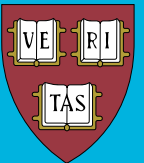


EDUCATION OR MEMORIZATION: ARE WE TEACHING THE RIGHT THING?

**Eric Mazur
Harvard University**

**Université de Lausanne
Lausanne, Switzerland, 23 June 2003**



Outline

▶ **Problem**

Outline

▶ **Problem**

▶ **Cause**

Outline

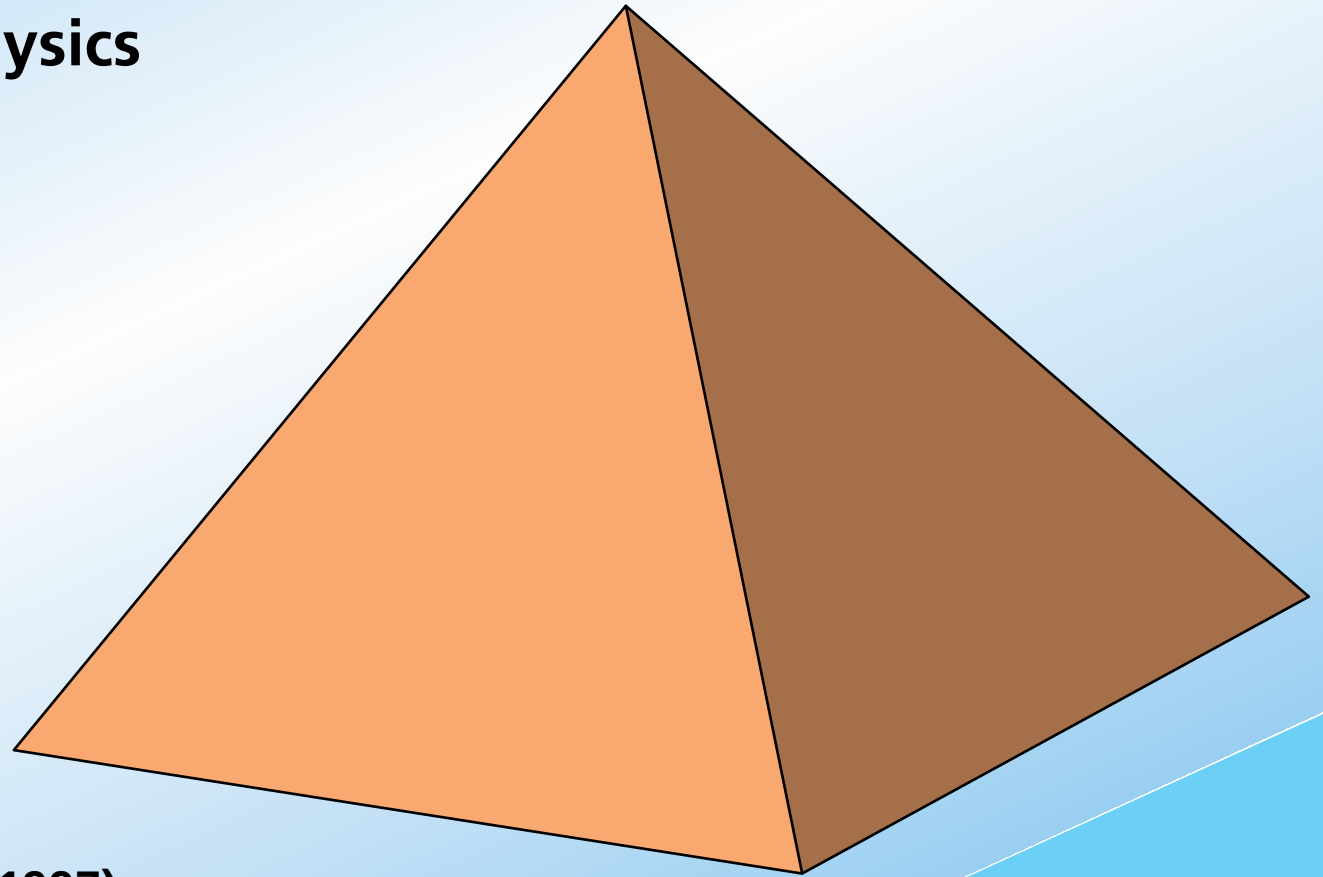
▶ **Problem**

▶ **Cause**

▶ **Remedy**

We have a problem

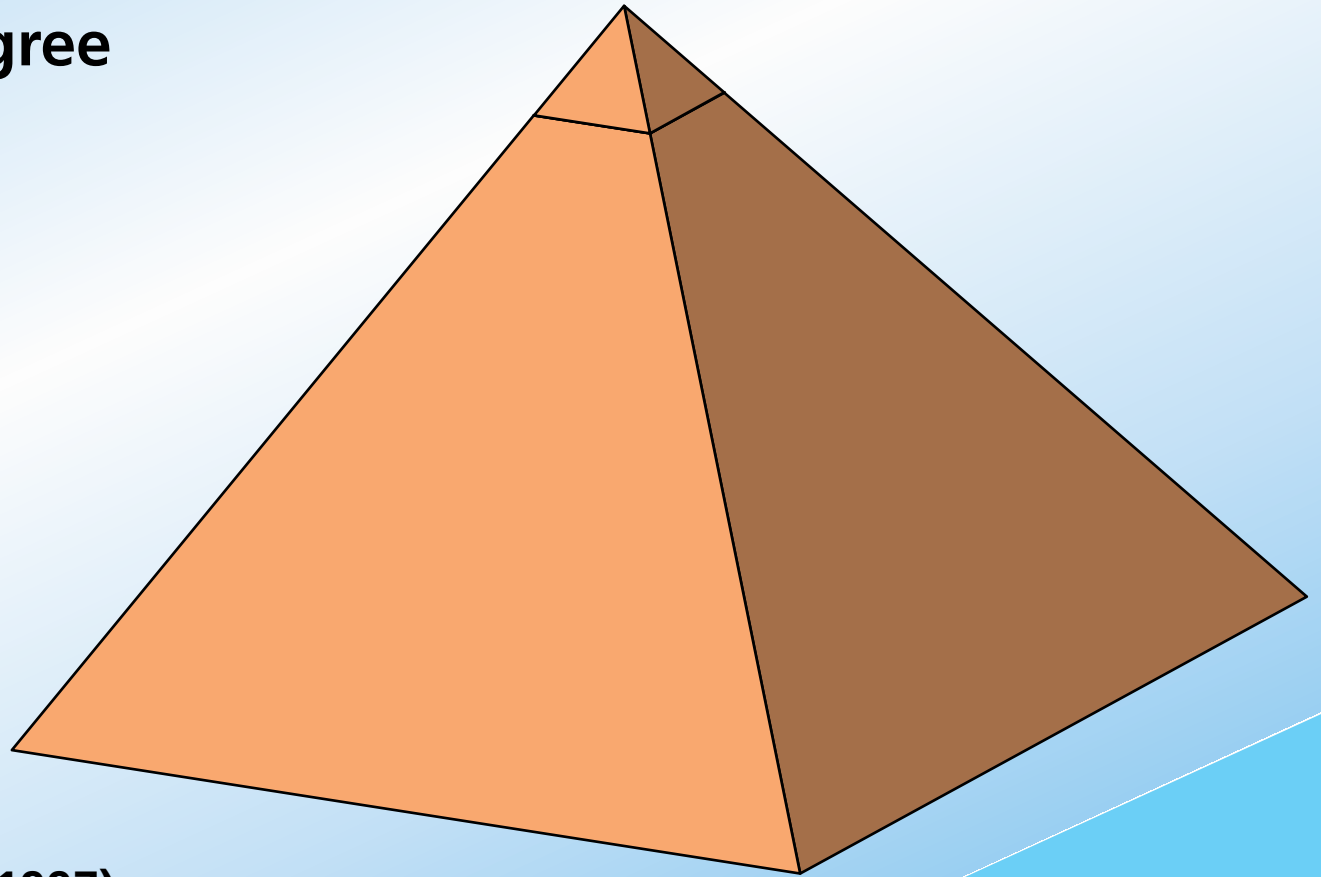
**380,000 students take
introductory physics
each year...**



AIP Report R-151.33 (1997)

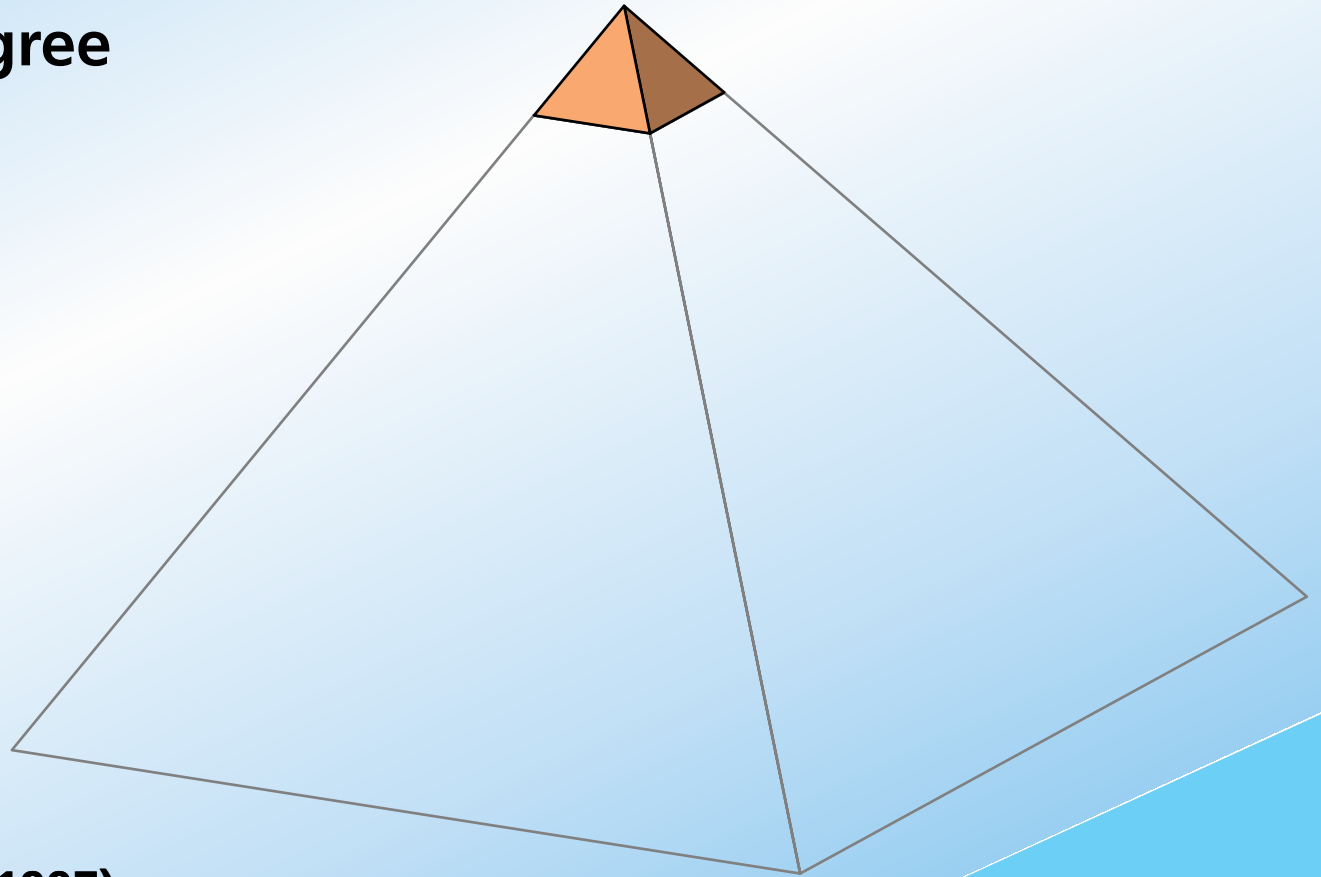
We have a problem

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



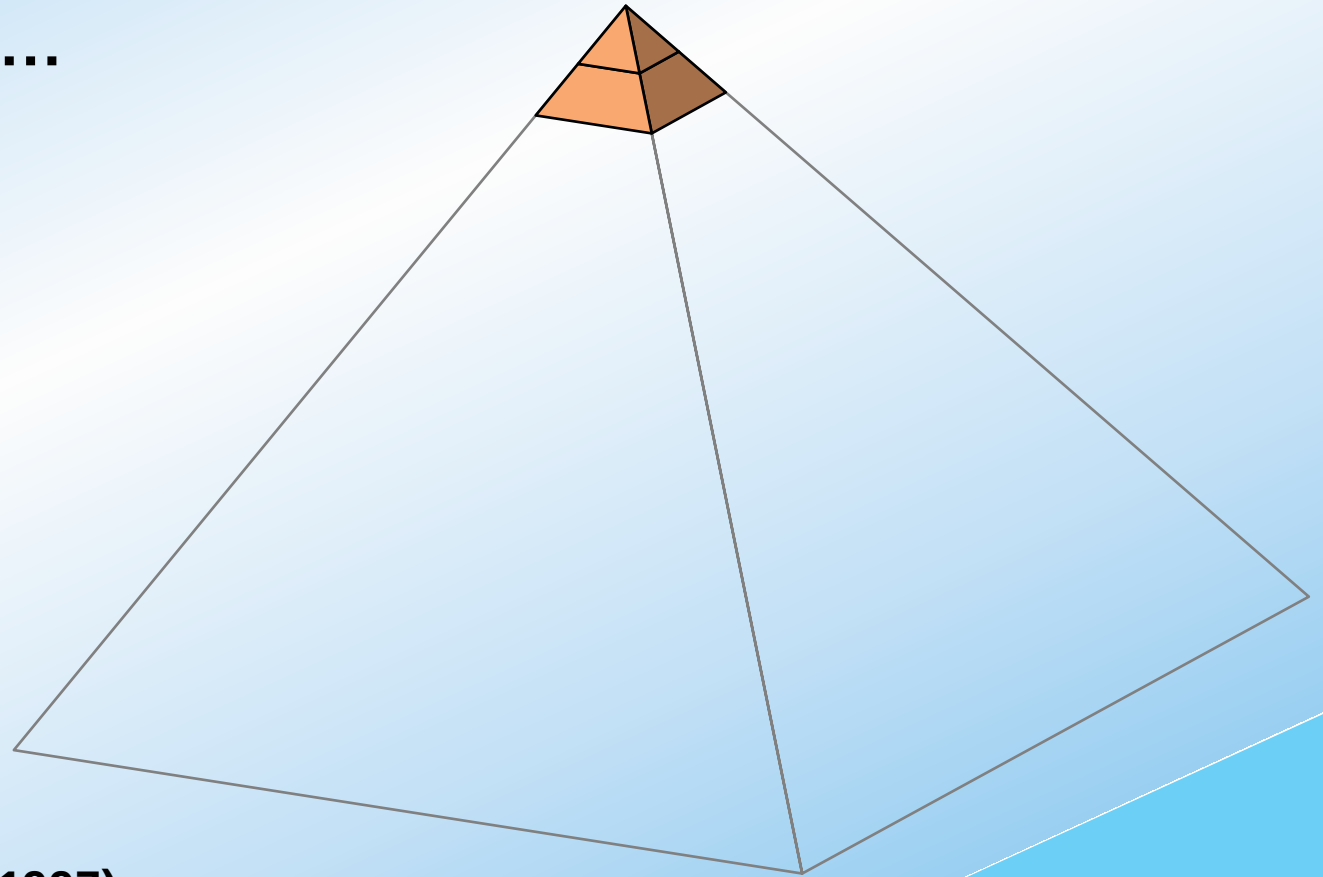
We have a problem

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



We have a problem

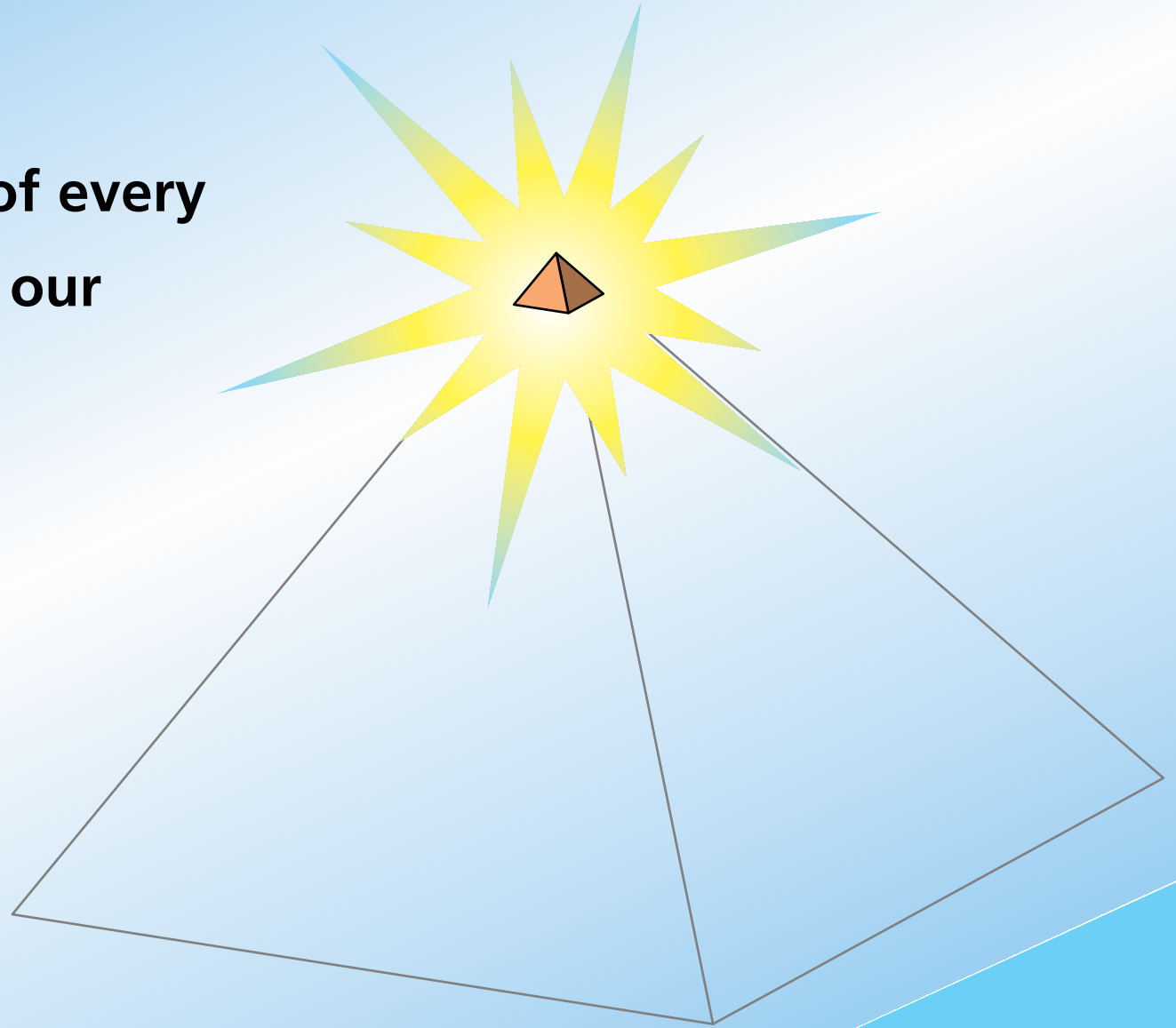
**about 35% go on to get a
Ph.D. in physics...**



AIP Report R-151.33 (1997)

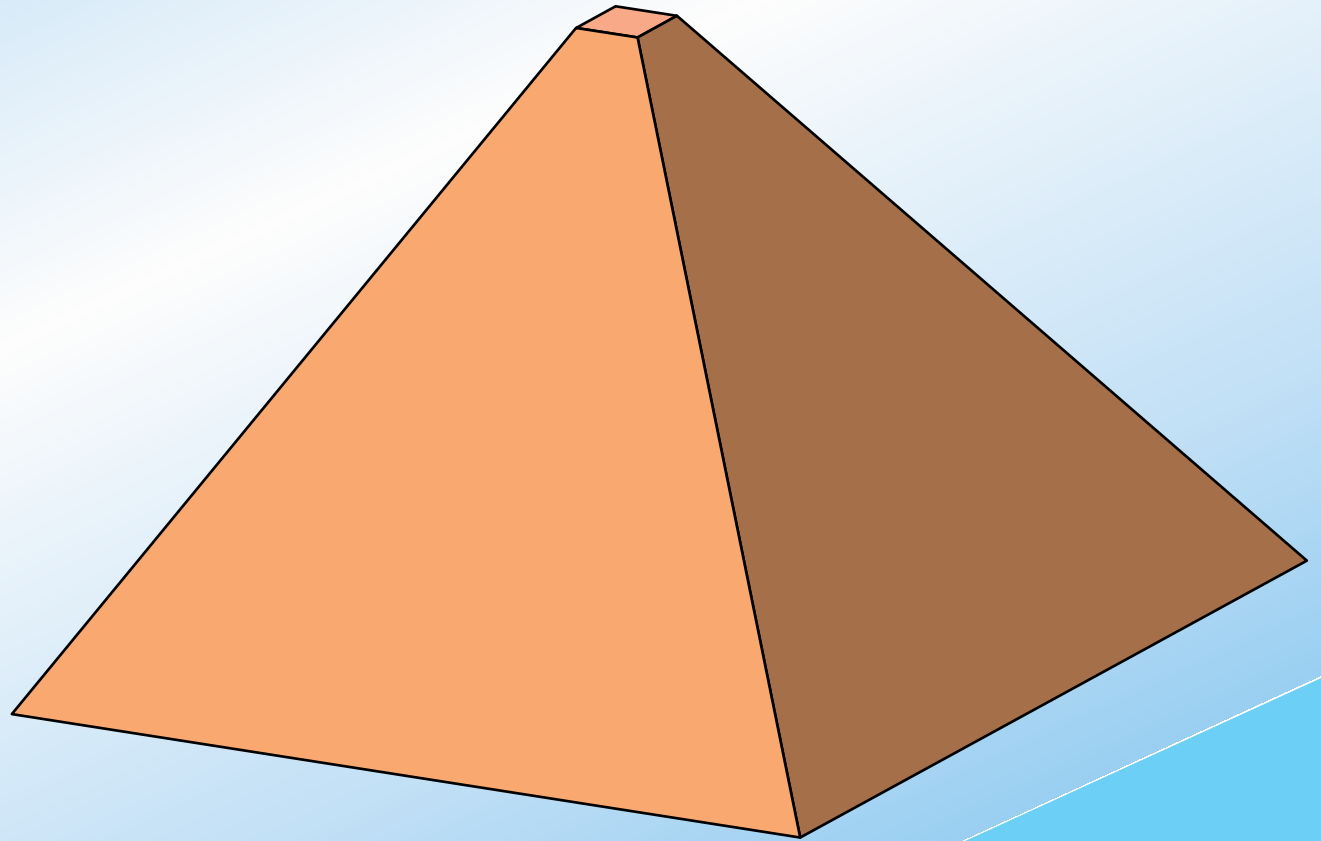
We have a problem

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



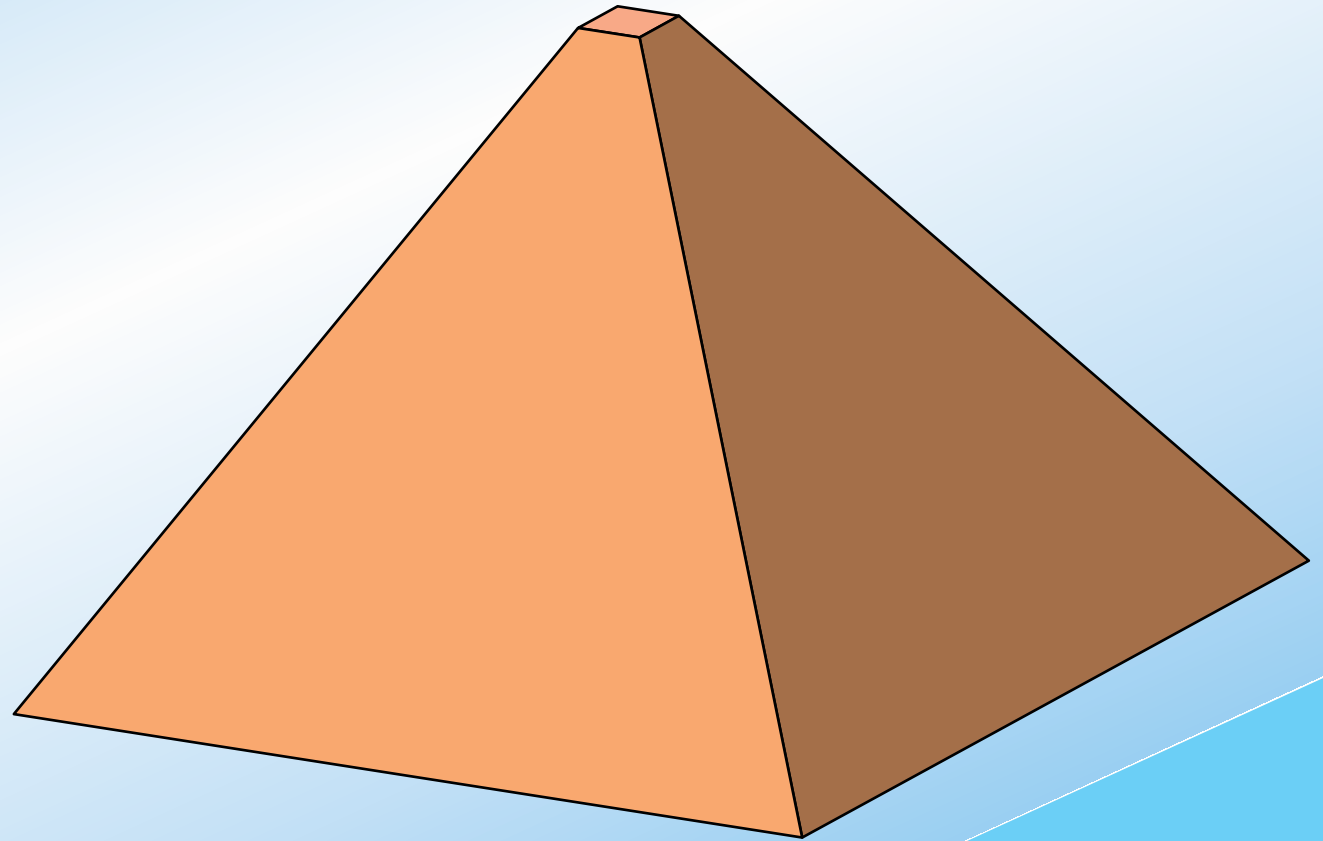
We have a problem

**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?*"



A close-up photograph of a diverse group of young people, likely students, smiling and looking towards the left. The image has a warm, slightly desaturated color palette. The text "Why do we have this problem?" is overlaid in the lower center of the image.

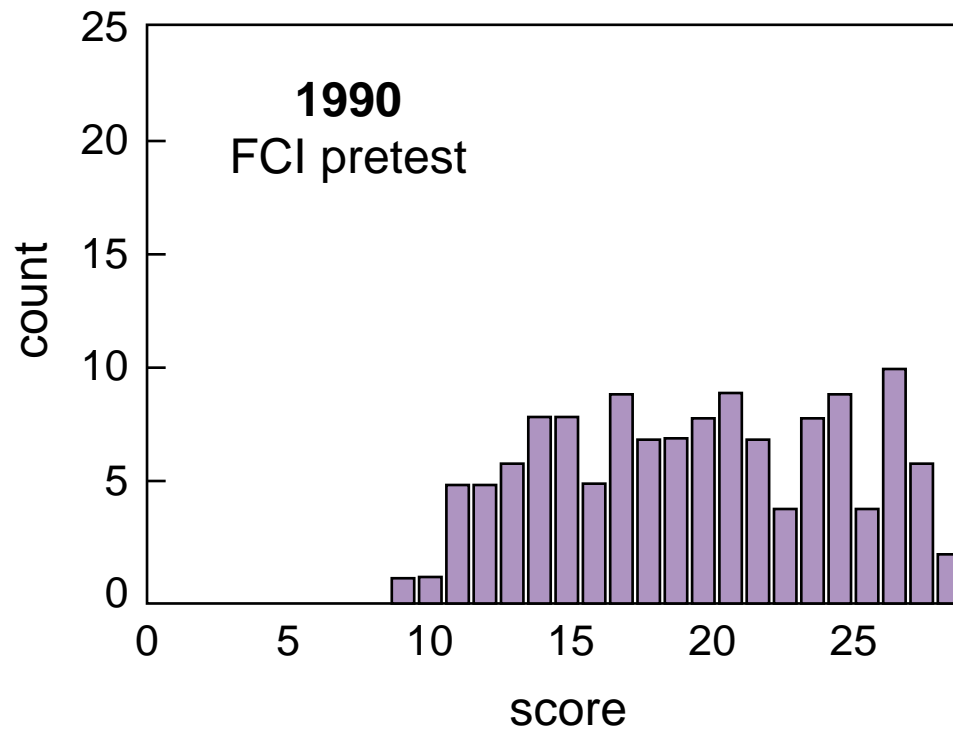
Why do we have this problem?

Why do we have this problem?

Lectures focus on transfer of information...

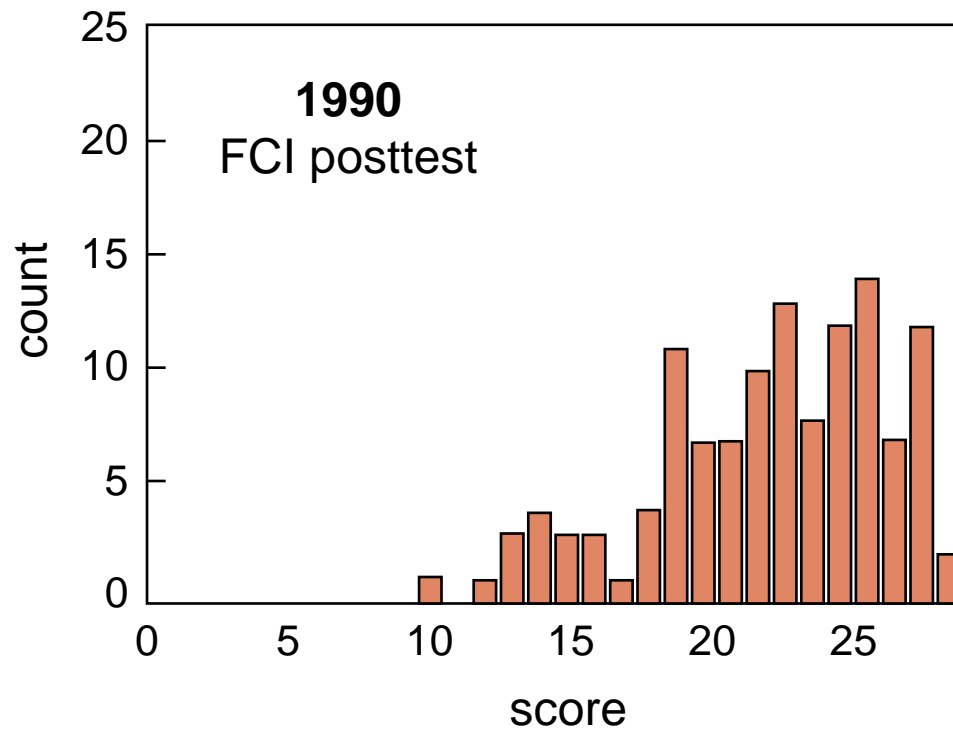
Why do we have this problem?

Lectures focus on transfer of information...



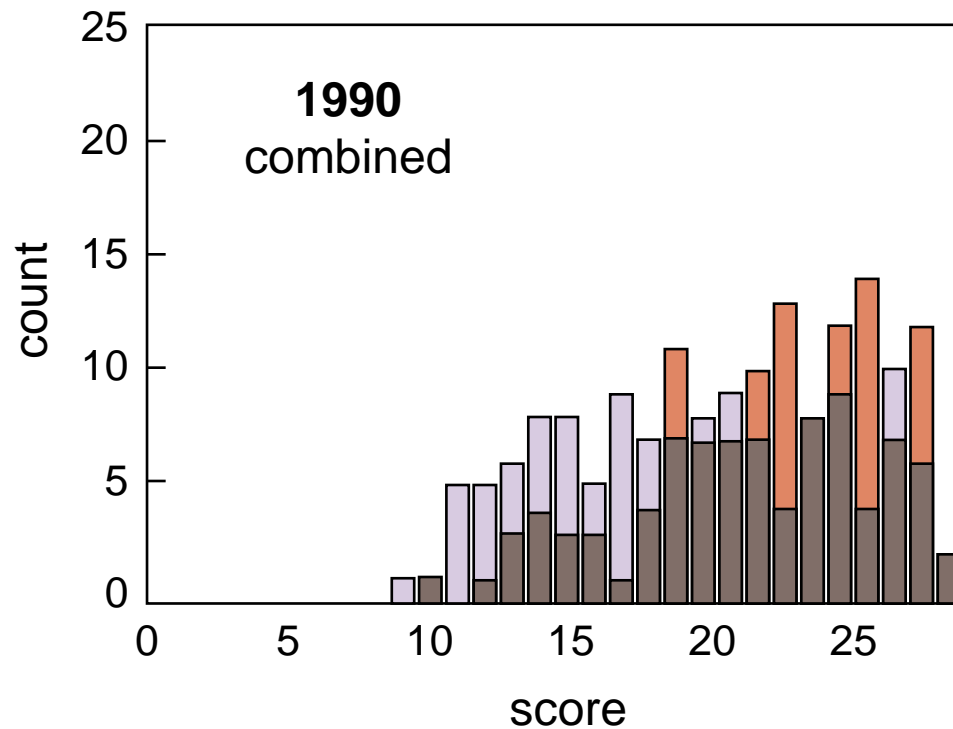
Why do we have this problem?

Lectures focus on transfer of information...

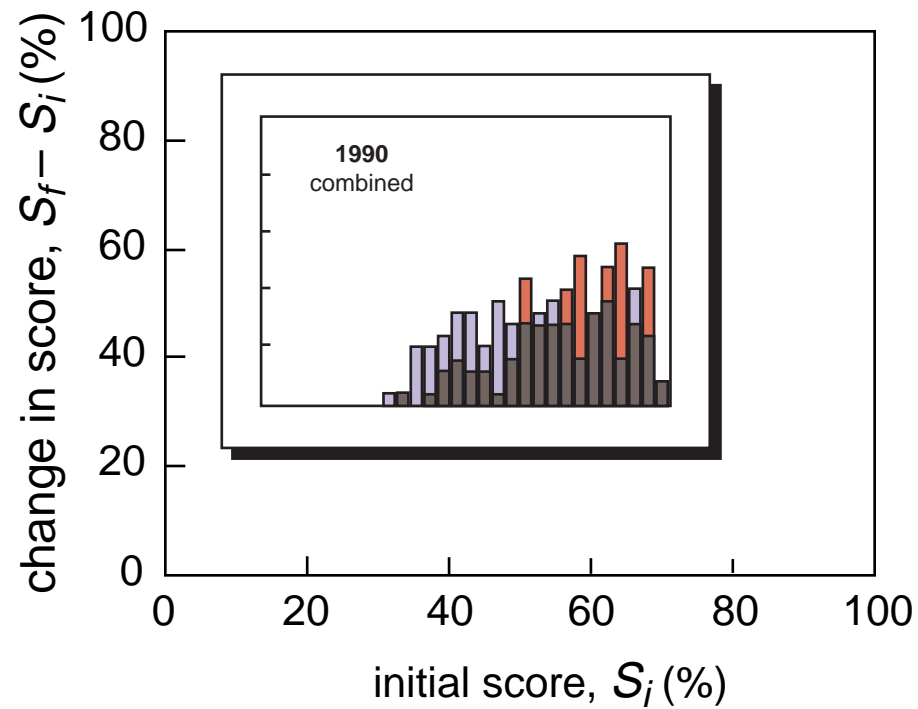


Why do we have this problem?

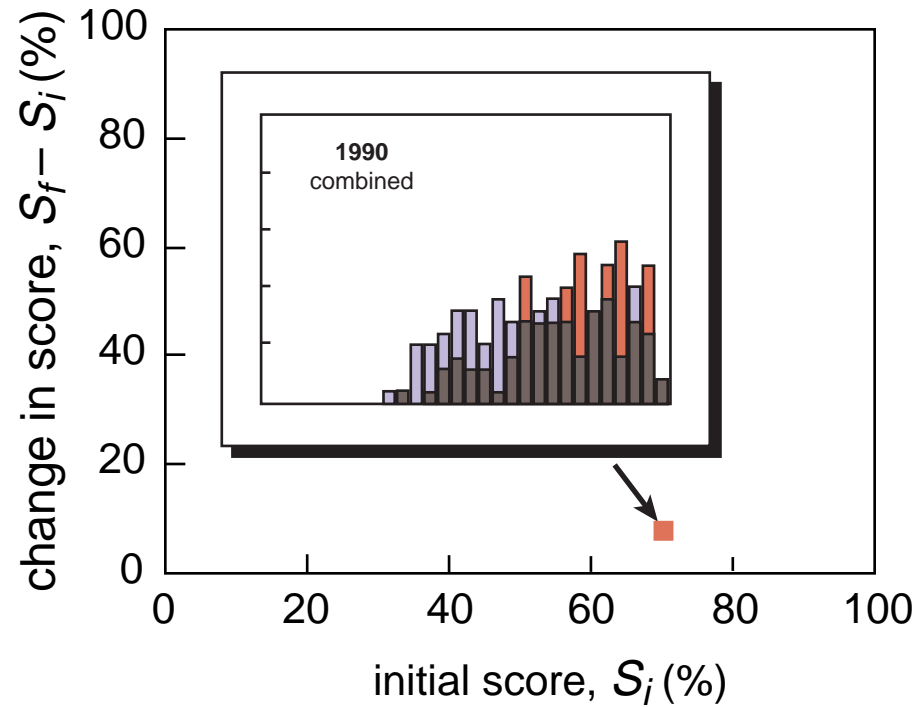
Lectures focus on transfer of information...



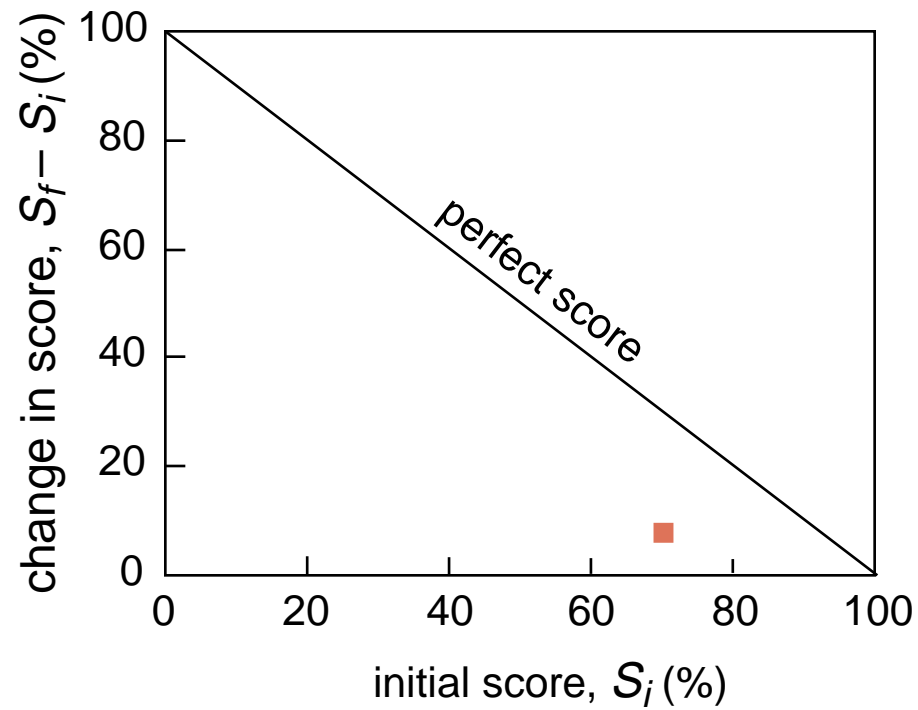
Why do we have this problem?



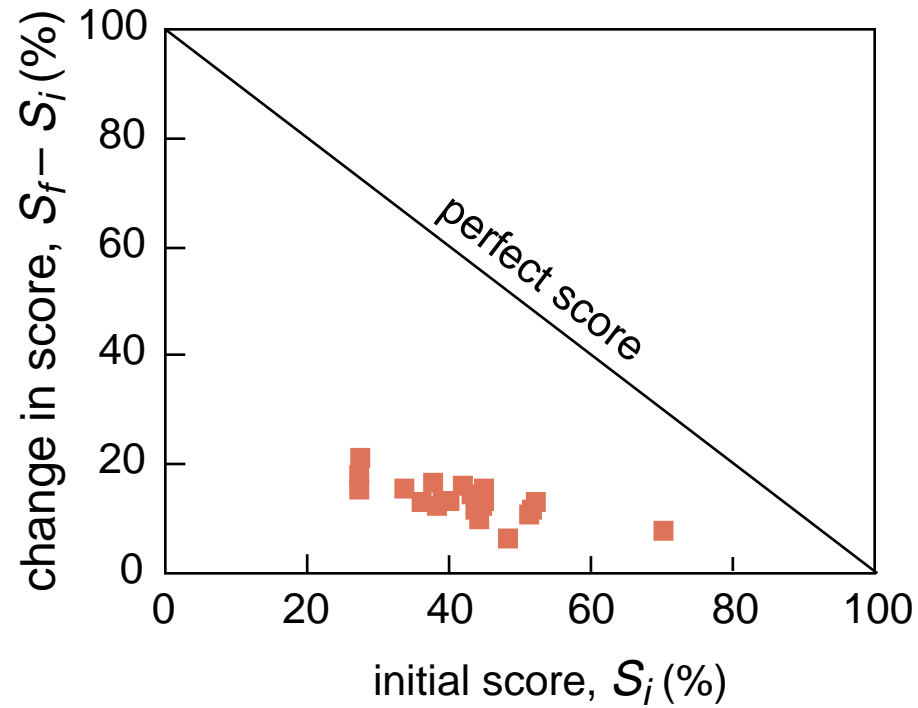
Why do we have this problem?



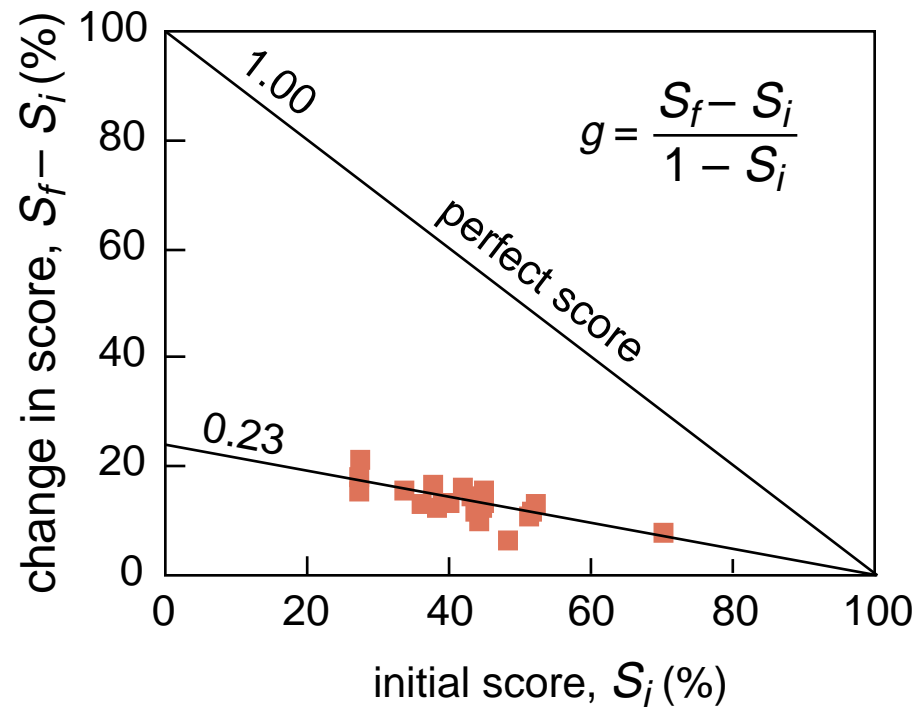
Why do we have this problem?



Why do we have this problem?



Why do we have this problem?

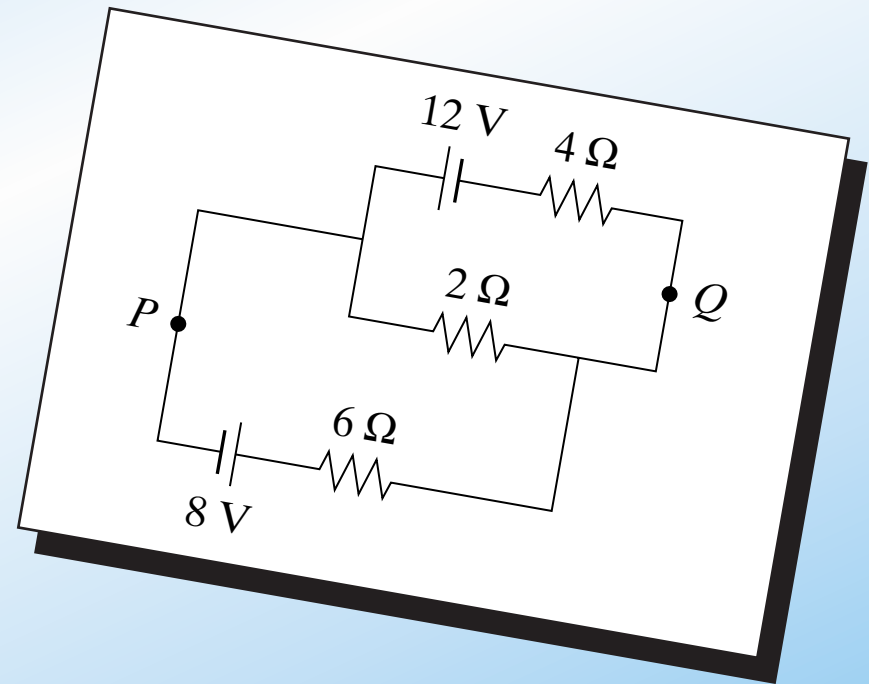


Why do we have this problem?

Conventional problems reinforce bad study habits

Why do we have this problem?

Conventional problems reinforce bad study habits

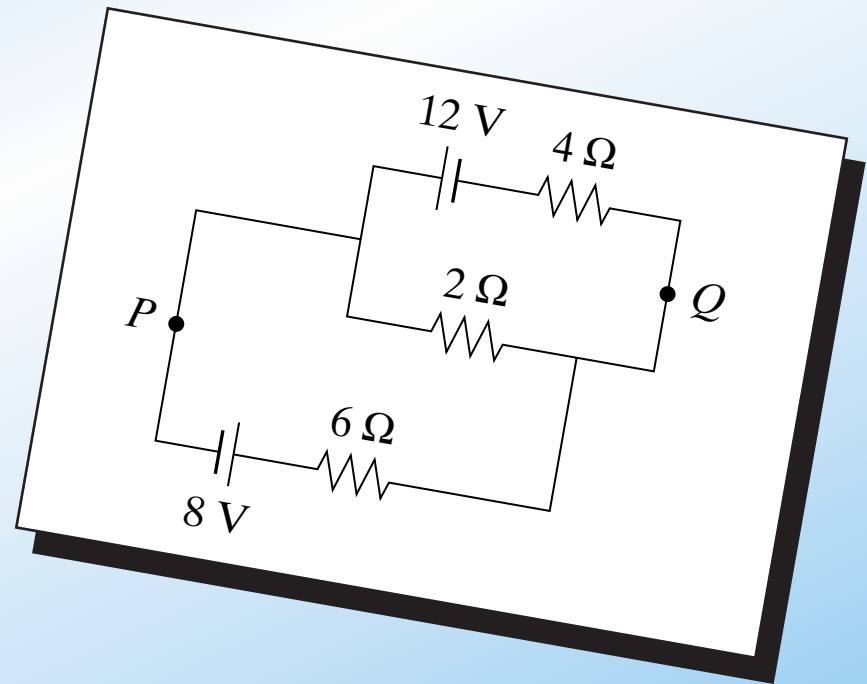


Why do we have this problem?

Conventional problems reinforce bad study habits

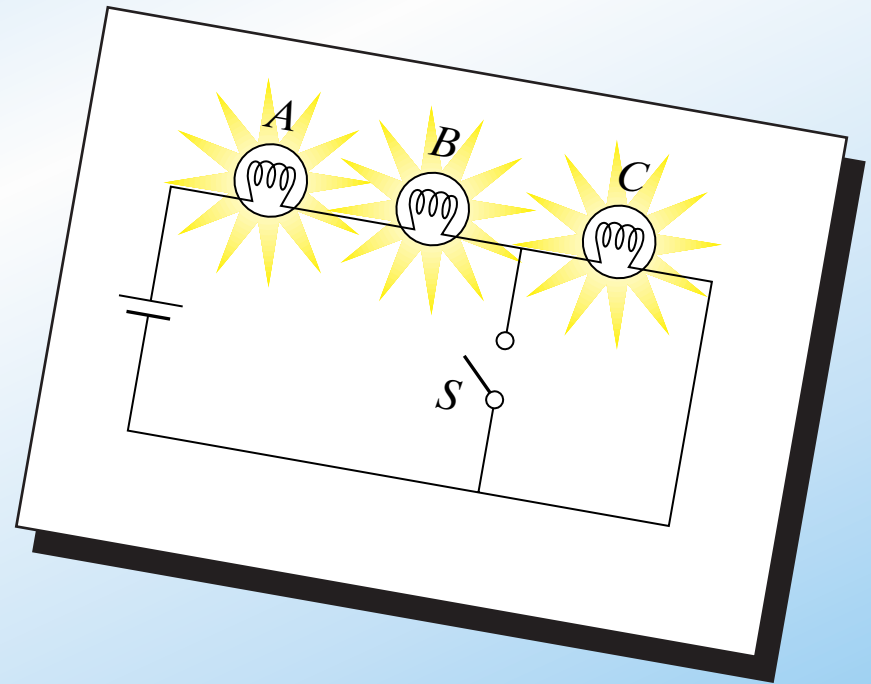
Calculate:

- (a) the current in the $2\text{-}\Omega$ resistor, and
- (b) the potential difference between points P and Q



Why do we have this problem?

Are basic principles understood?

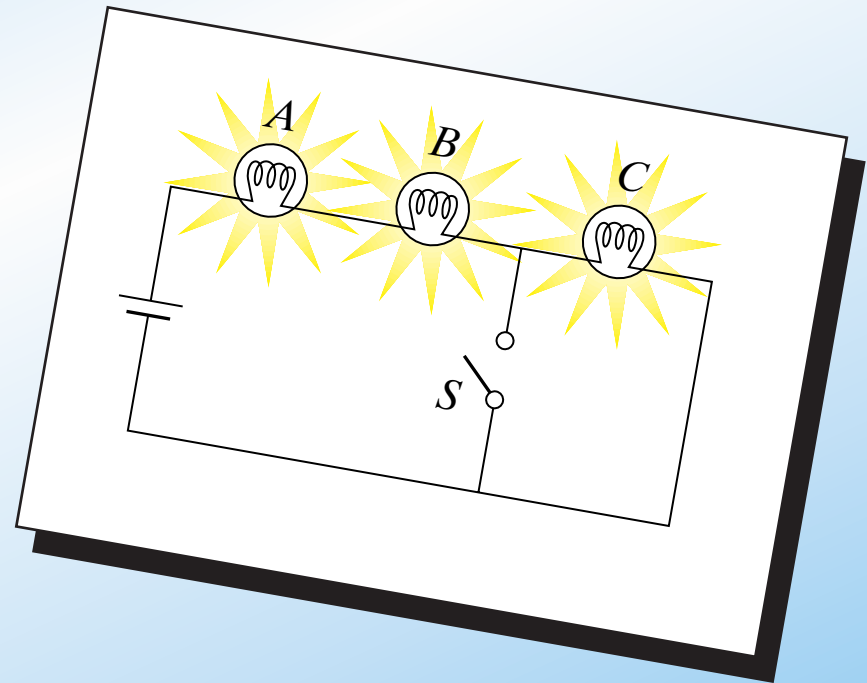


Why do we have this problem?

Are basic principles understood?

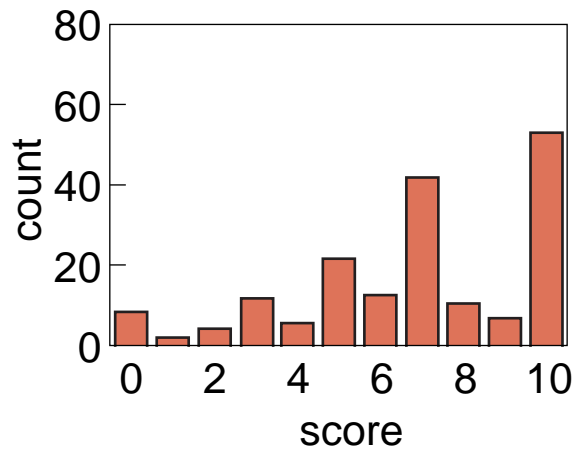
When S is closed, what happens to the:

- (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?

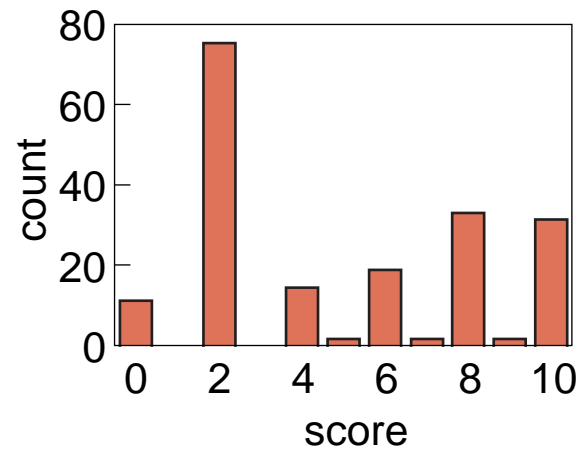


Why do we have this problem?

conventional

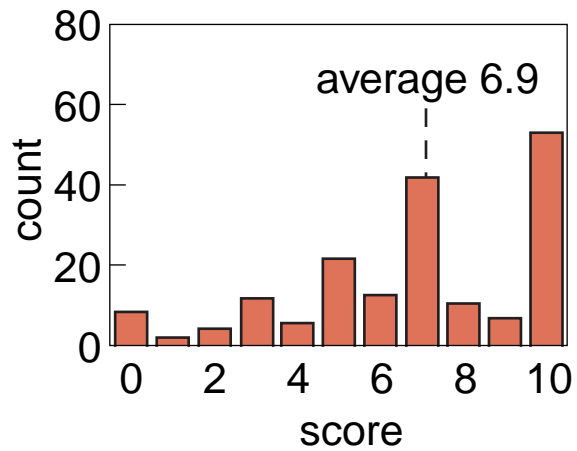


conceptual

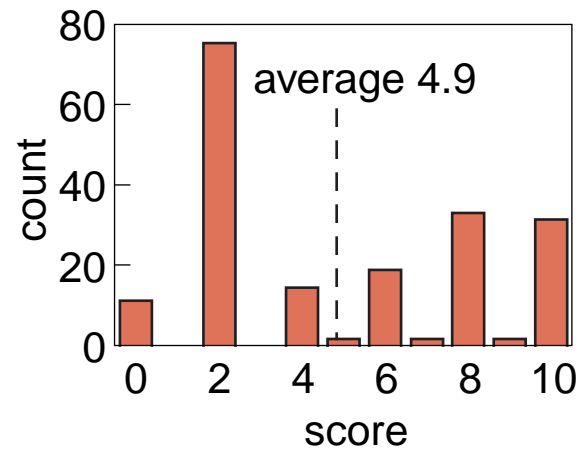


Why do we have this problem?

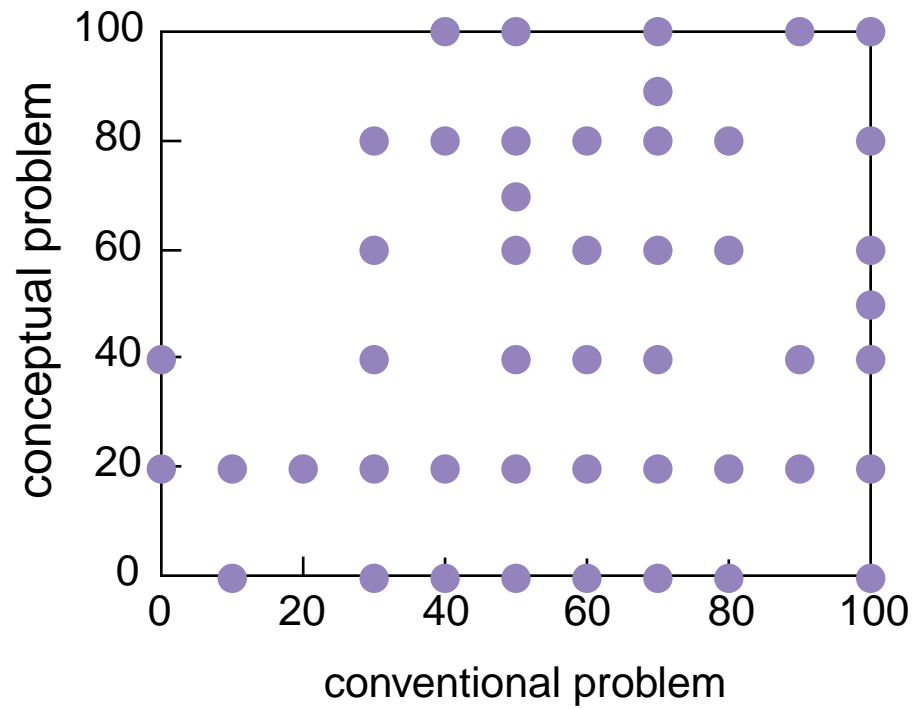
conventional



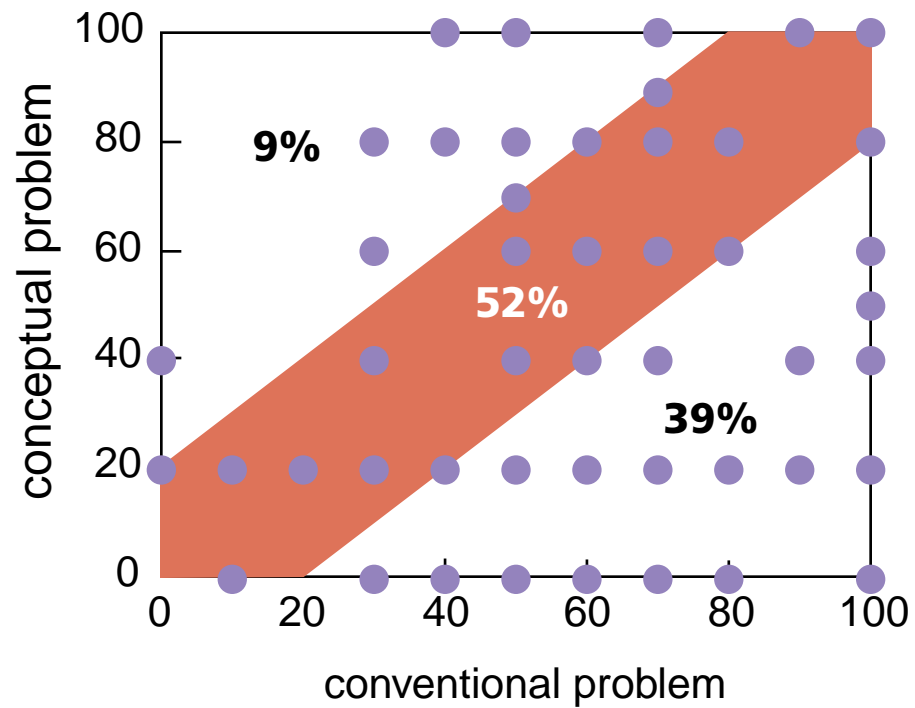
conceptual



Why do we have this problem?



Why do we have this problem?



A wide-angle photograph of a large lecture hall. In the foreground, the backs of many students' heads and shoulders are visible as they sit at desks, facing the front of the room. The students are diverse in age and appearance. At the front of the hall, a professor in a light-colored shirt stands behind a podium, addressing the class. Behind the professor is a large projection screen displaying a slide with text and a silhouette of a person. To the right of the screen, there is a smaller, illuminated display board. The room has a curved wall and is dimly lit, with the primary light source being the projection screen and the podium area. The overall atmosphere is that of a formal academic setting.

So what should we do?

Peer Instruction

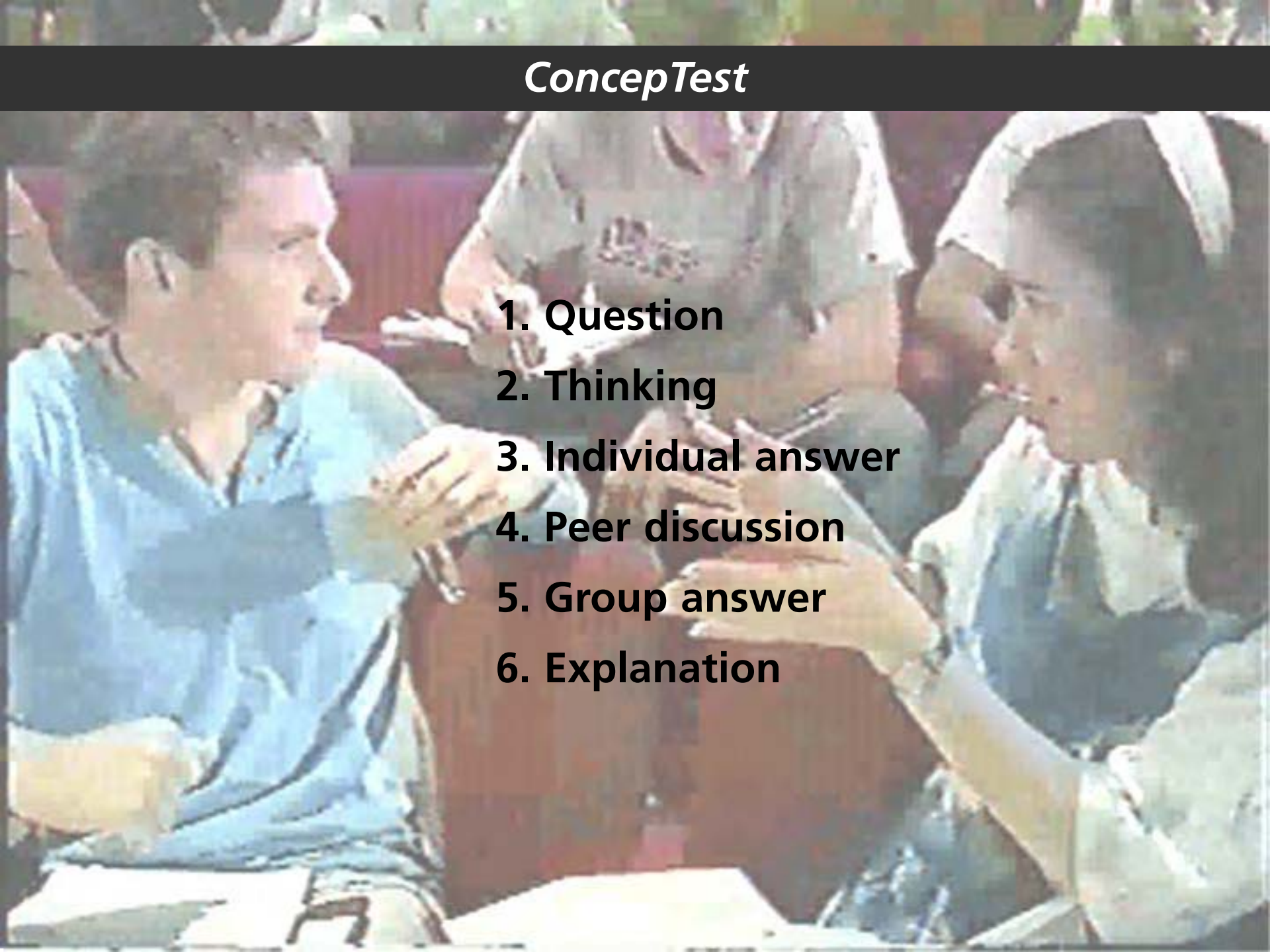
Help students take more responsibility for learning!

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**
- 
- A photograph of three students in a classroom setting. A male student on the left is wearing a blue shirt and is gesturing with his hands while speaking. A female student on the right is wearing a white headscarf and a blue vest over a white shirt, and is also gesturing with her hands as if in a discussion. A third student is partially visible in the background, looking down at a book or paper. The scene is brightly lit, and the students appear to be engaged in a collaborative learning activity.

Is it any good?

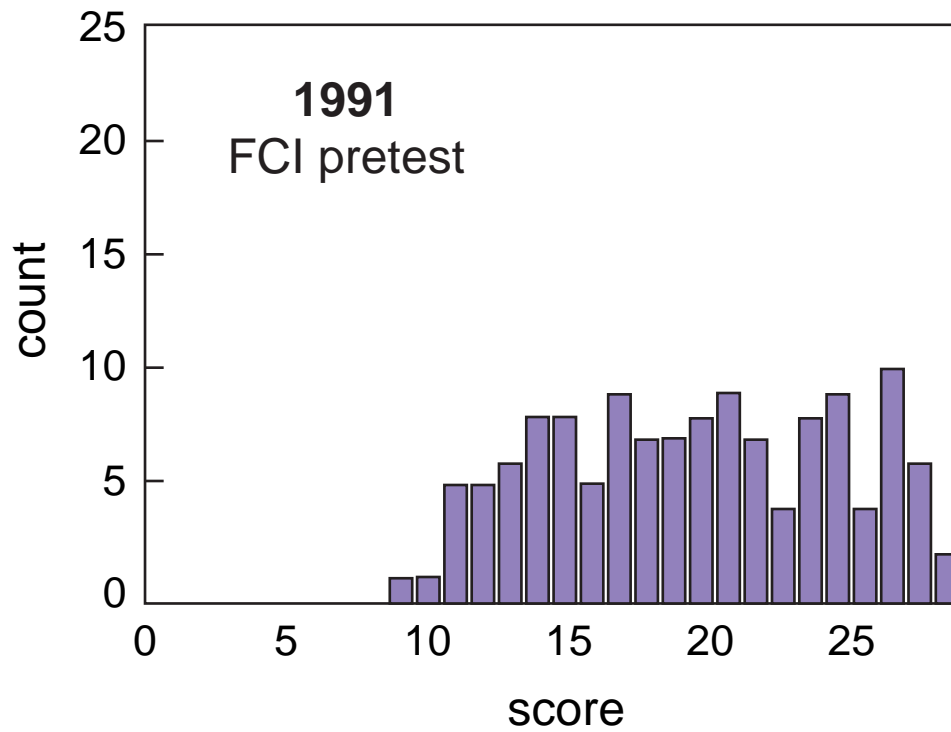
Is it any good?

▶ **Results**

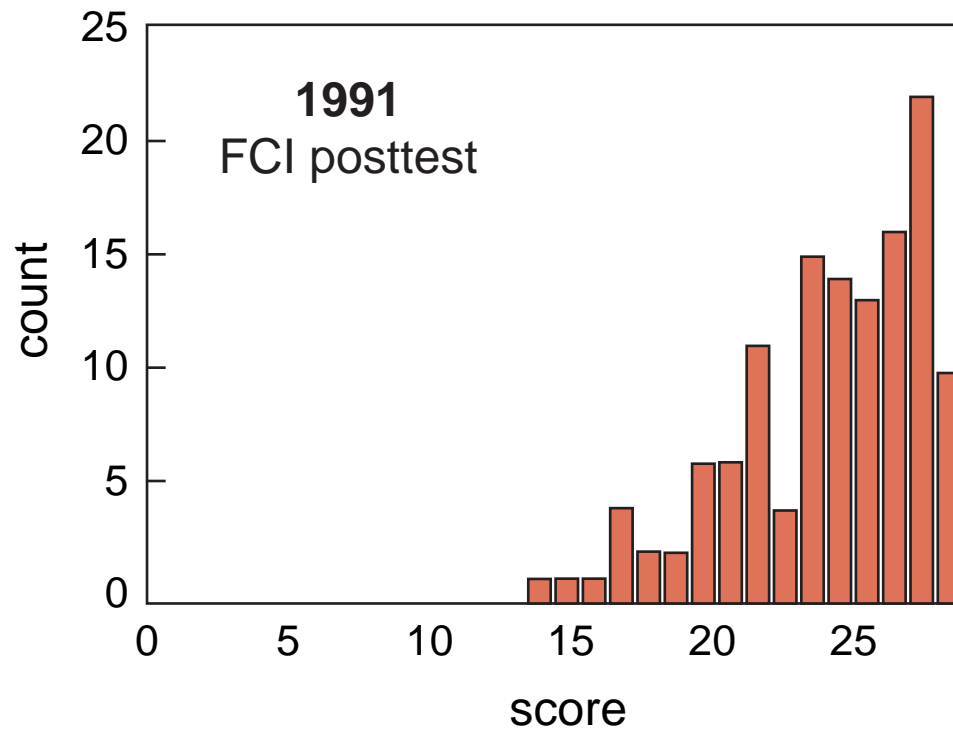
Is it any good?

- ▶ **Results**
- ▶ **Student Reactions**

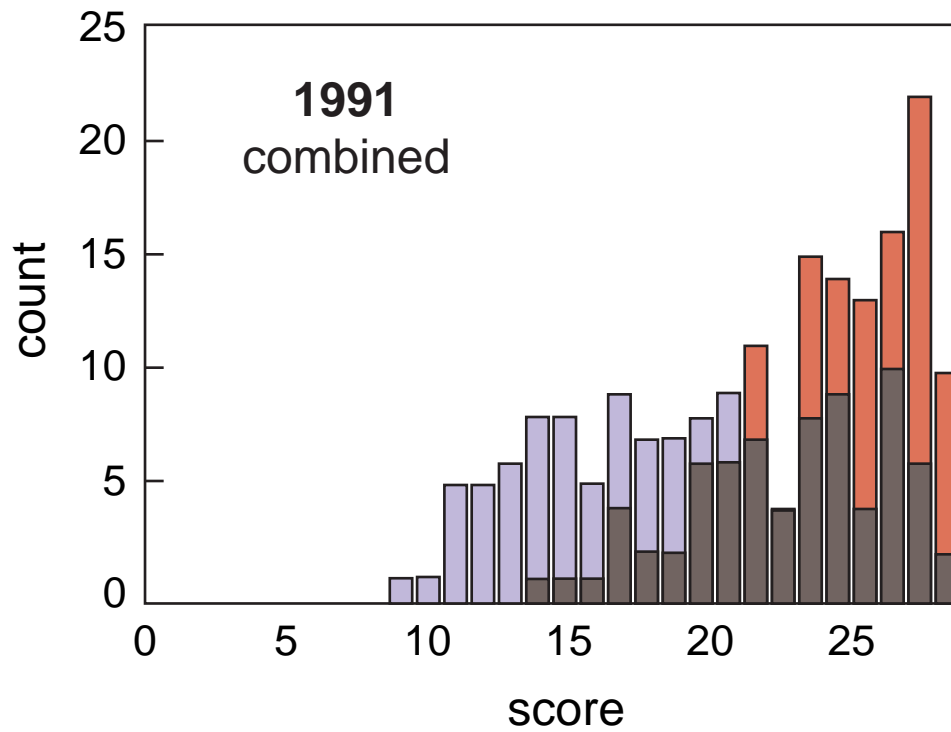
Results



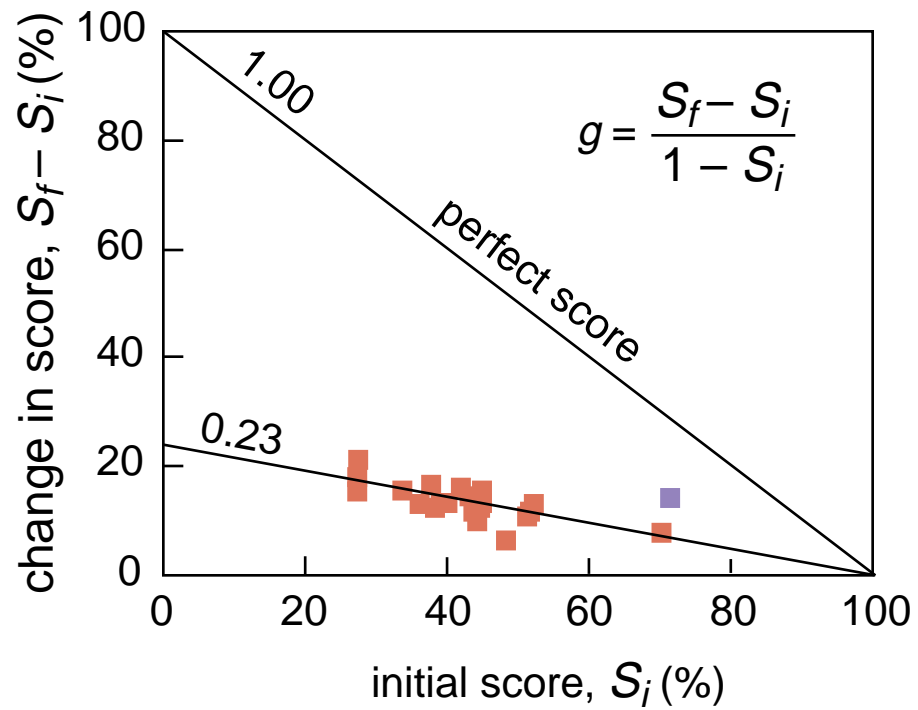
Results



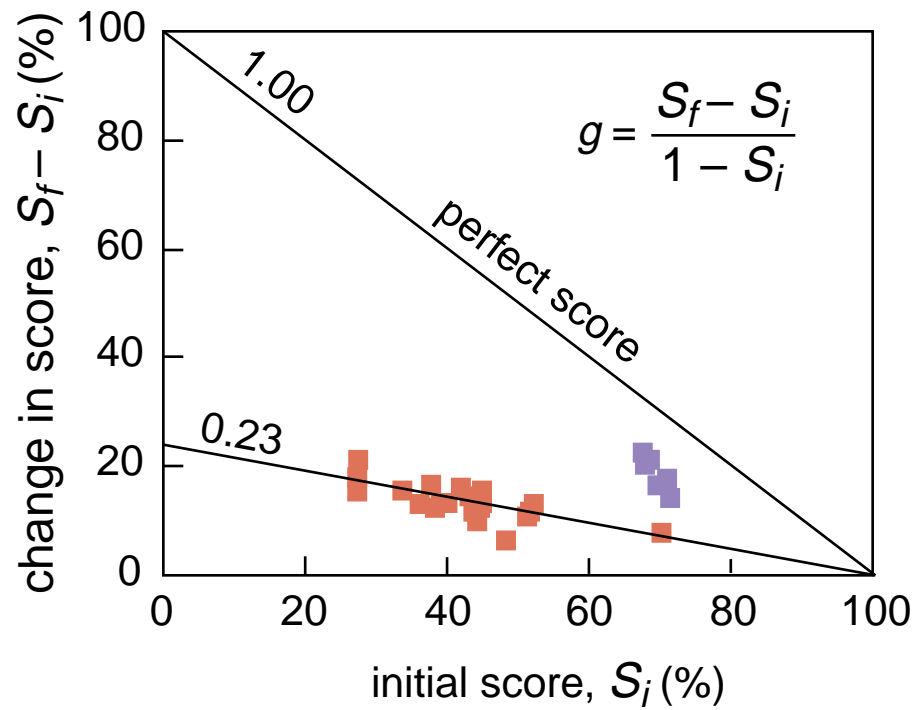
Results



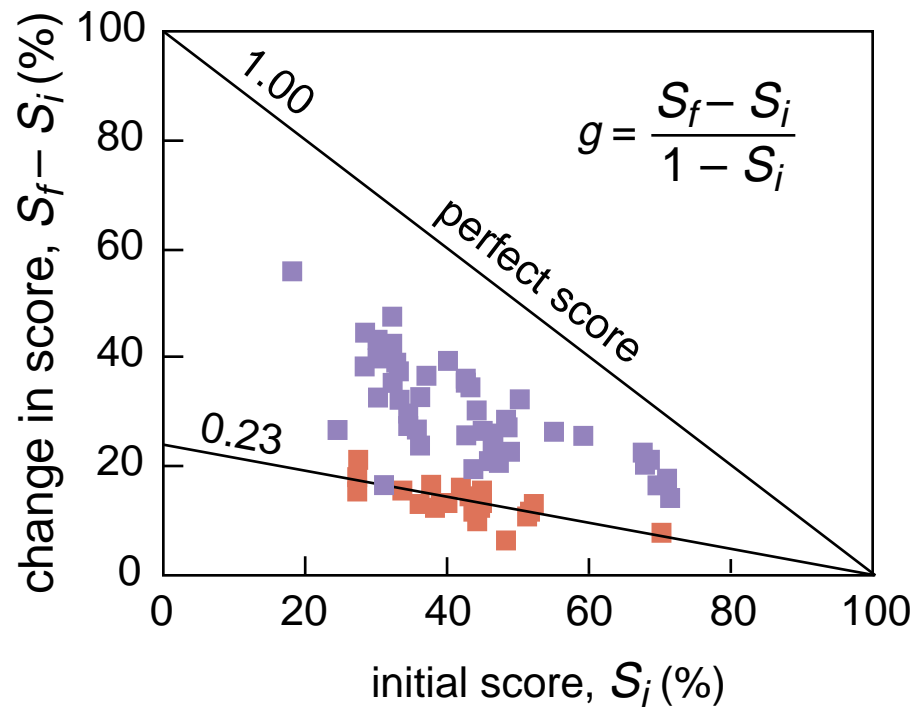
Results



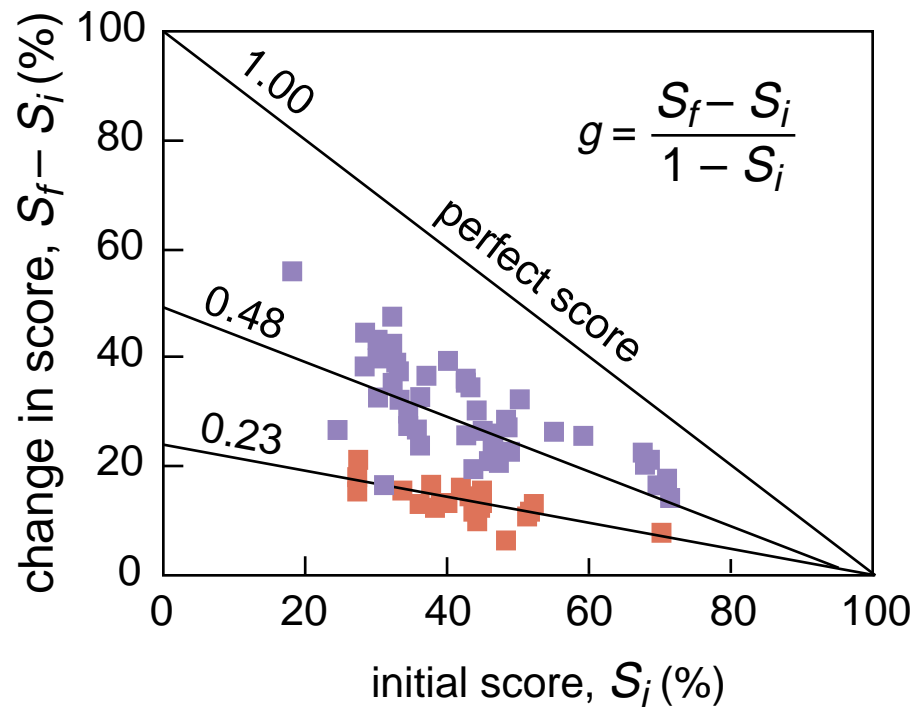
Results



Results



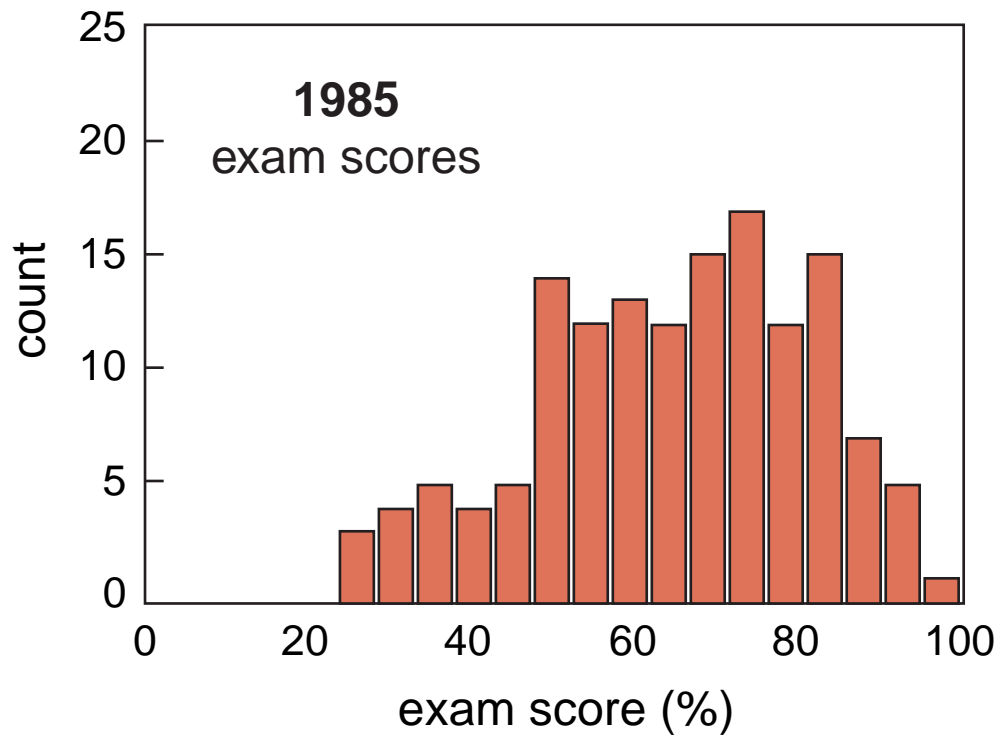
Results



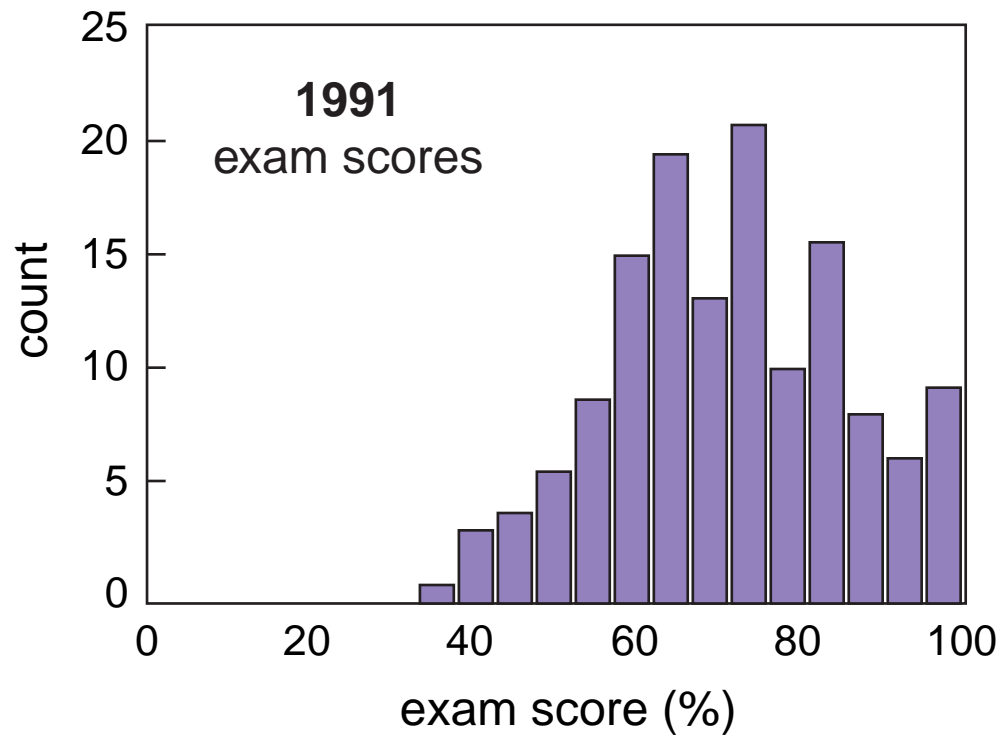
Results

What about problem solving...?

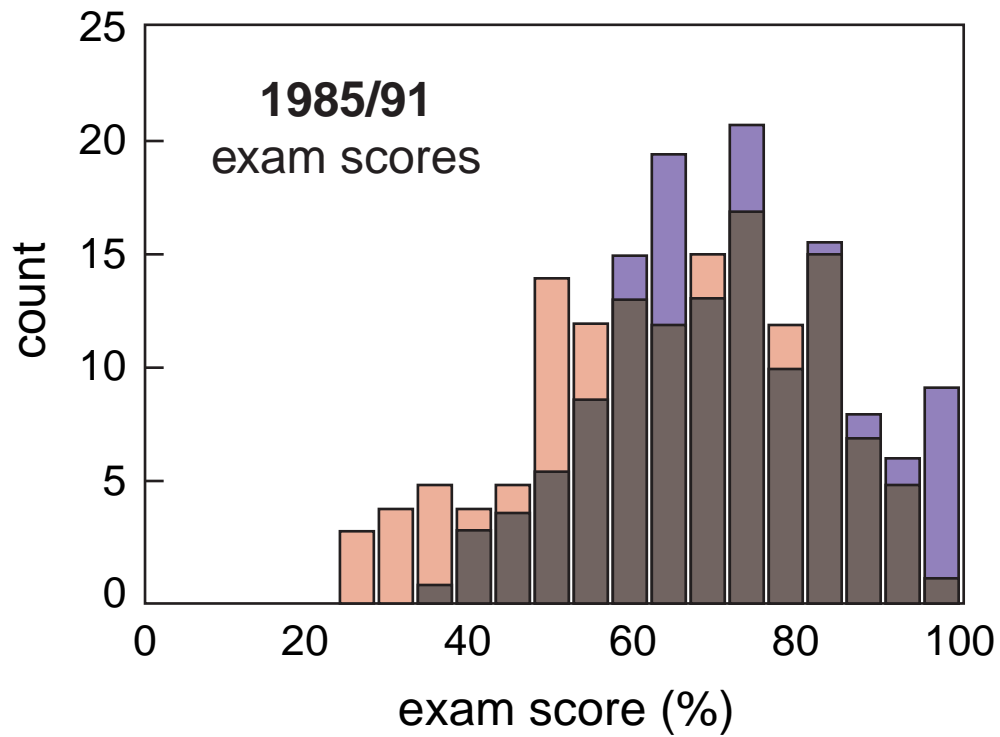
Results



Results



Results



Results

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

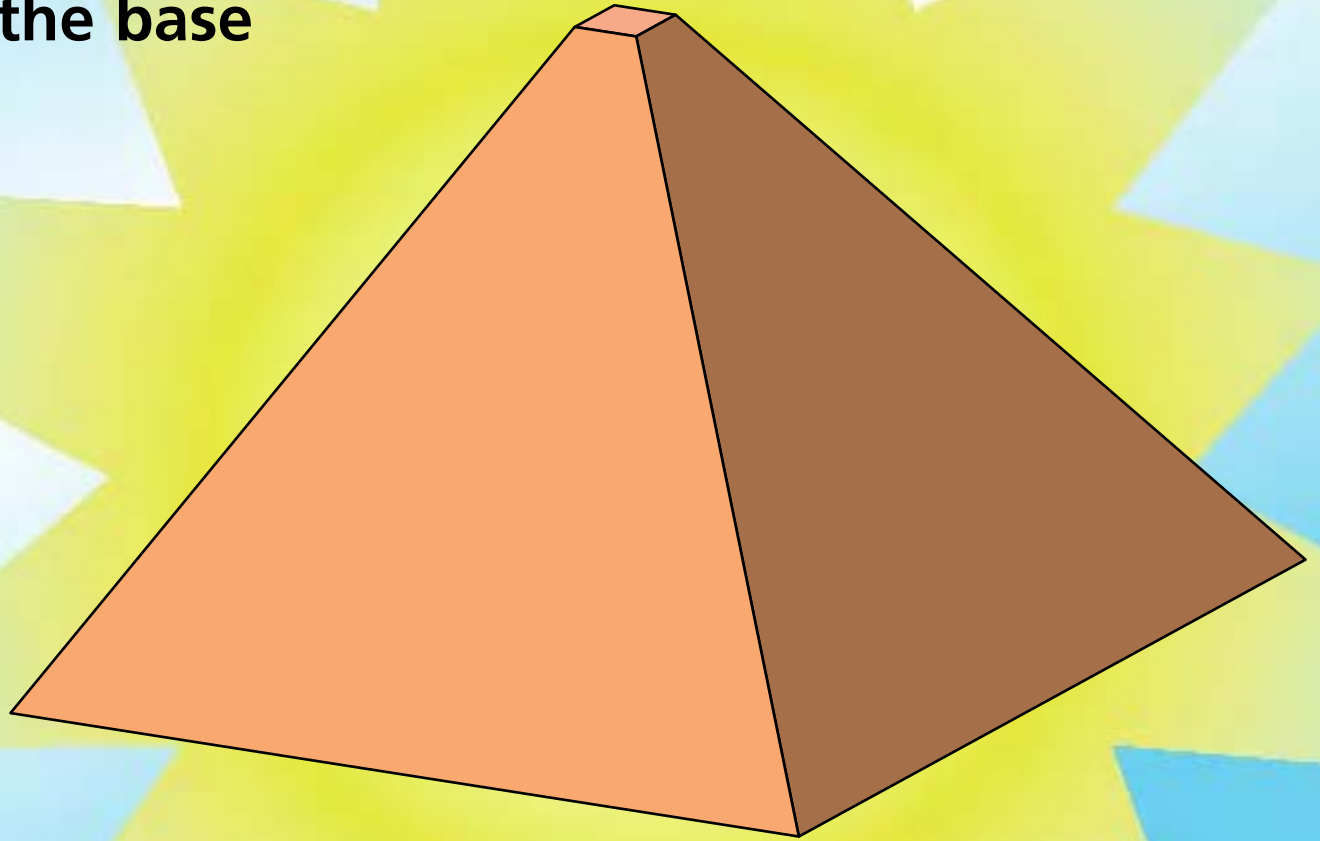
Results

So better understanding leads to better problem solving!

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

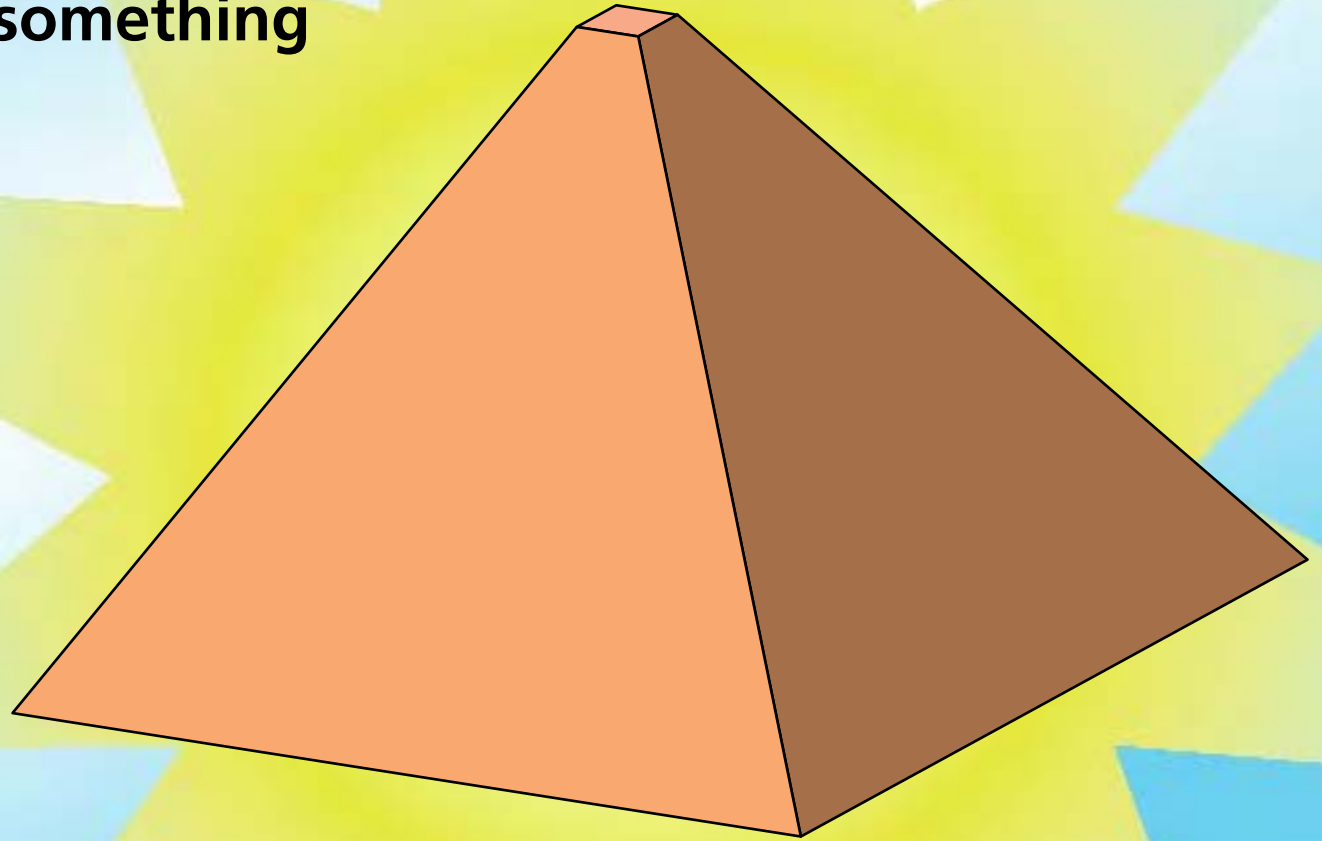
Conclusion

**Let's not forget the base
of the pyramid!**



Conclusion

**Let's give them something
of value!**



Funding

National Science Foundation

**For a copy of this talk and
additional information:**

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