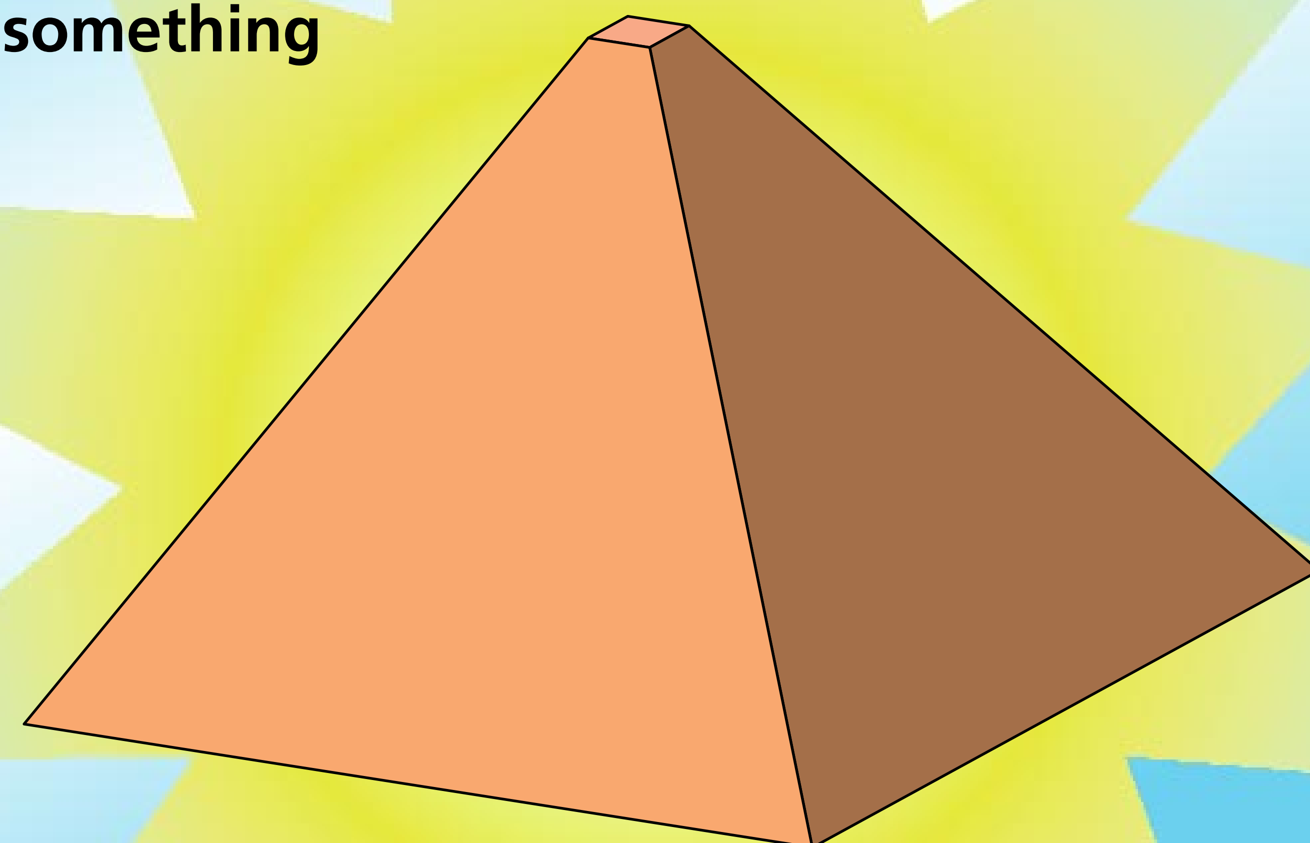
Conclusion

Let's not forget the base of the pyramid!



Conclusion

Let's give them something of value!

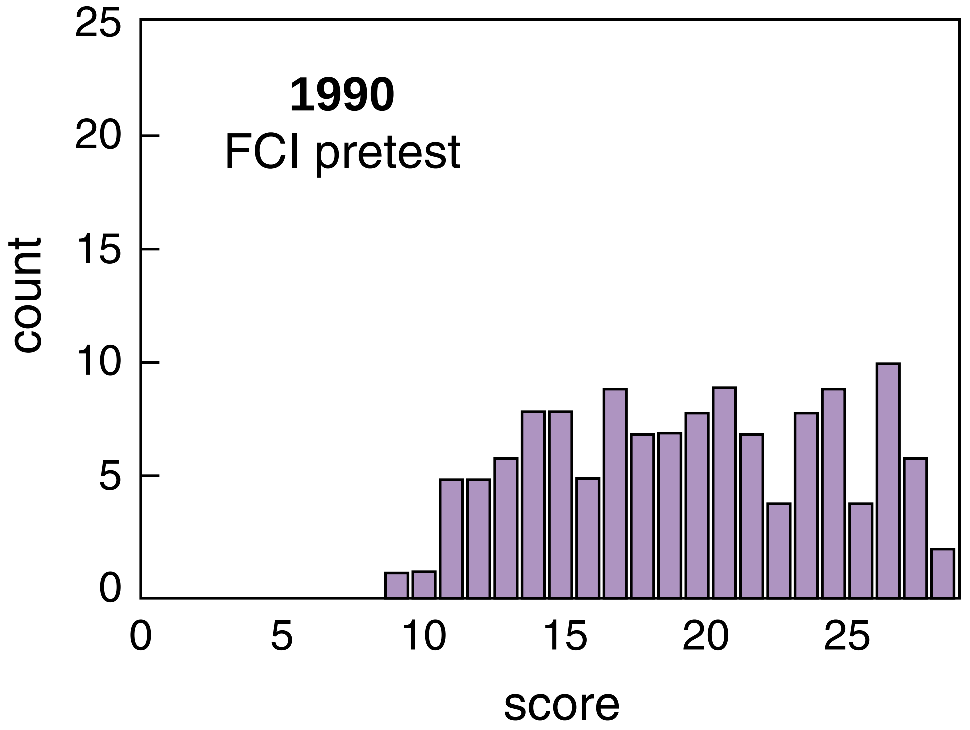


Outline

- 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)

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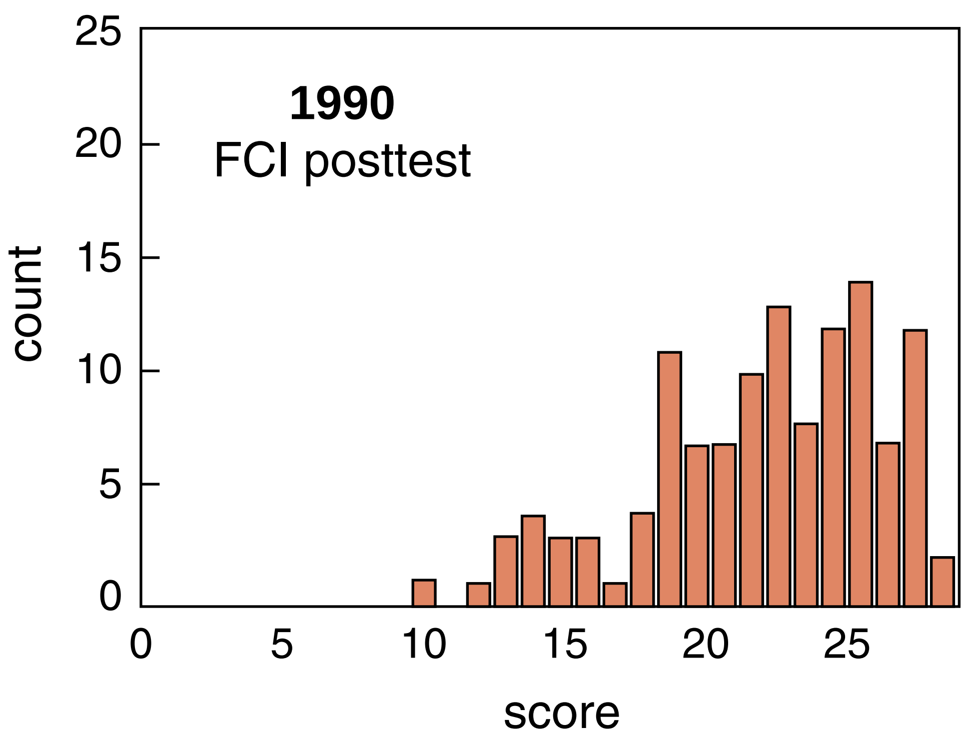

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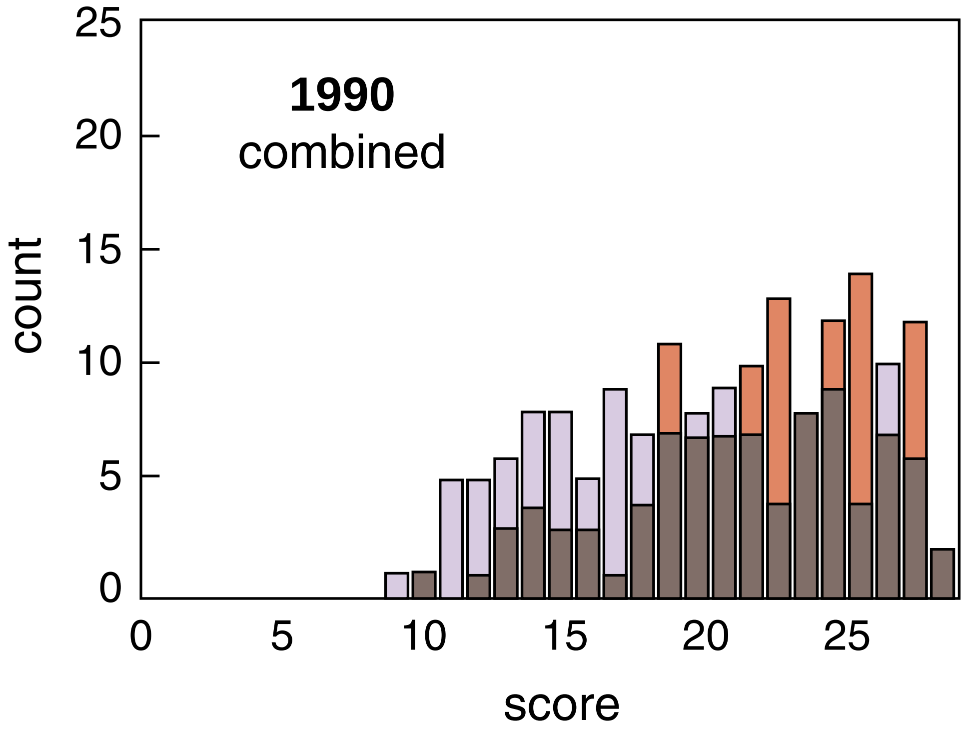

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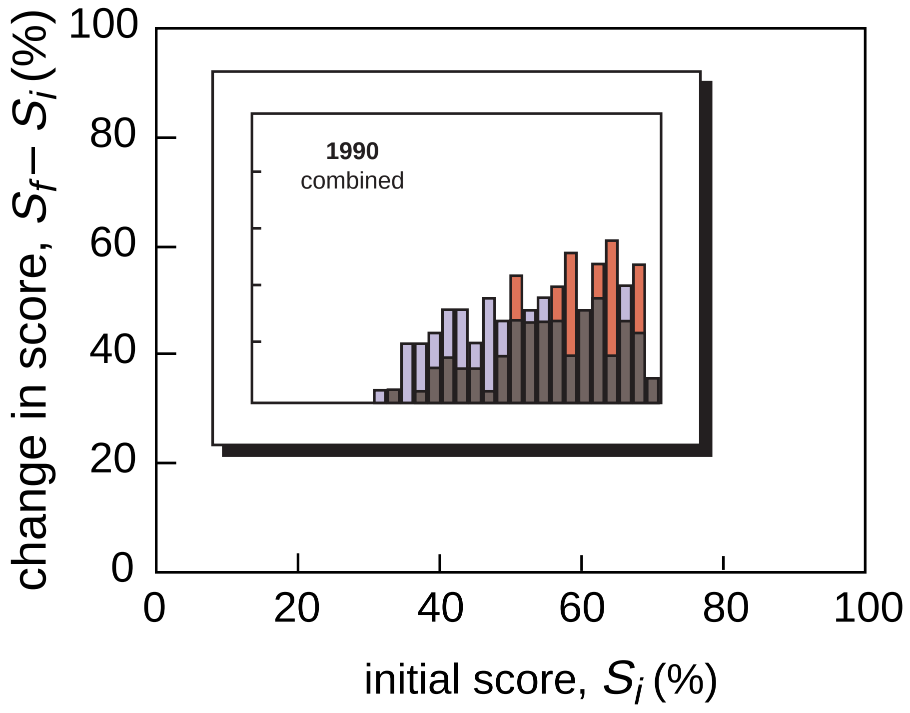

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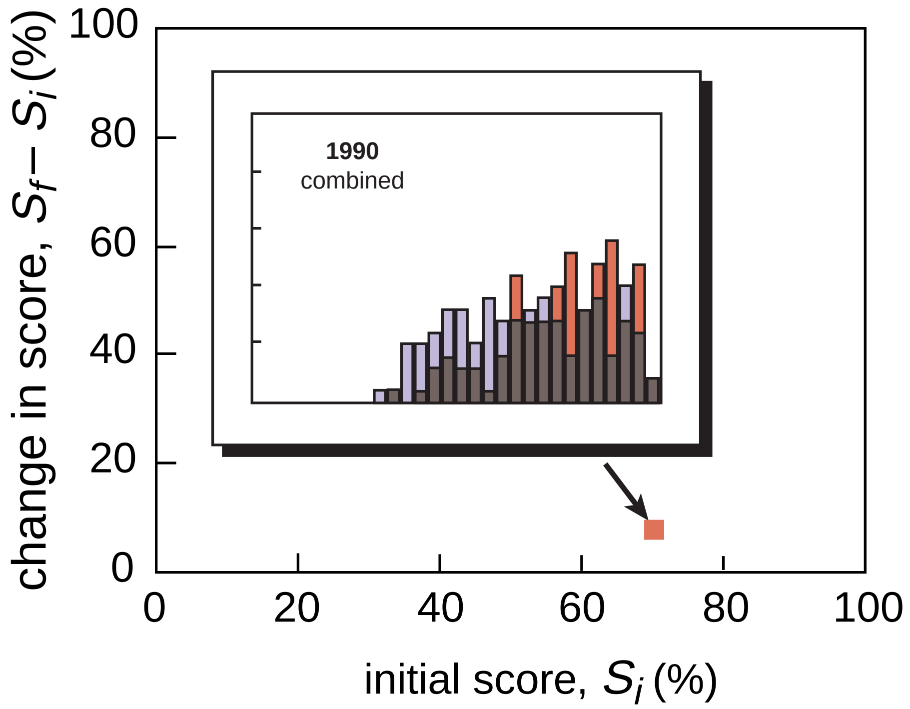

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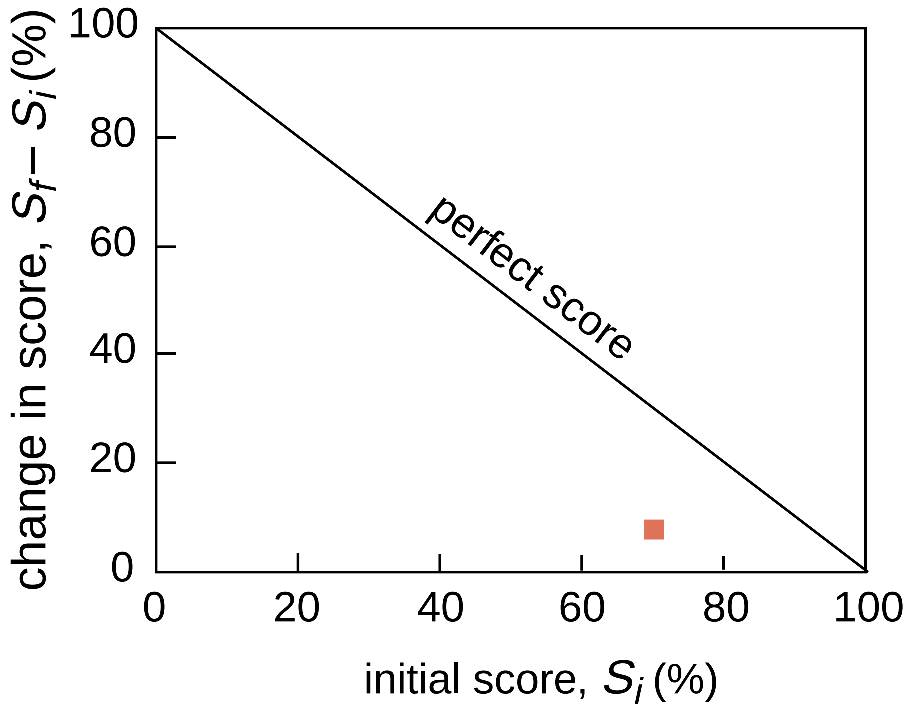

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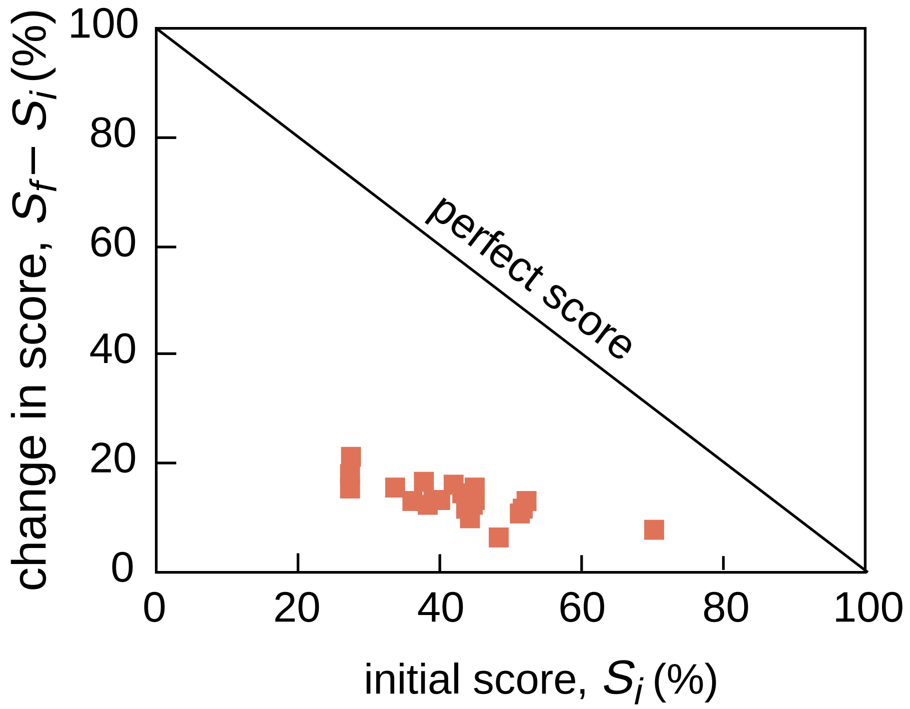

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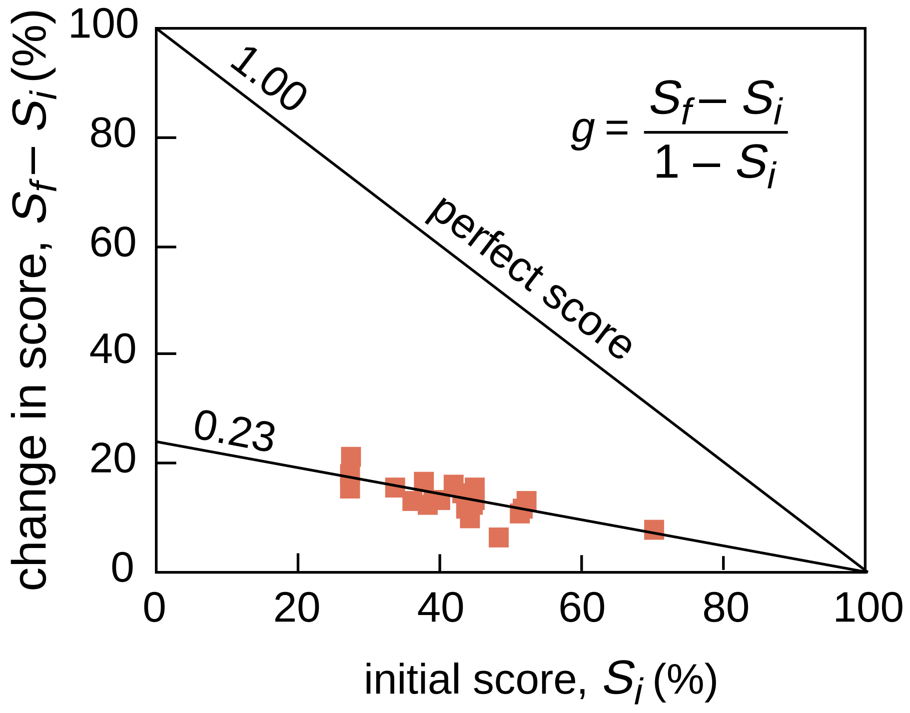
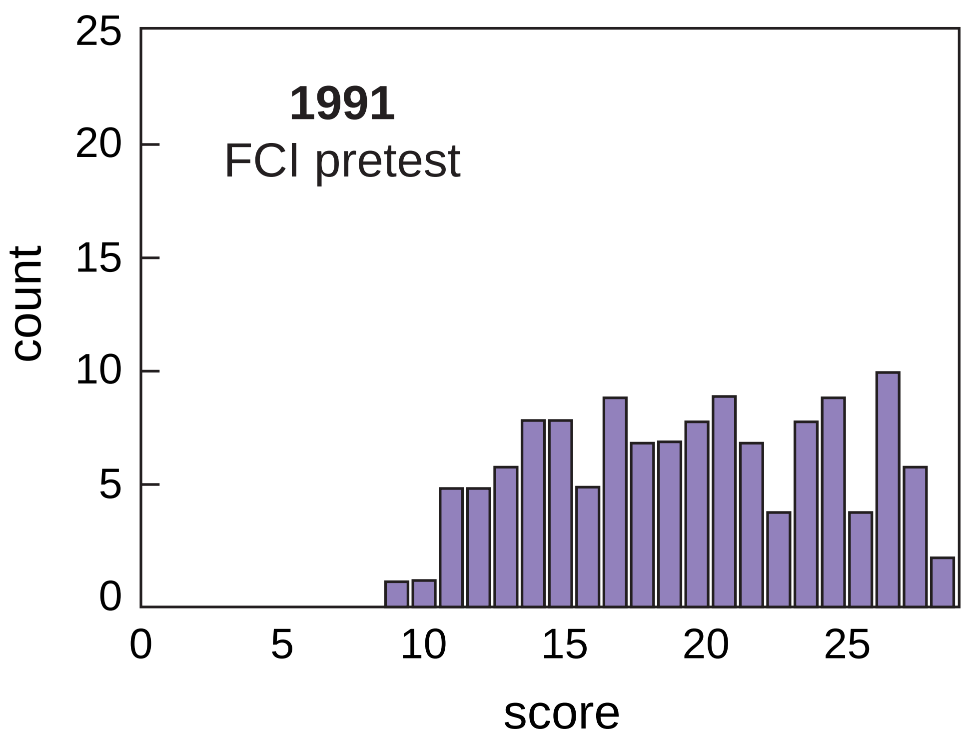


Results



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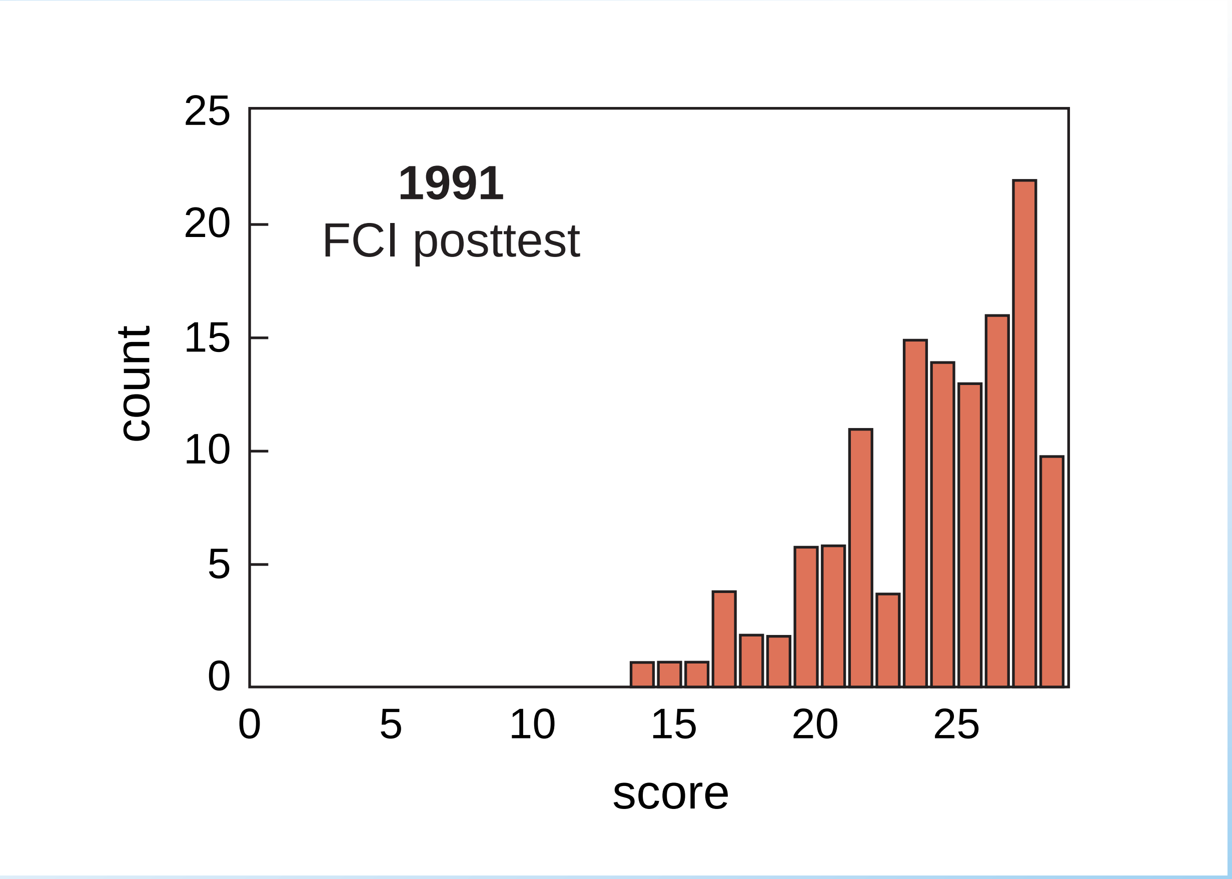

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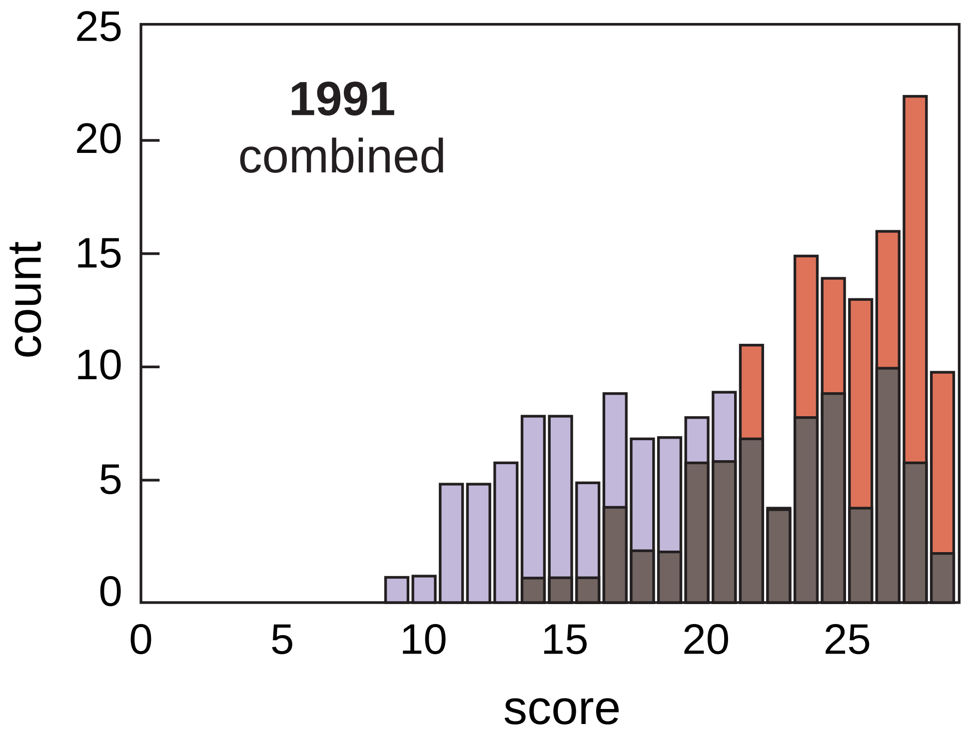

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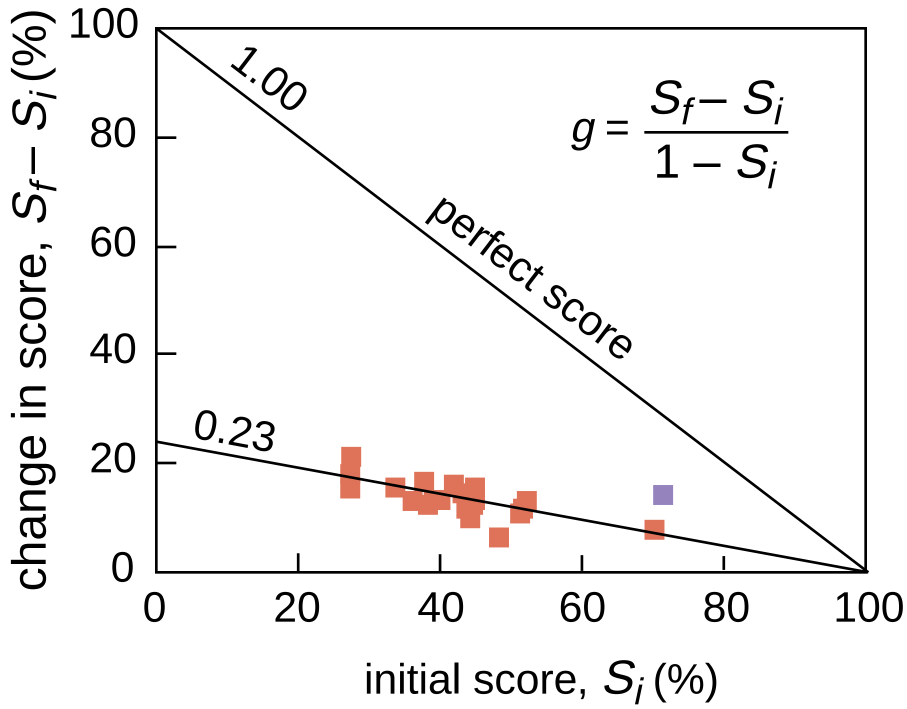
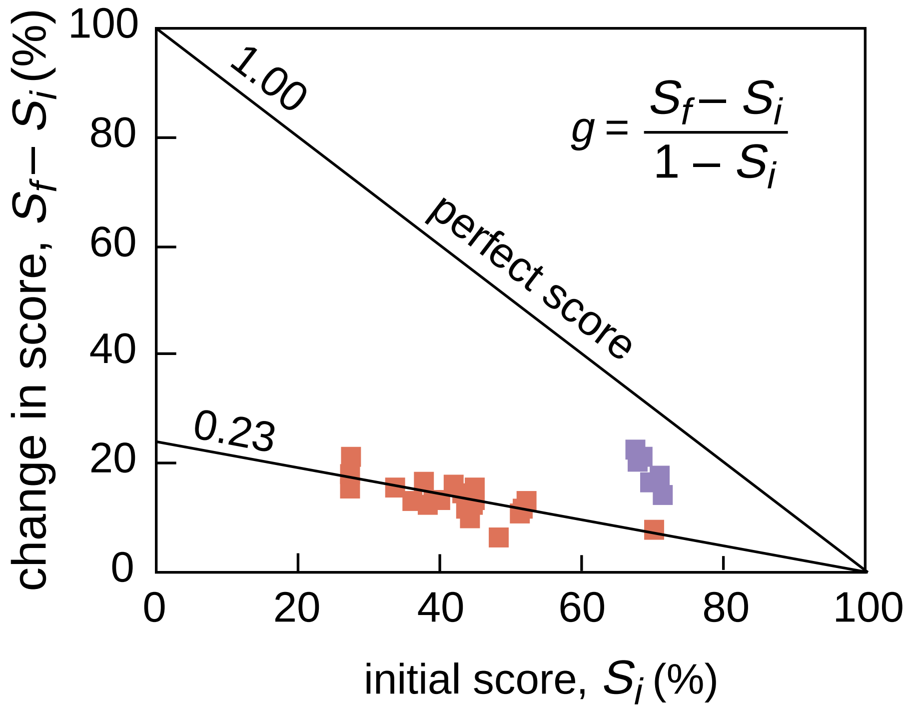


change in score, $S_f - S_i$ (%)
100
80
60
40
20
0
1.00
perfect score
0.23
$g = \frac{S_f - S_i}{1 - S_i}$
0
20
40
60
80
100
initial score, S_i (%)

Results



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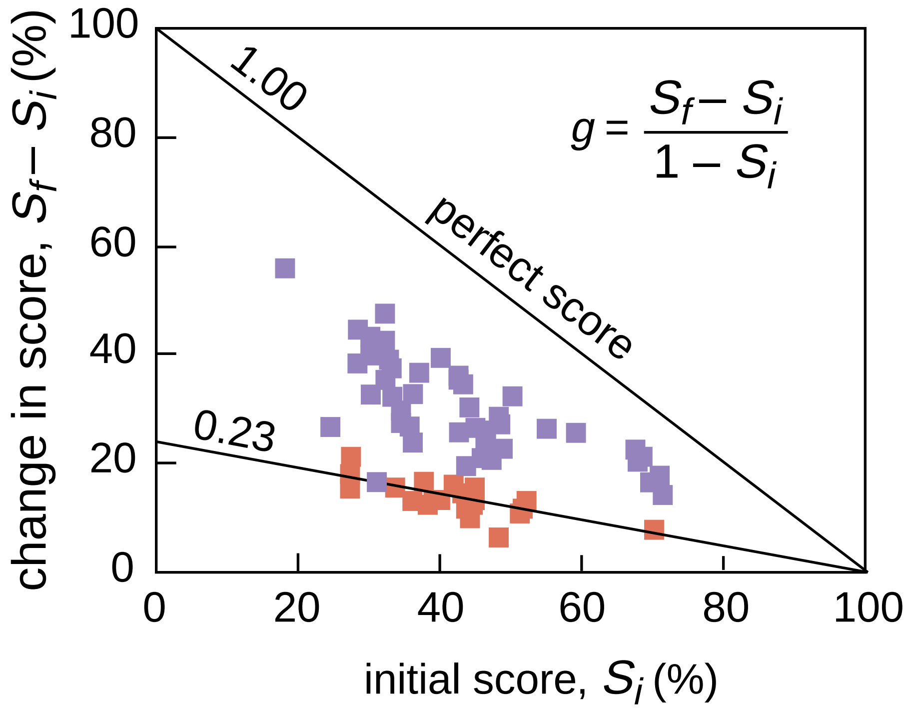

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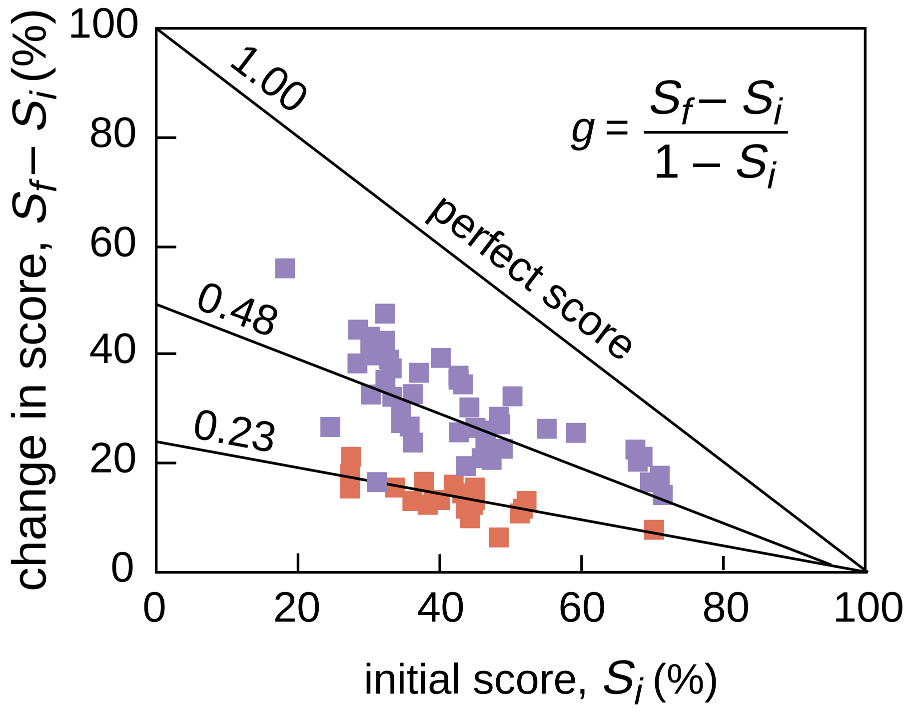
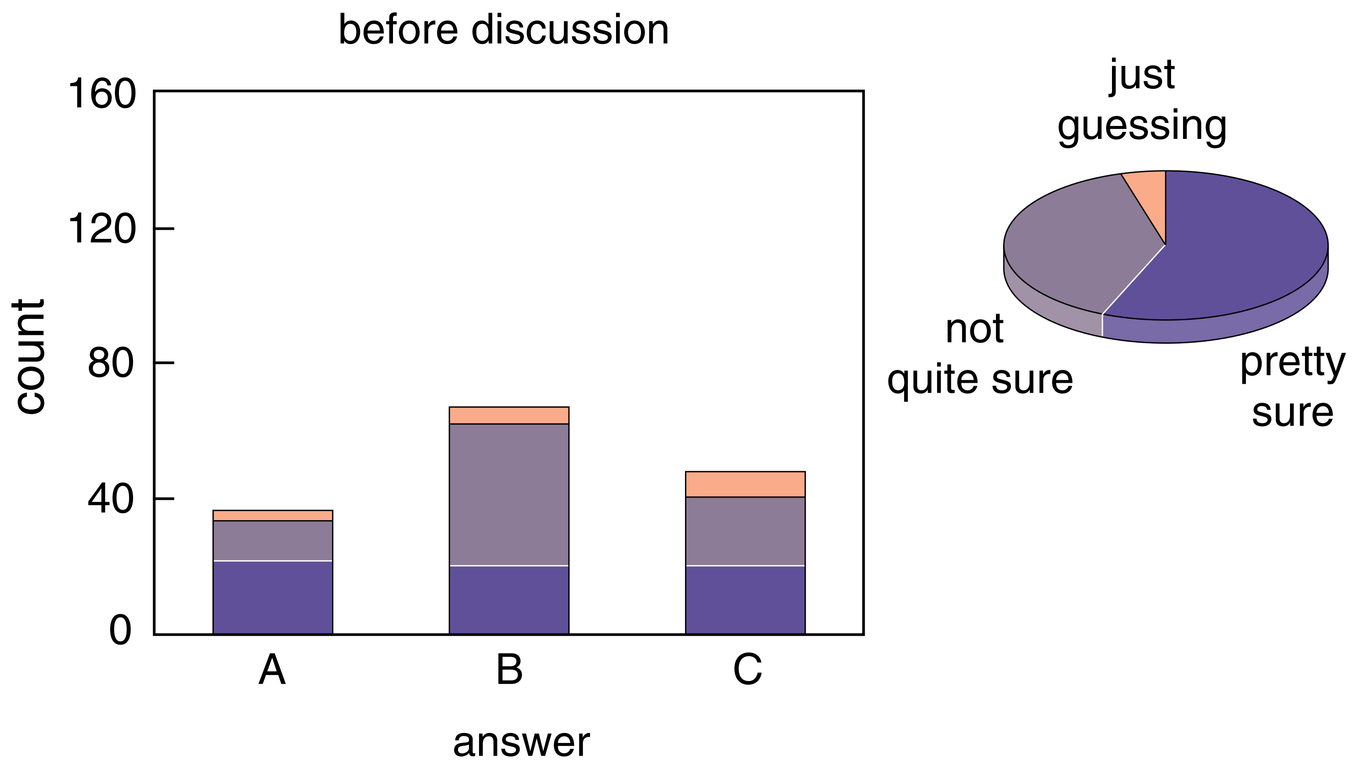
Results



g = (Sf − Si) / (1 − Si)
1.00
perfect score
0.48
0.23
change in score, Sf − Si (%)
initial score, Si (%)
0
20
40
60
80
100

ConcepTest data



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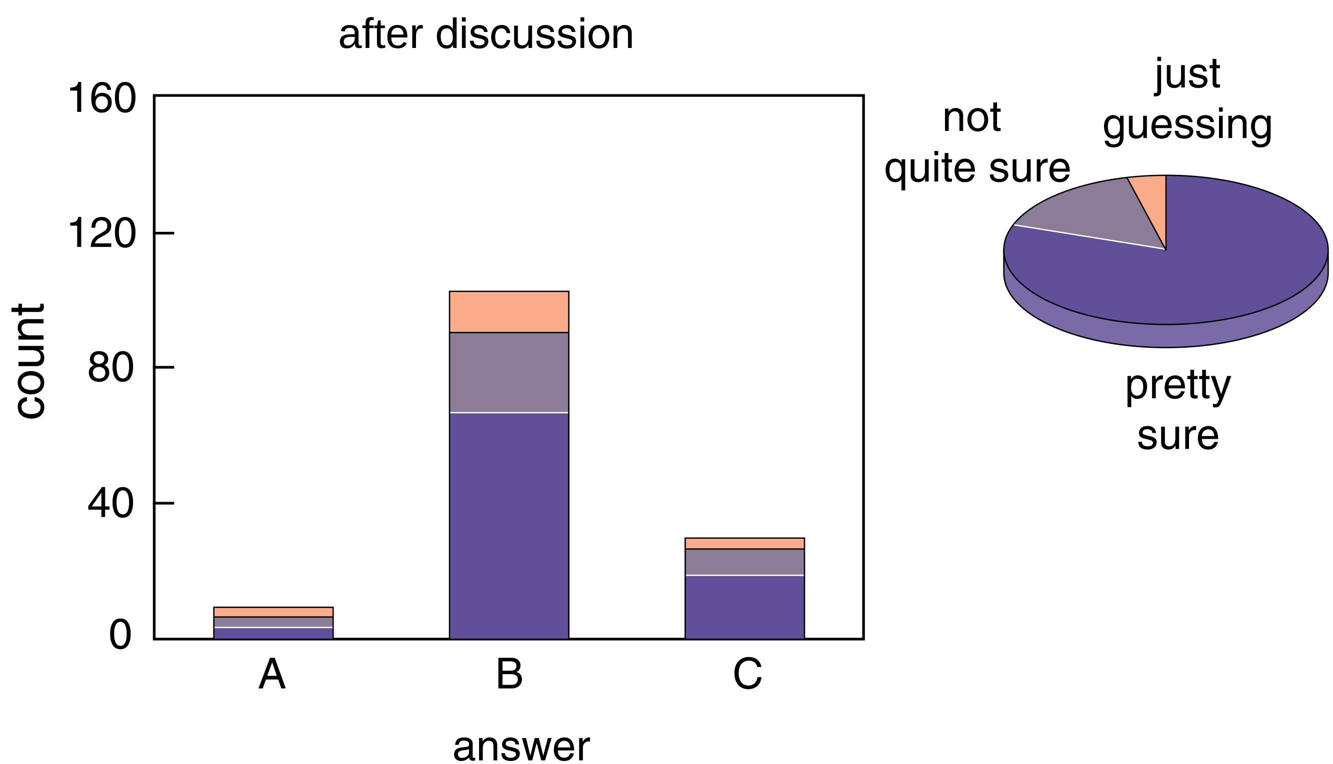

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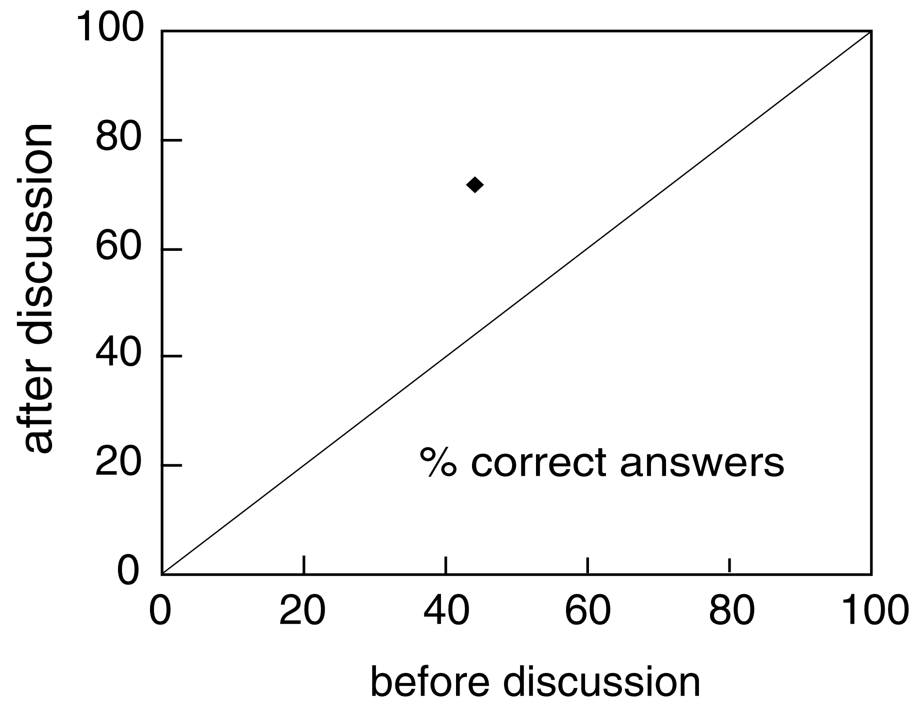

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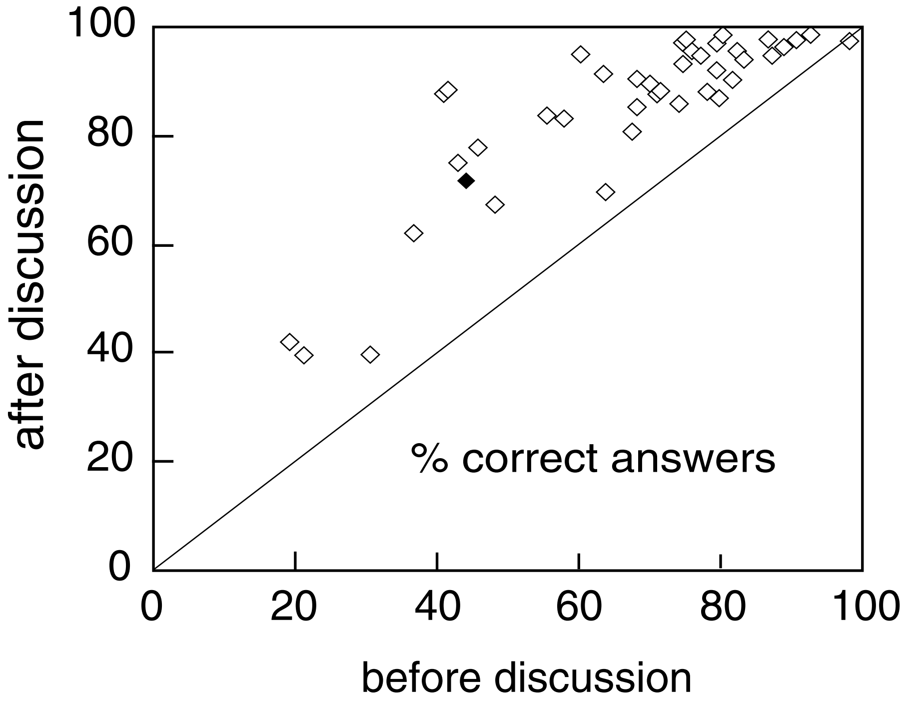

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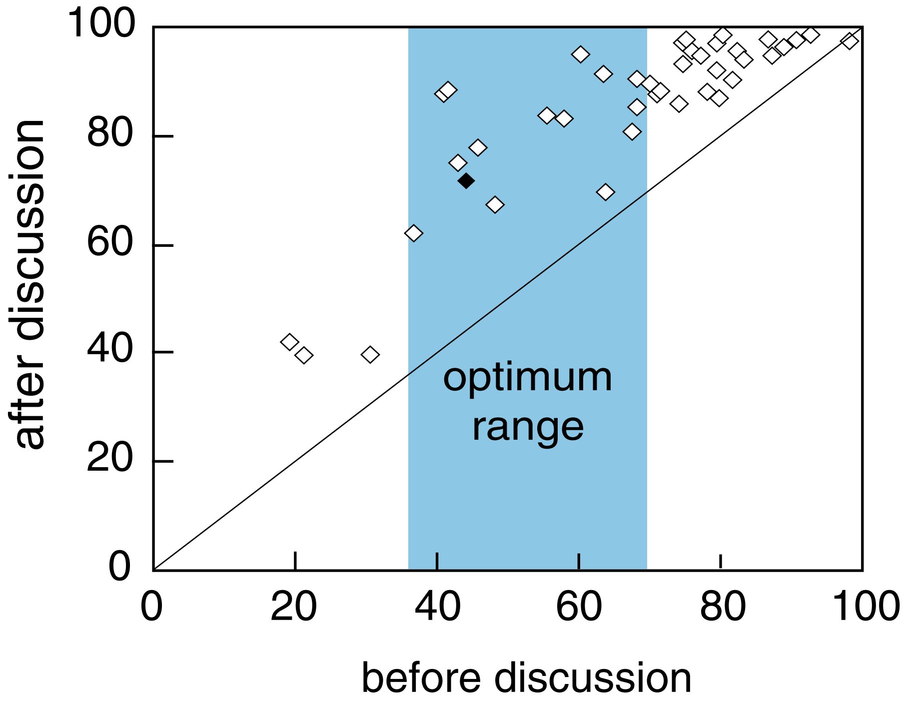
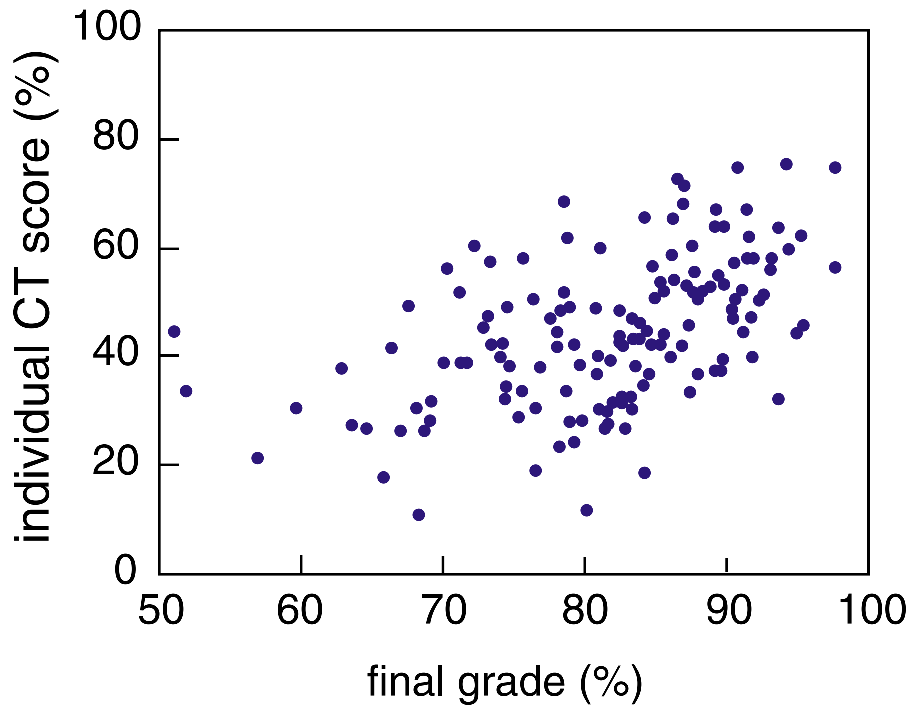


Who benefits?



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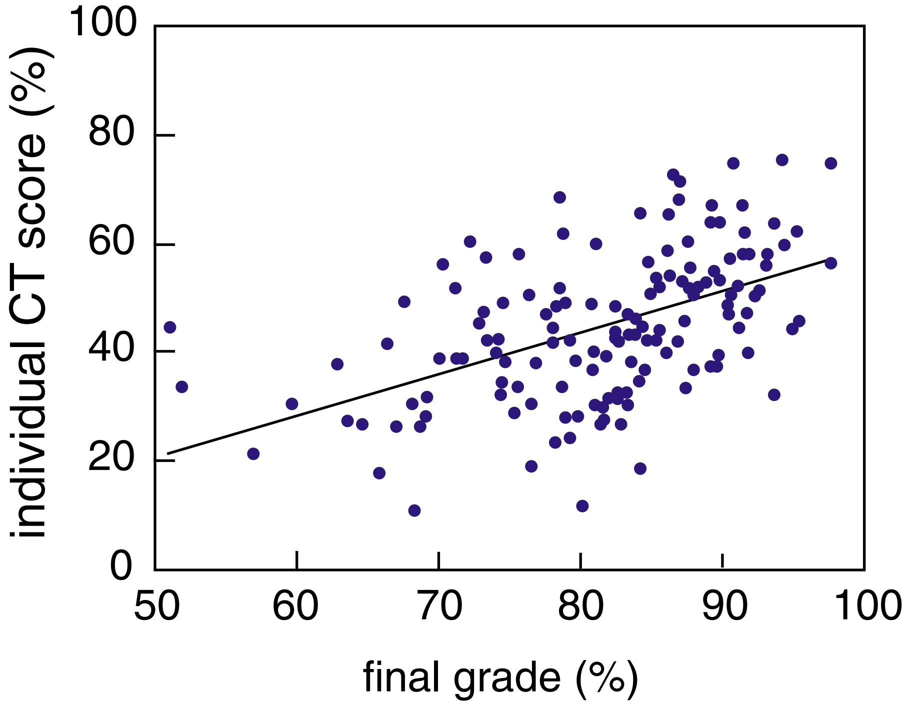
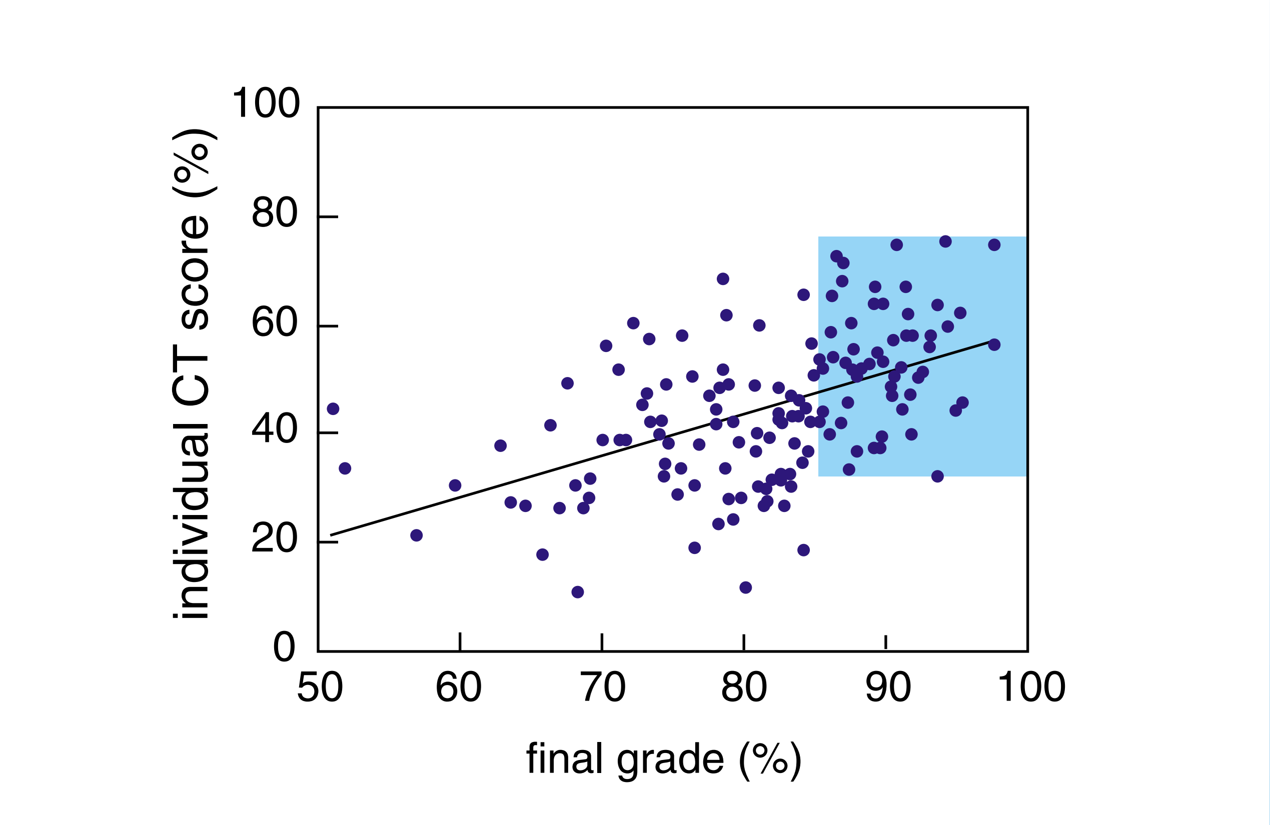


Who benefits?

even best students are challenged!



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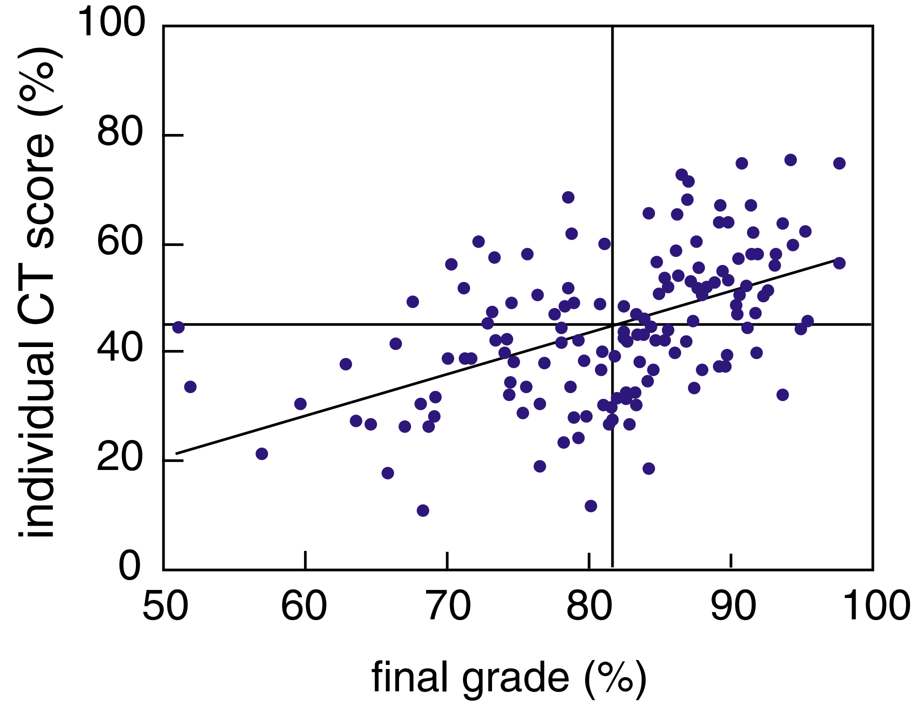
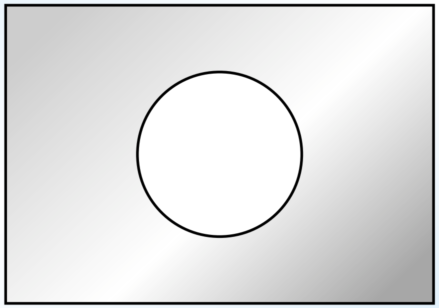


Question 1

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



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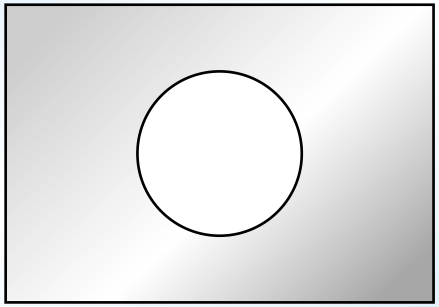

Consider a rectangular metal plate with a circular hole in it.

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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A boat carrying a large boulder is floating on 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

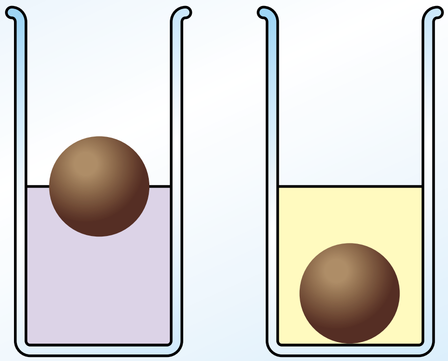
3. stay the same?

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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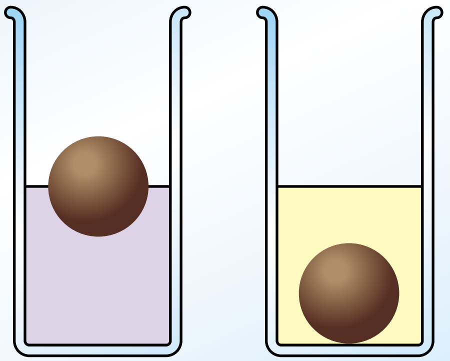
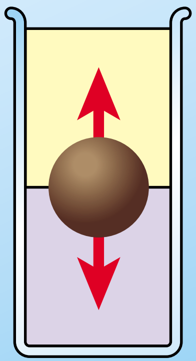


If we slowly pour oil on top of the water so it completely covers the object, the object

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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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

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

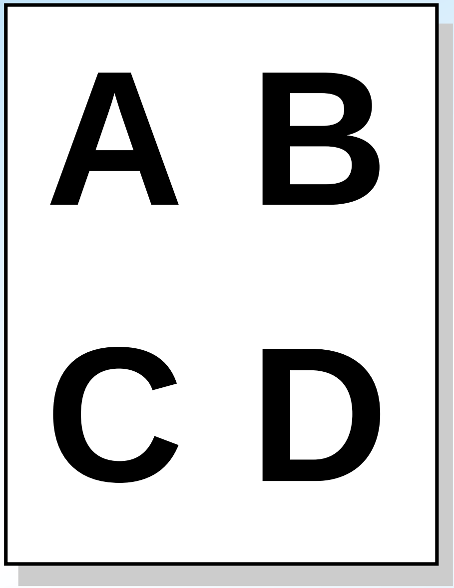
1. the mirror is oriented vertically,
2. we have two eyes in the horizontal plane,
3. the Earth's gravitation is directed downward,
4. a habit we have when looking at images in a mirror,
5. It only *appears* to run from left to right.

Message 4

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

Feedback

Flashcards: simple and effective!



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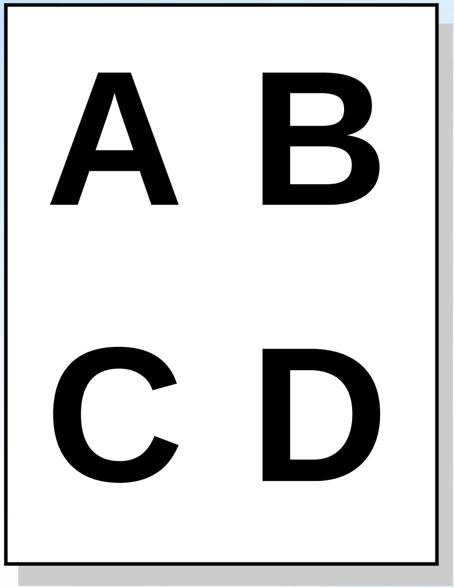

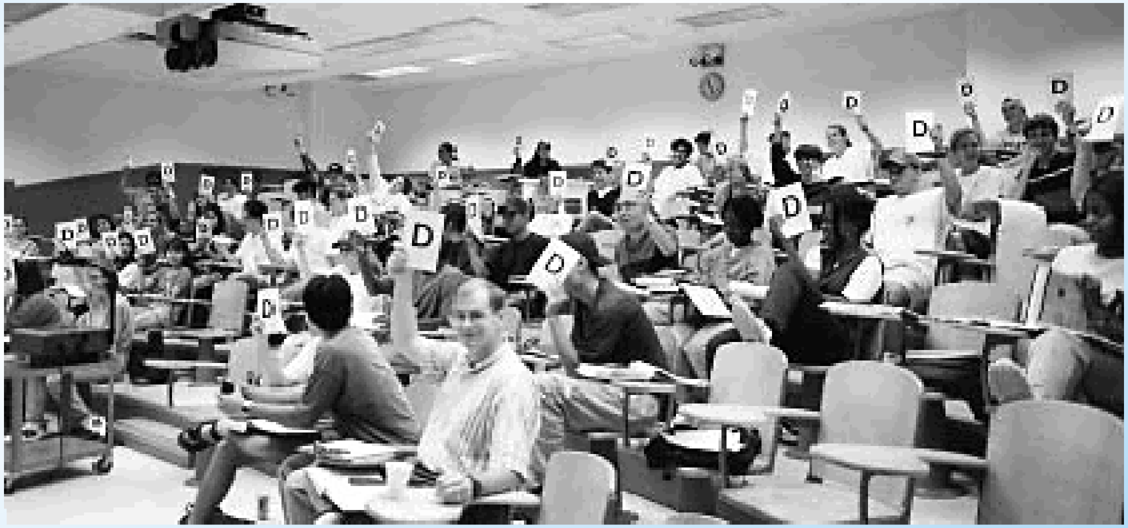

Problem with problems

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
Requires applying that model

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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. On average people shop for about 2 hours.

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Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?

Requires applying a (new) model

Problem with problems

On a Saturday afternoon, you pull into a parking lot with unmetered spaces near a shopping area where people are known to shop, on average, for two hours. 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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How long do you have to wait before someone frees up a space?

$$t_{wait} = \frac{T_{shop}}{N_{spaces}}$$

Problem with problems

On a Saturday afternoon, you pull into a parking lot with unmetered spaces near a shopping area where people are known to shop, on average, for two hours. 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.

How long do you have to wait before someone frees up a space?

Requires using a calculator

$$t_{wait} = \frac{T_{shop}}{N_{spaces}}$$

Essential elements

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

Coverage

	traditional
coverage	encyclopedic
retention	disappointing

Coverage

	traditional	interactive
coverage	encyclopedic	less?
retention	disappointing	more!

Coverage

	traditional	interactive
coverage	encyclopedic	less?
retention	disappointing	more!

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

Viki Weisskopf

Reading

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

Reading

- **Web-based assignment due before class**
- **Three questions (content and feedback)**

Reading

- **Web-based assignment due before class**
- **Three questions (content and feedback)**
- **Graded on effort**

Reading

- **Web-based assignment due before class**
- **Three questions (content and feedback)**
- **Graded on effort**
- **5% of final grade**

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

Conclusion

Challenges:

- internal skepticism
- growing pains
- limited circle of influence

Conclusion

Rewards:

- engagement
- improved understanding
- class is fun!

Funding

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