

PEER INSTRUCTION: TURNING A LECTURE INTO A SEMINAR

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Outline

▶ **Problem**

Outline

▶ **Problem**

▶ **Cause**

Outline

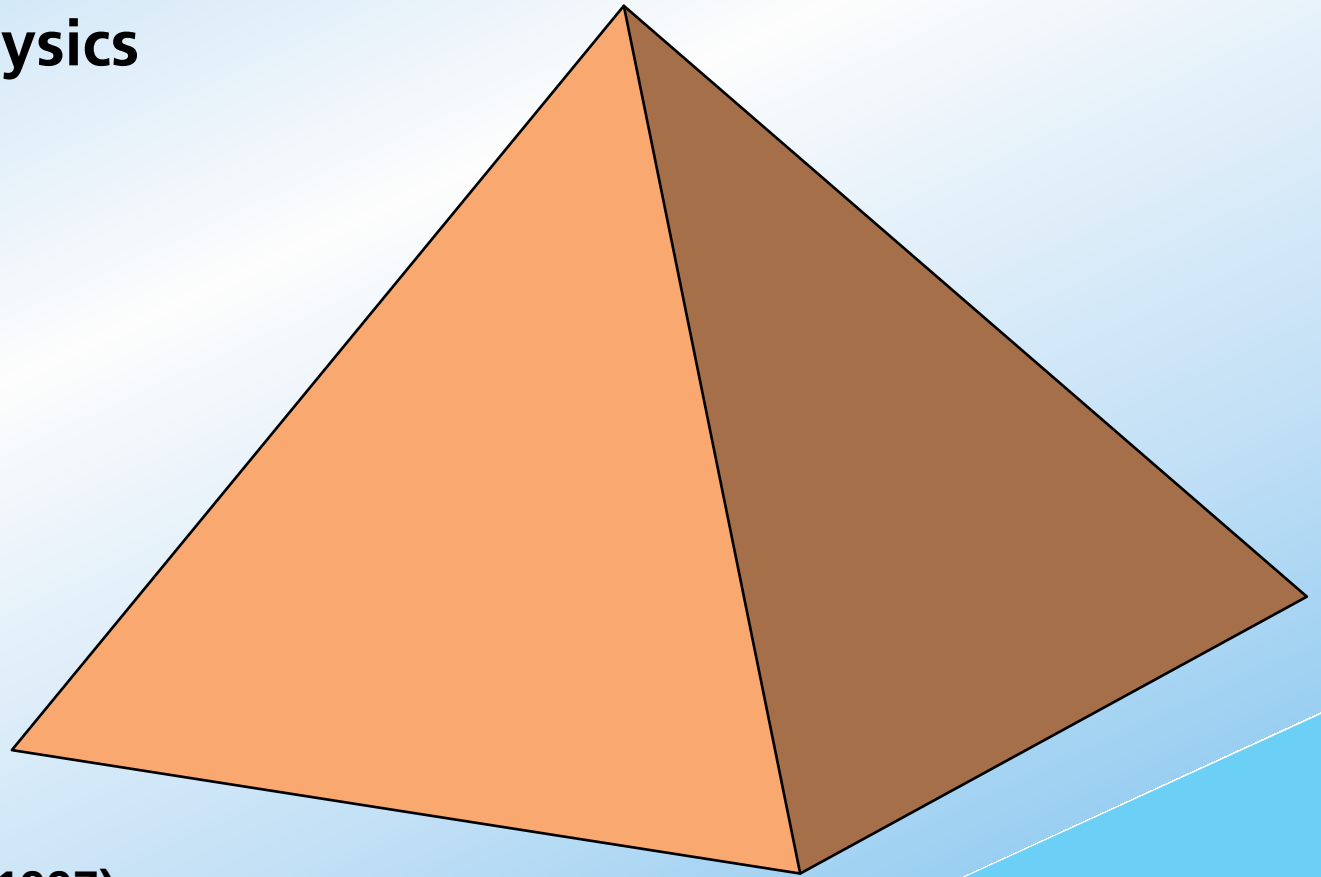
▶ **Problem**

▶ **Cause**

▶ **Remedy**

We have a problem

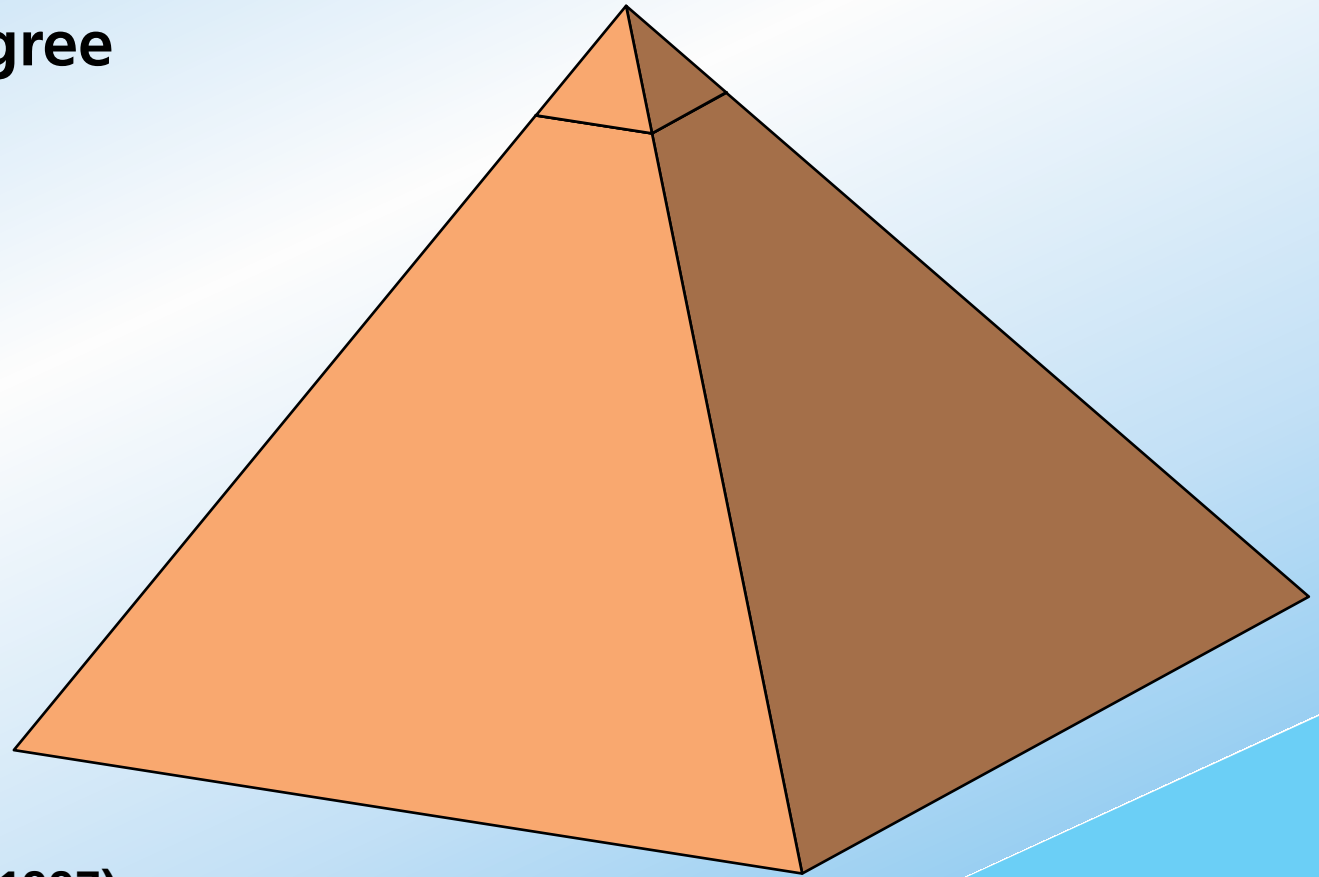
**380,000 students take
introductory physics
each year...**



AIP Report R-151.33 (1997)

We have a problem

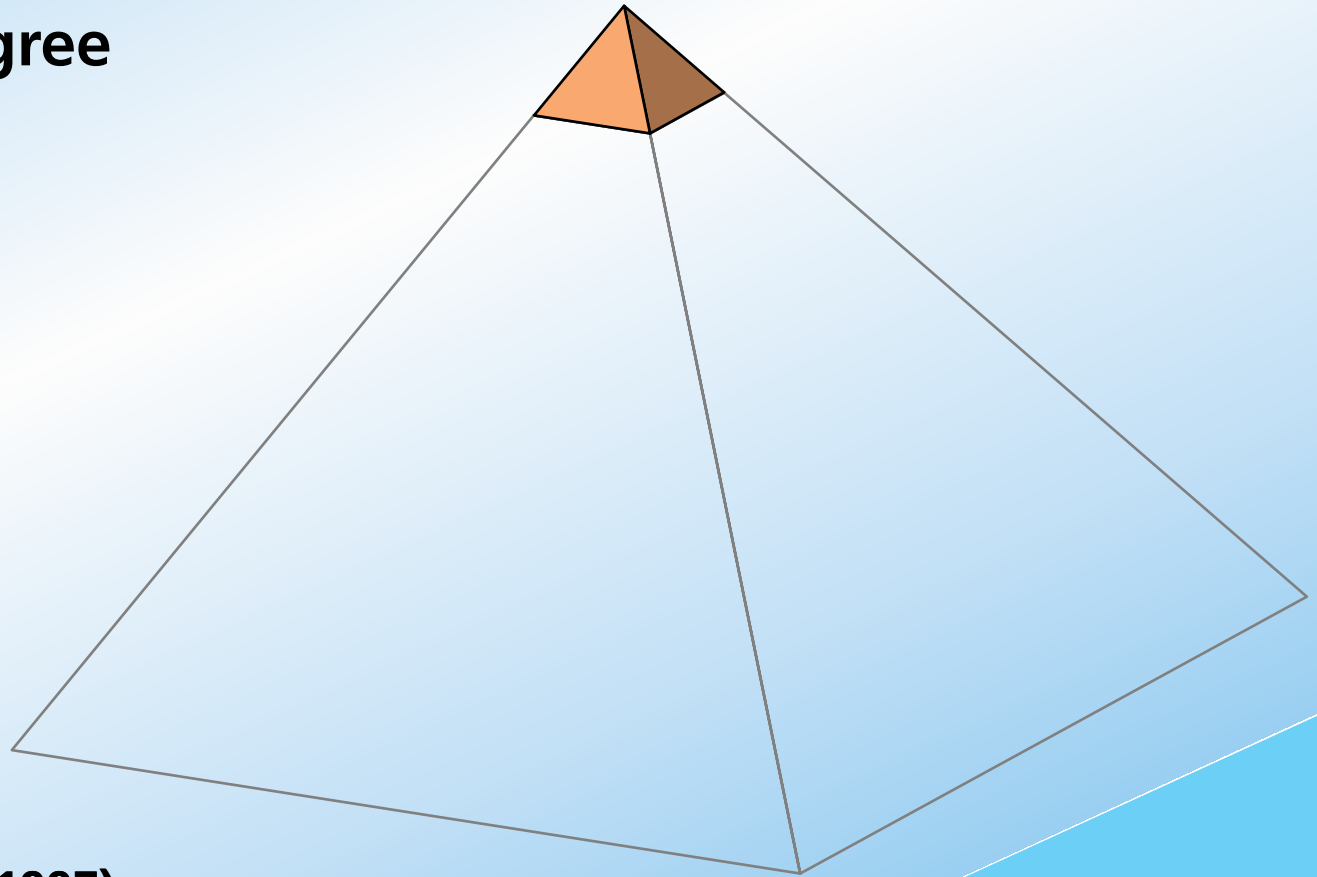
**about 1% of these get
a bachelor's degree
in physics**



AIP Report R-151.33 (1997)

We have a problem

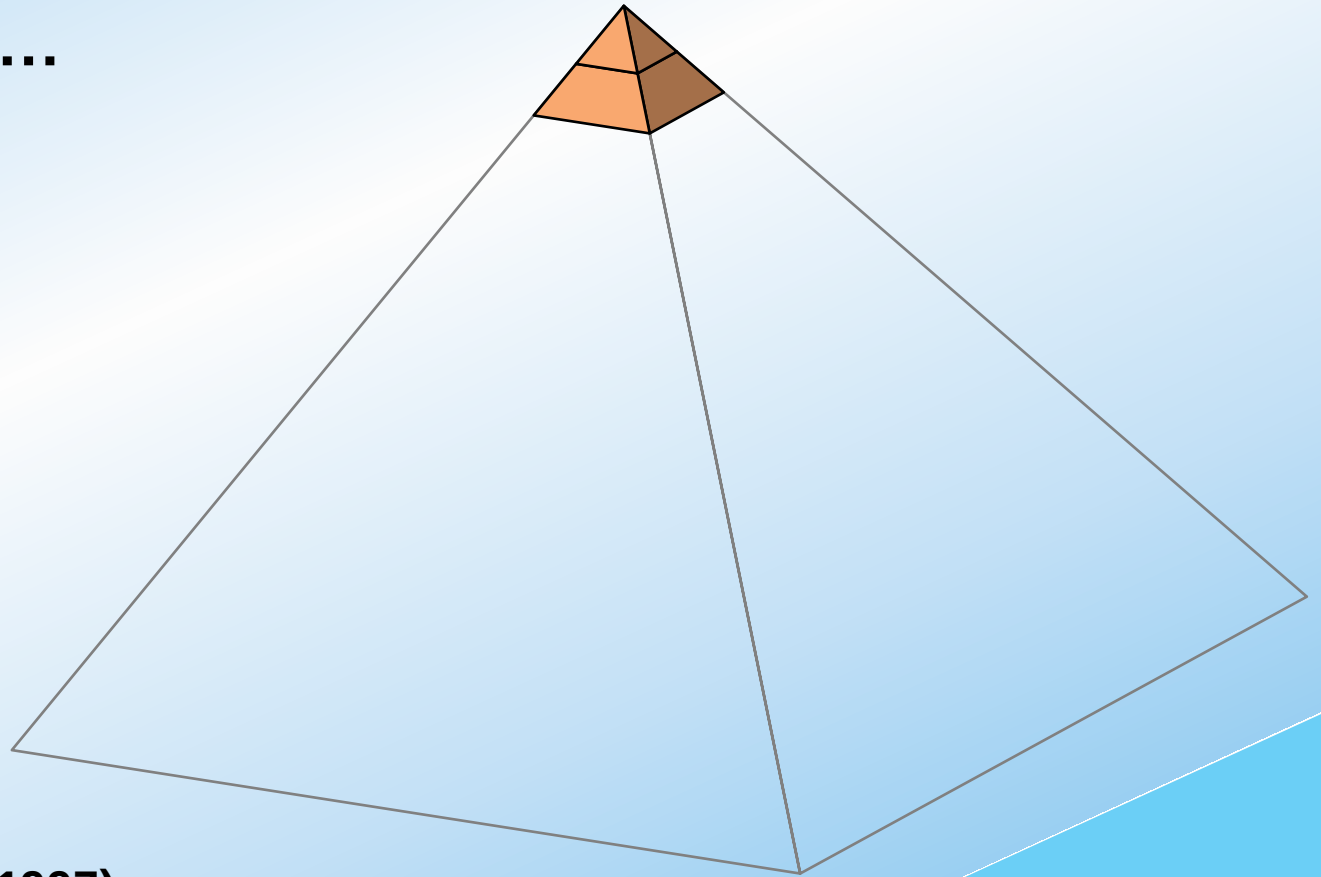
**Of the 4,300 students with
a bachelor's degree
in physics...**



AIP Report R-151.33 (1997)

We have a problem

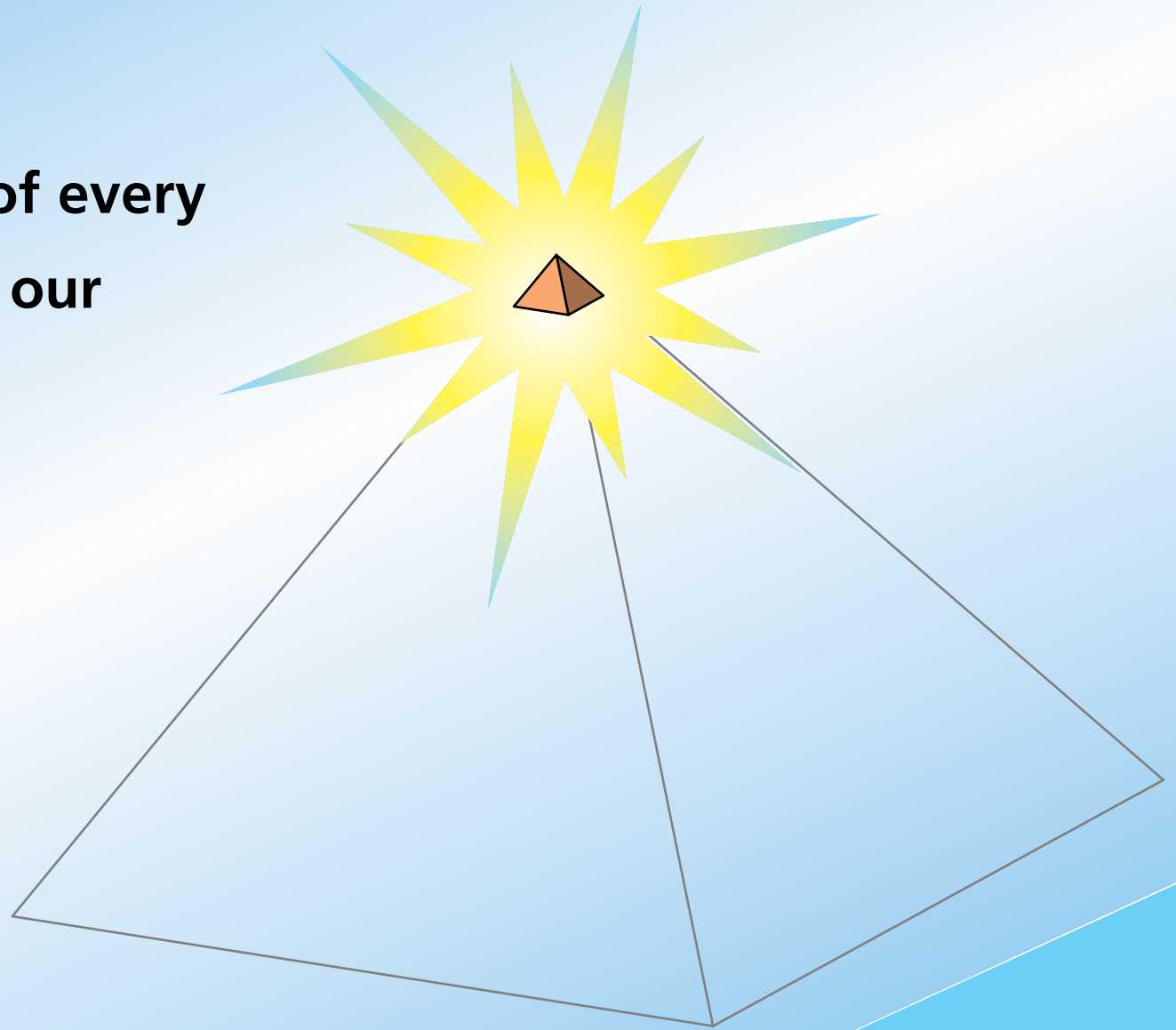
**about 35% go on to get a
Ph.D. in physics...**



AIP Report R-151.33 (1997)

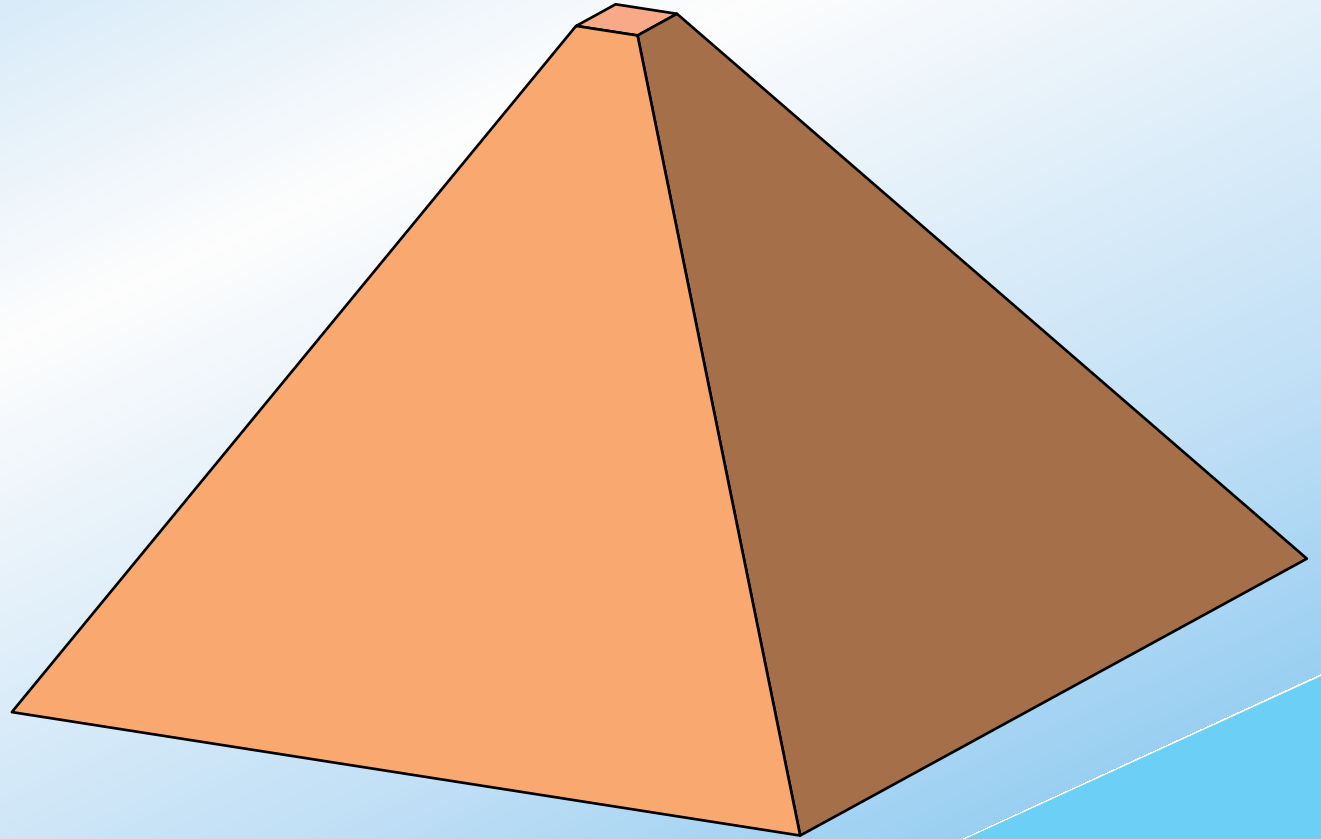
We have a problem

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



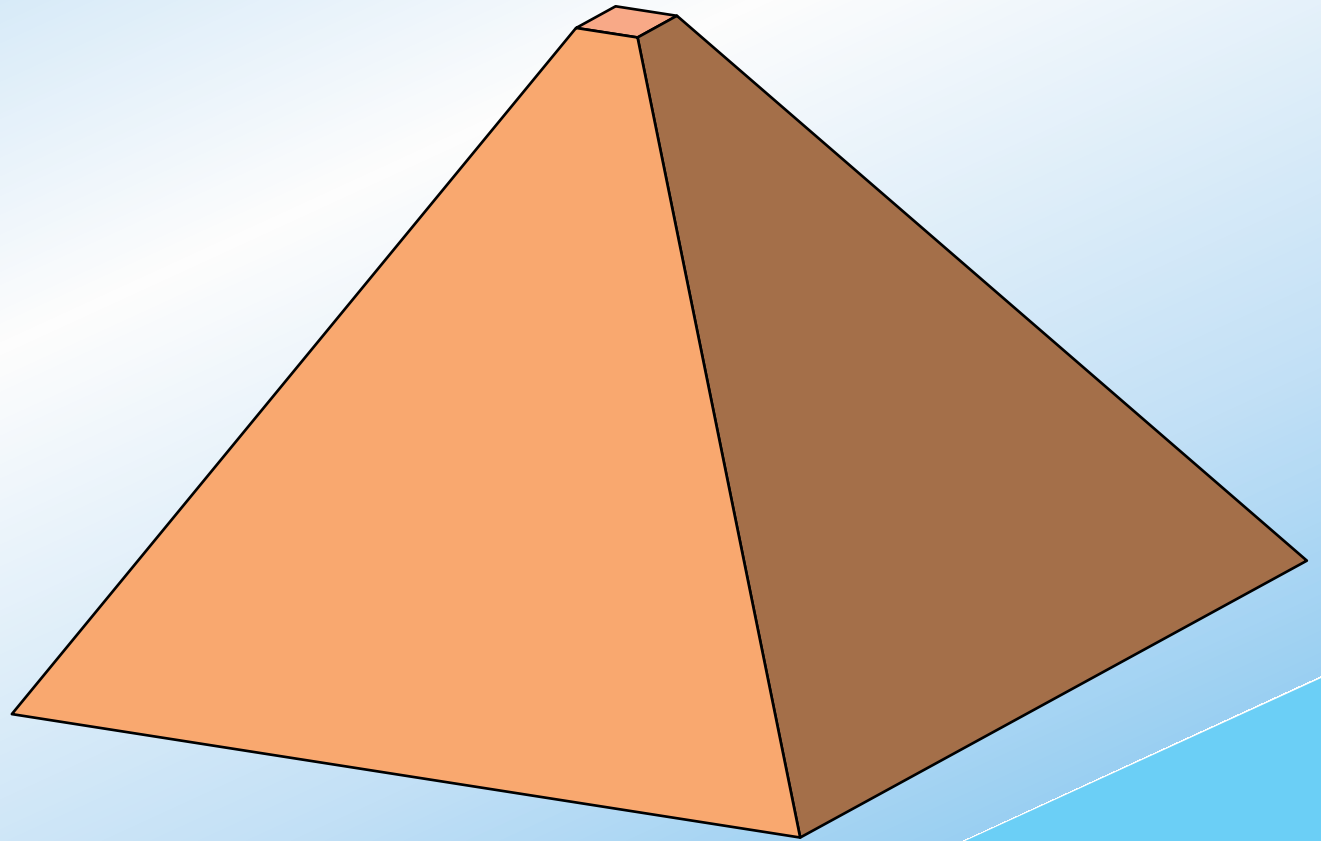
We have a problem

**What about the
other 259...?**



We have a problem

**What do we know
about these
students?**



We have a problem

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?*"



We have a problem

Some disturbing symptoms:

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

A close-up, slightly blurred photograph of a diverse group of young people, likely students, smiling and looking towards the left side of the frame. 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.

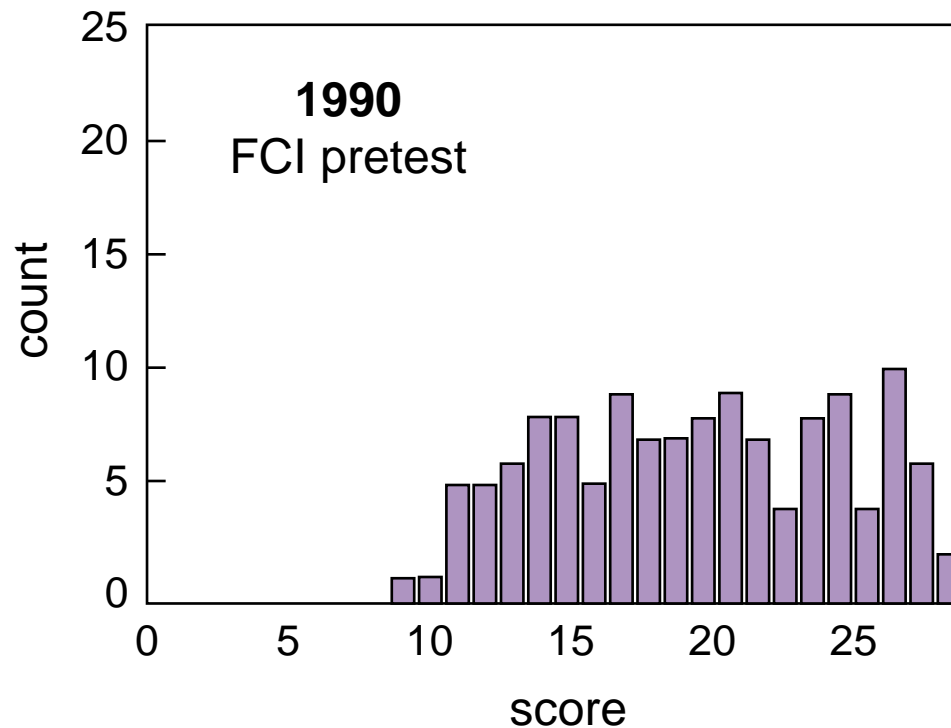
Why do we have this problem?

Why do we have this problem?

Lectures focus on transfer of information...

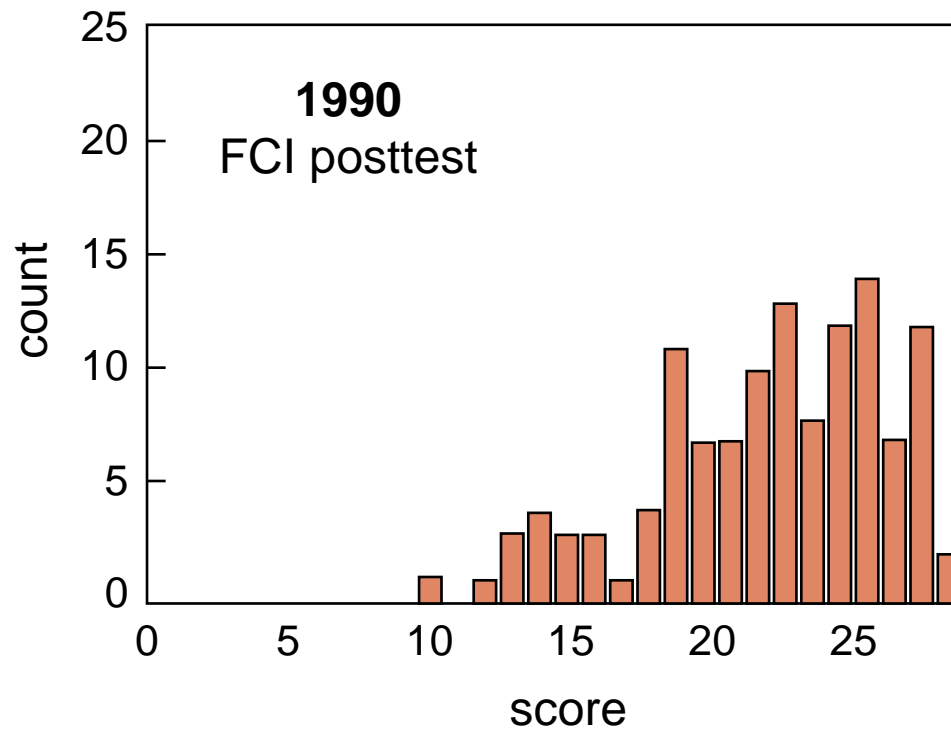
Why do we have this problem?

...but physics is not just information!



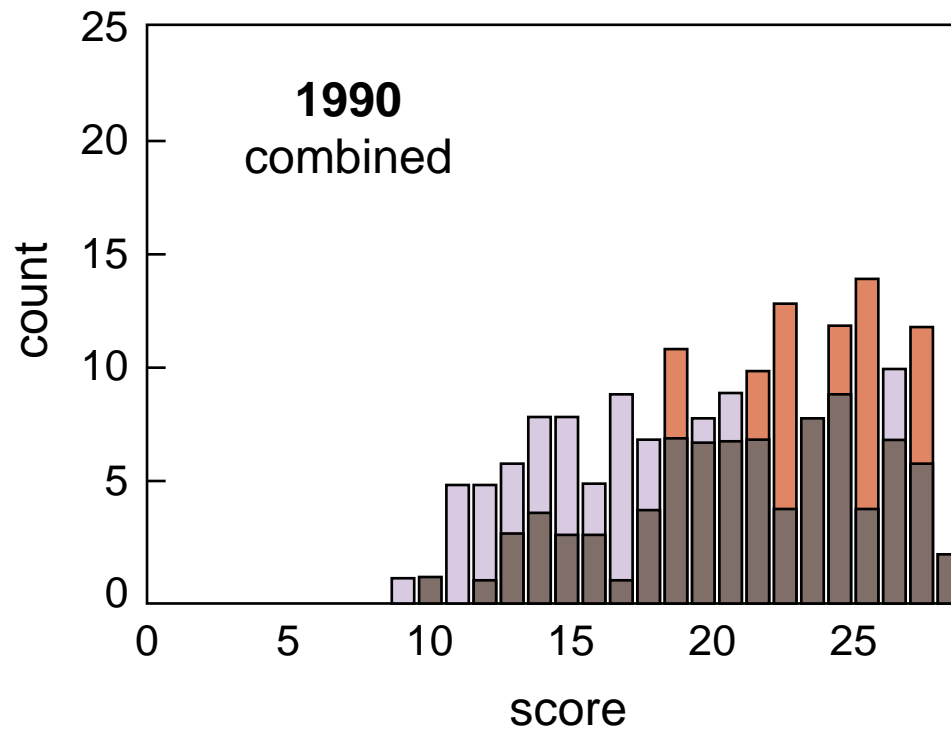
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...but physics is not just information!

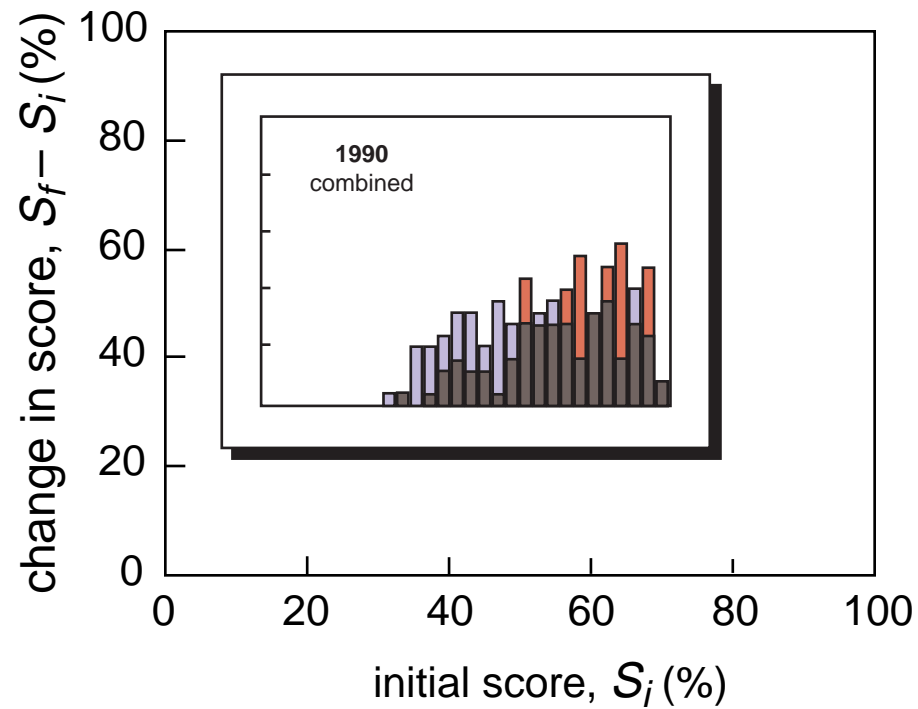


Why do we have this problem?

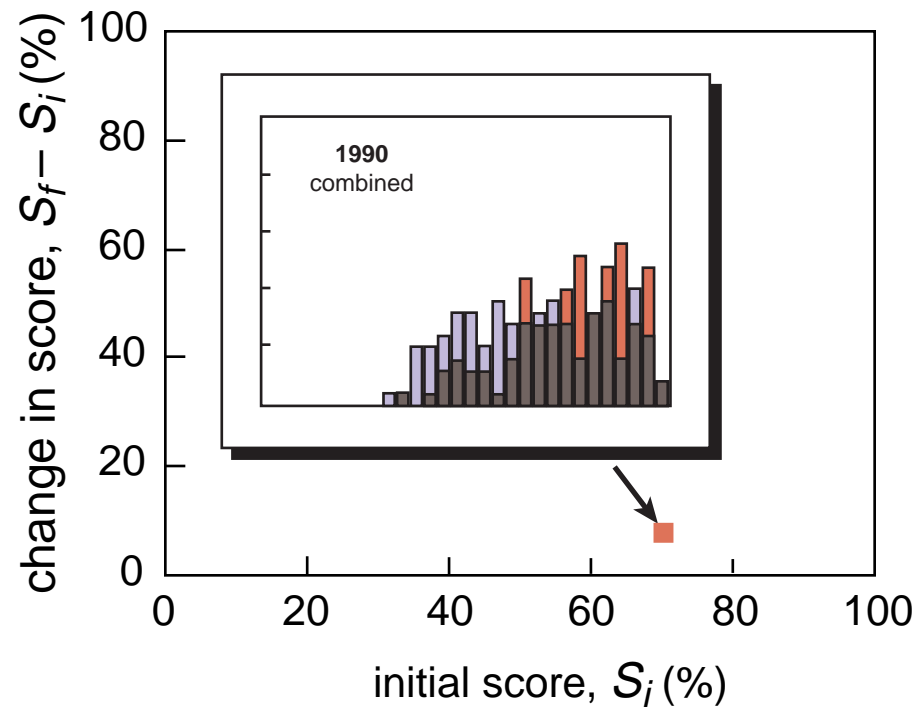
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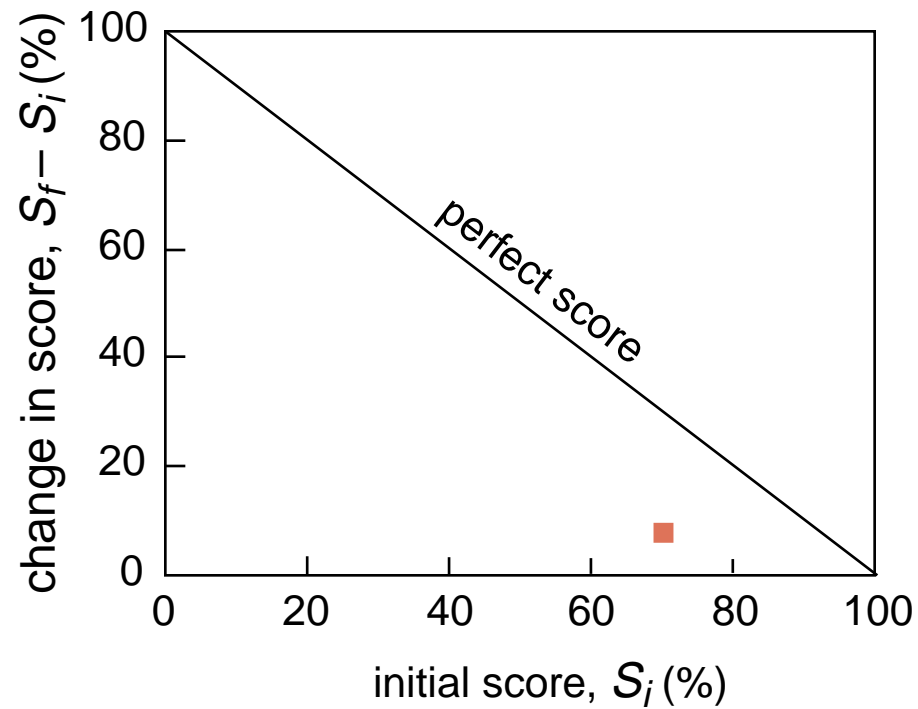
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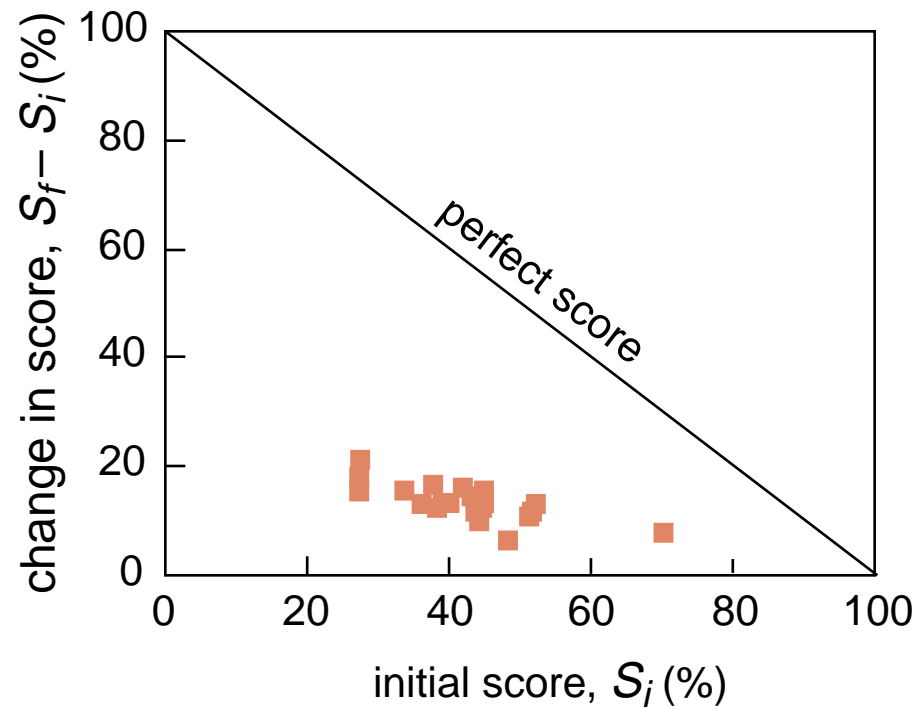
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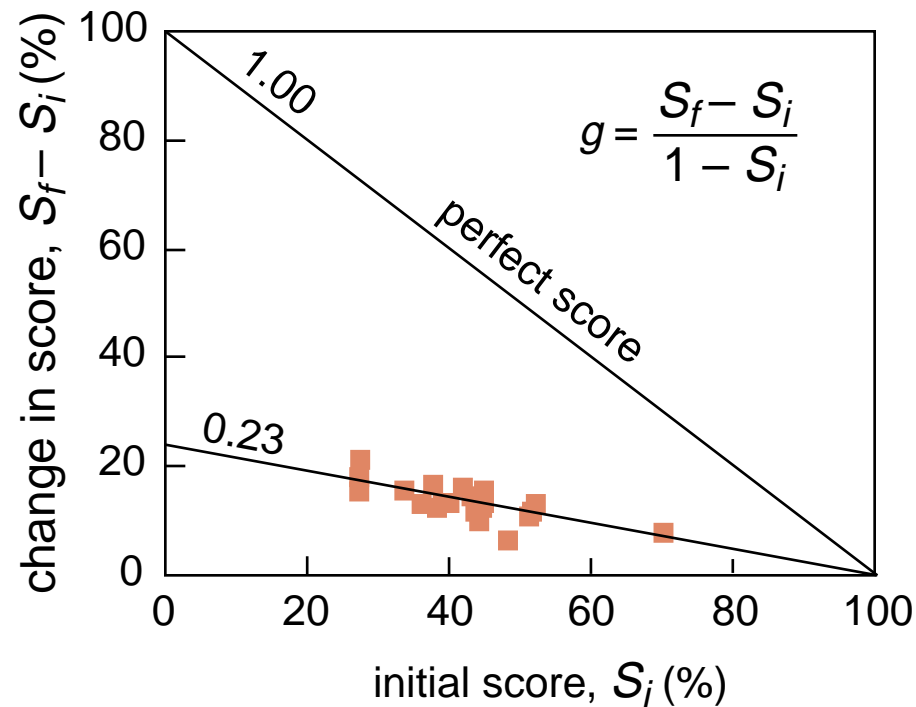
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Why do we have this problem?



Why do we have this problem?

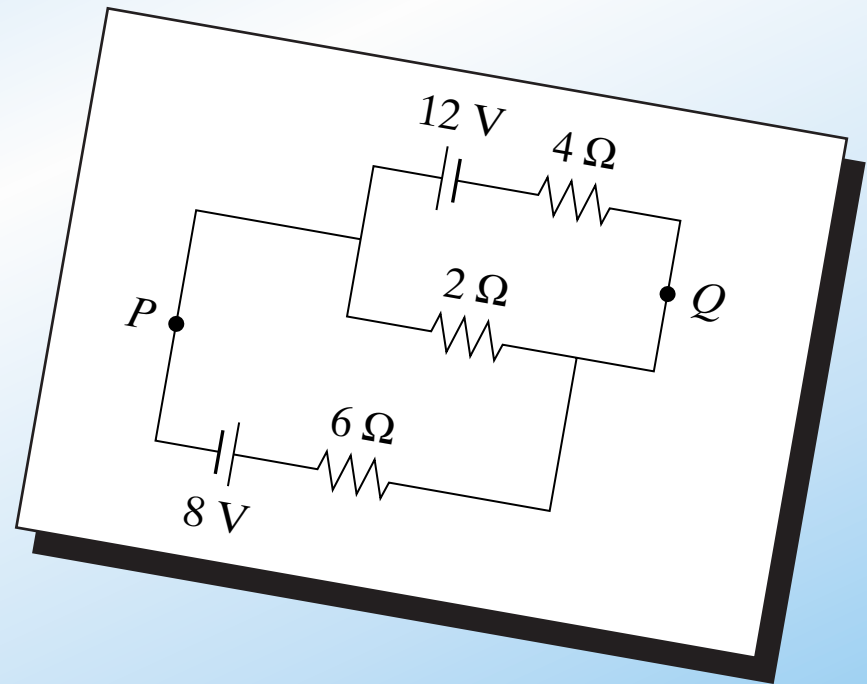


Why do we have this problem?

Conventional problems reinforce bad study habits

Why do we have this problem?

Conventional problems reinforce bad study habits

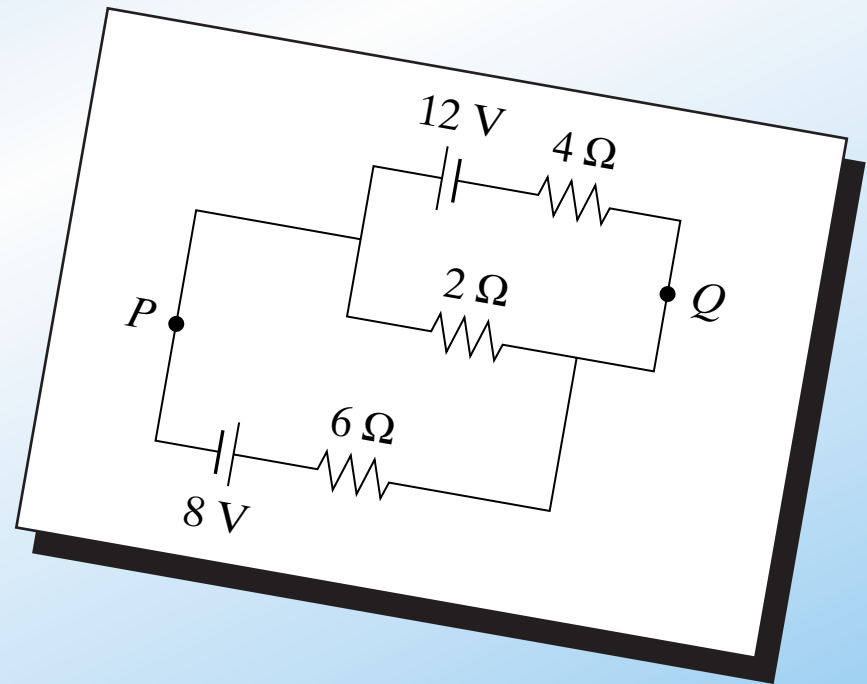


Why do we have this problem?

Conventional problems reinforce bad study habits

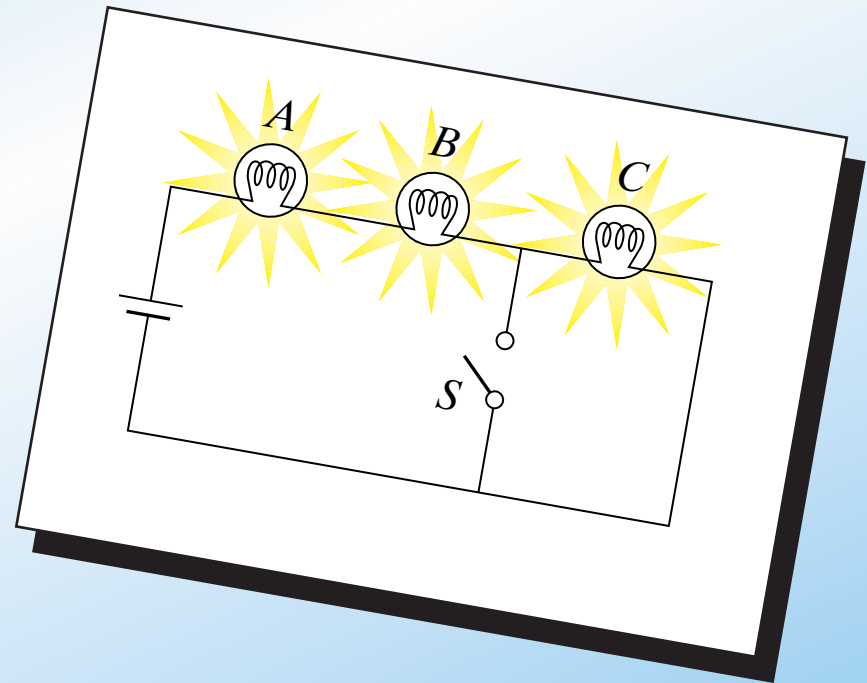
Calculate:

- (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?

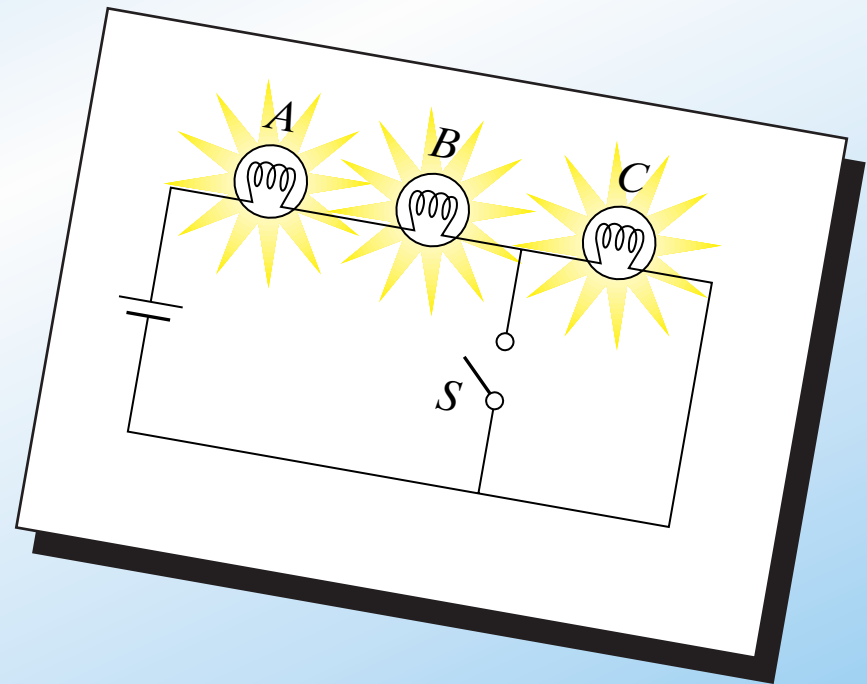


Why do we have this problem?

Are basic principles understood?

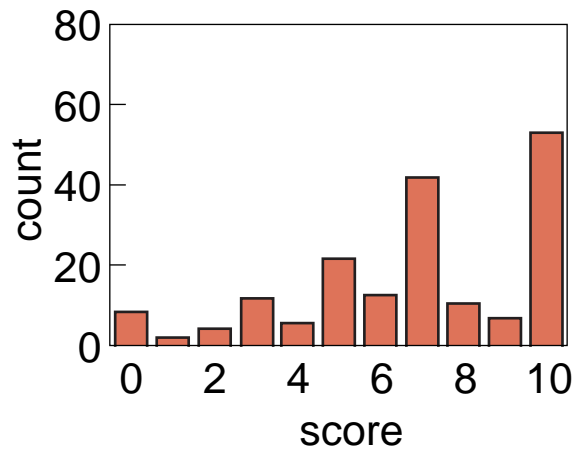
When S is closed, what happens to the:

- (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?

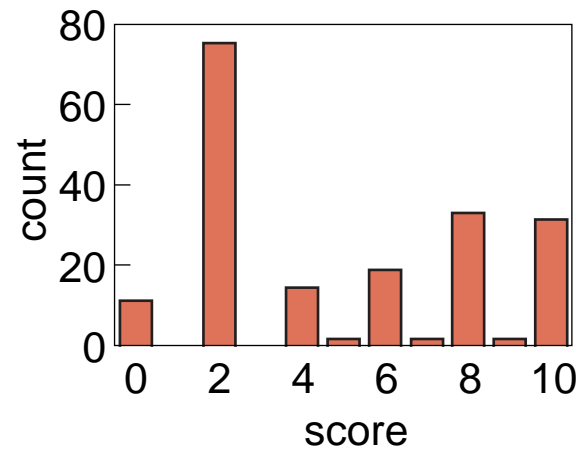


Why do we have this problem?

conventional

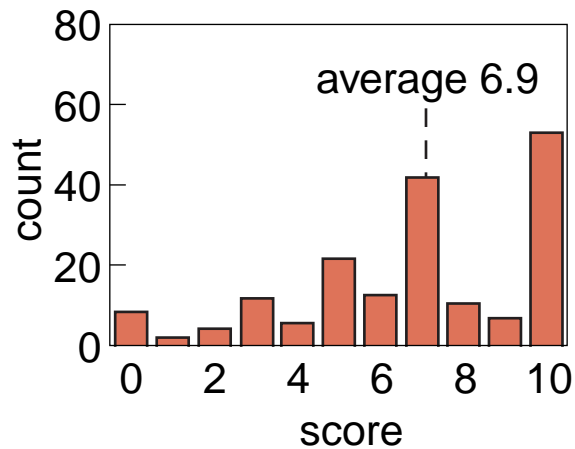


conceptual

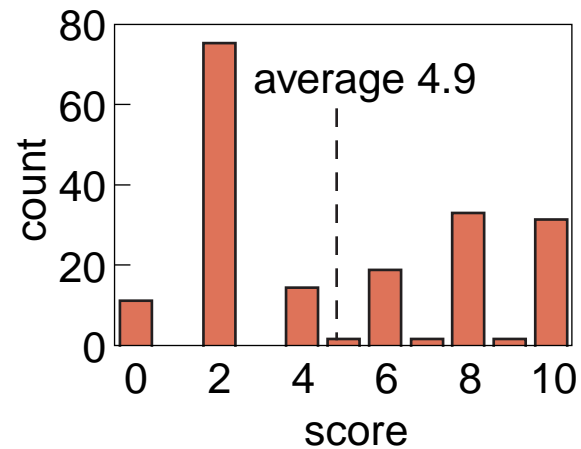


Why do we have this problem?

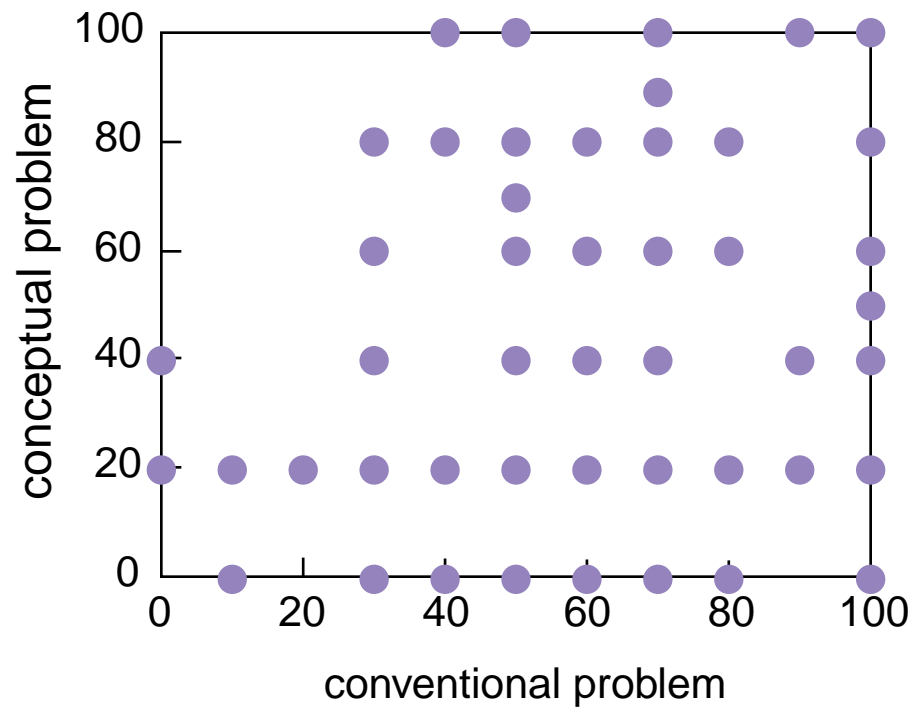
conventional



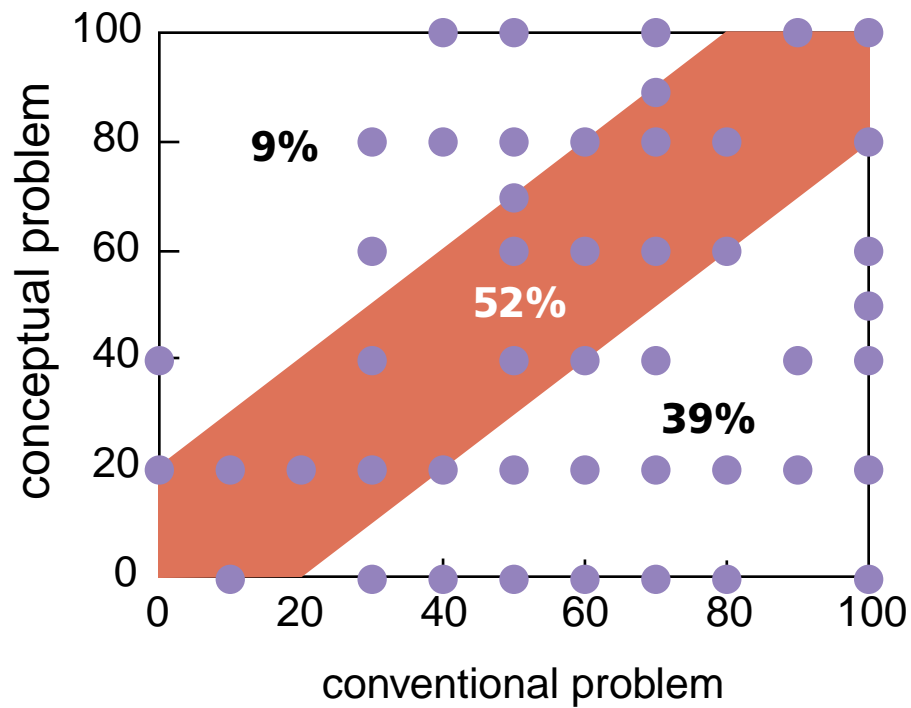
conceptual



Why do we have this problem?



Why do we have this problem?



[illegible]

Peer Instruction

Help students take more responsibility for learning!

Peer Instruction

- ▶ **Move first exposure to the material out of the classroom...**

Peer Instruction

- ▶ **Move first exposure to the material out of the classroom: *assign reading!***

Peer Instruction

- ▶ **Move first exposure to the material out of the classroom: *assign reading!***
- ▶ **Use class to deepen and broaden understanding**

Peer Instruction

- ▶ Move first exposure to the material out of the classroom: **assign reading!**
- ▶ Use class to deepen and broaden understanding
- ▶ by identifying **key ideas**

Peer Instruction

- ▶ Move first exposure to the material out of the classroom: **assign reading!**
- ▶ Use class to deepen and broaden understanding
- ▶ by identifying **key ideas**
- ▶ and giving students opportunities to **think**

Peer Instruction

Main features:

- ▶ **Pre-class reading**

Reading

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

Reading

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

Reading

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- ▶ **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

Peer Instruction

Main features:

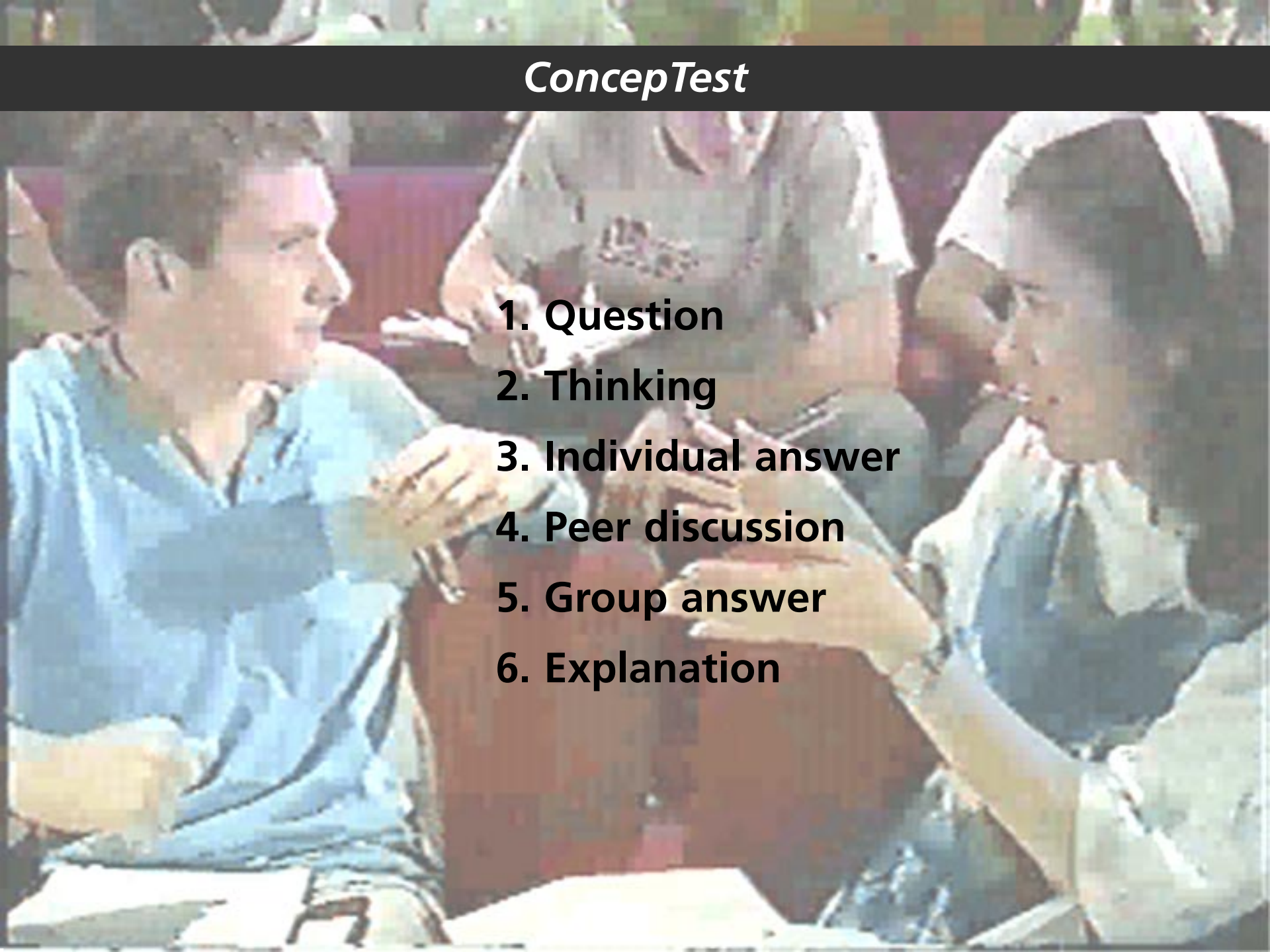
- ▶ **Pre-class reading**
- ▶ **In class: depth, not coverage**

Peer Instruction

Main features:

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

ConcepTest

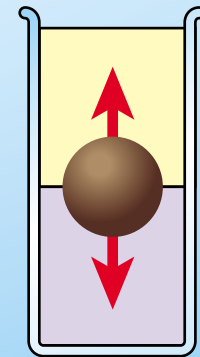
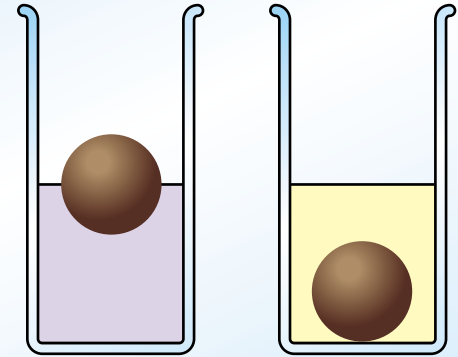
- 
- A photograph of three students in a classroom. A male student in a blue shirt is on the left, gesturing with his hands while speaking. A female student in a grey shirt is in the center, looking towards the male student. Another female student in a grey shirt is on the right, also looking towards the male student. They appear to be engaged in a discussion or a group activity.
1. Question
 2. Thinking
 3. Individual answer
 4. Peer discussion
 5. Group answer
 6. Explanation

Sample ConceptTest

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

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.



Motivating students

▶ Suitable ConceptTests

Motivating students

- ▶ **Suitable ConcepTests**
- ▶ **Rewards for participation**

Motivating students

- ▶ **Suitable ConcepTests**
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- ▶ **Noncompetitive grading**

Motivating students

- ▶ **Suitable ConcepTests**
- ▶ **Rewards for participation**
- ▶ **Noncompetitive grading**
- ▶ **Conceptual exam questions**

Is it any good?

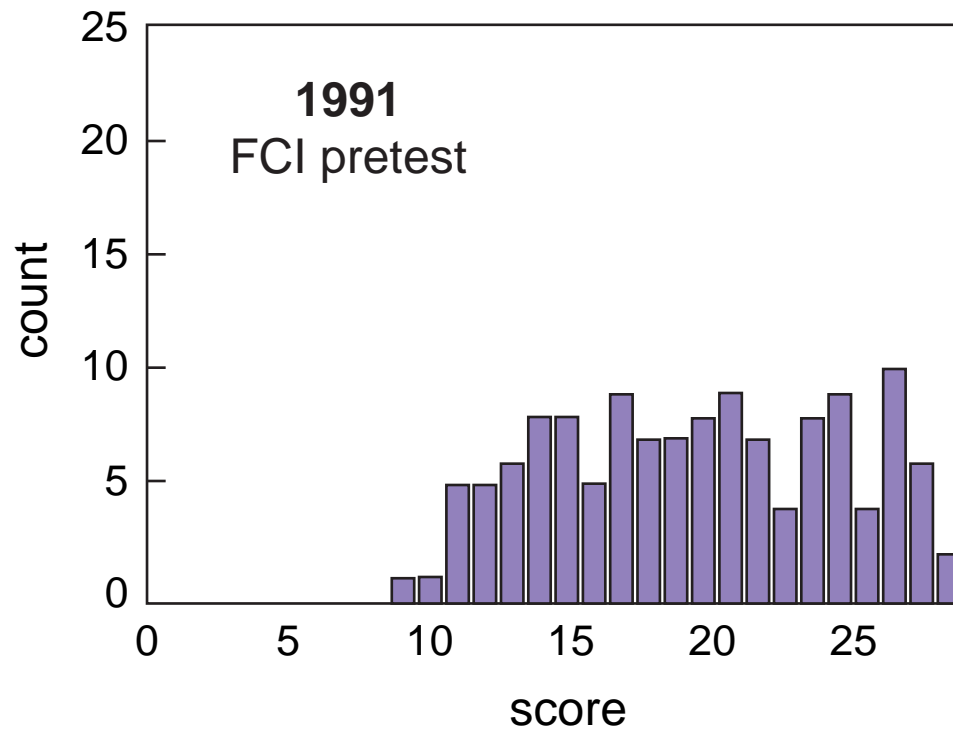
Is it any good?

► **Results**

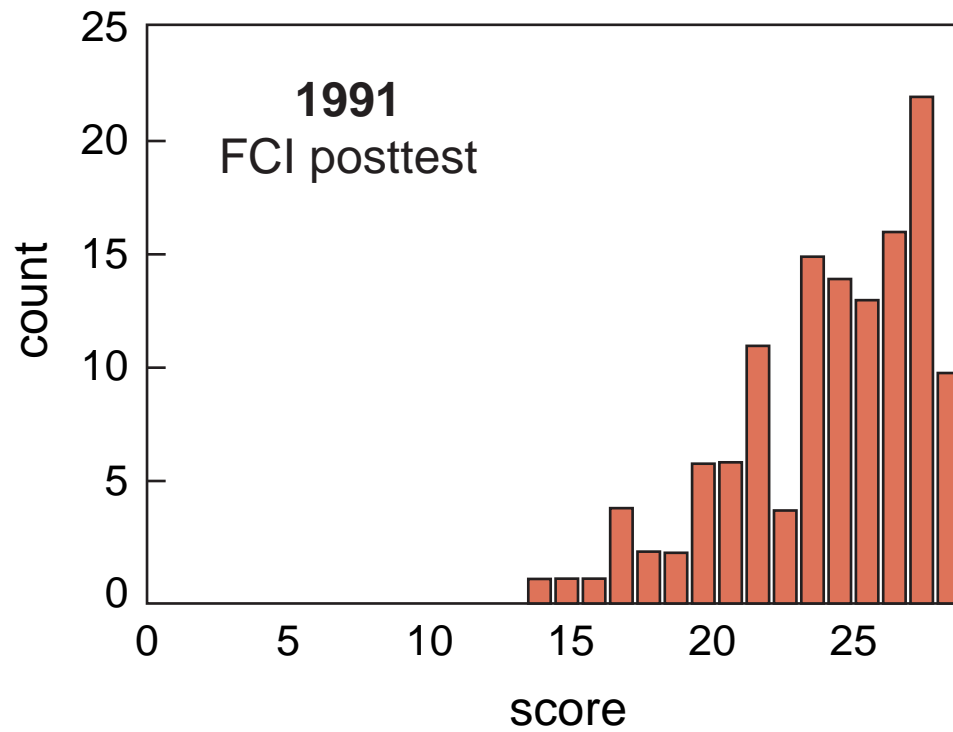
Is it any good?

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

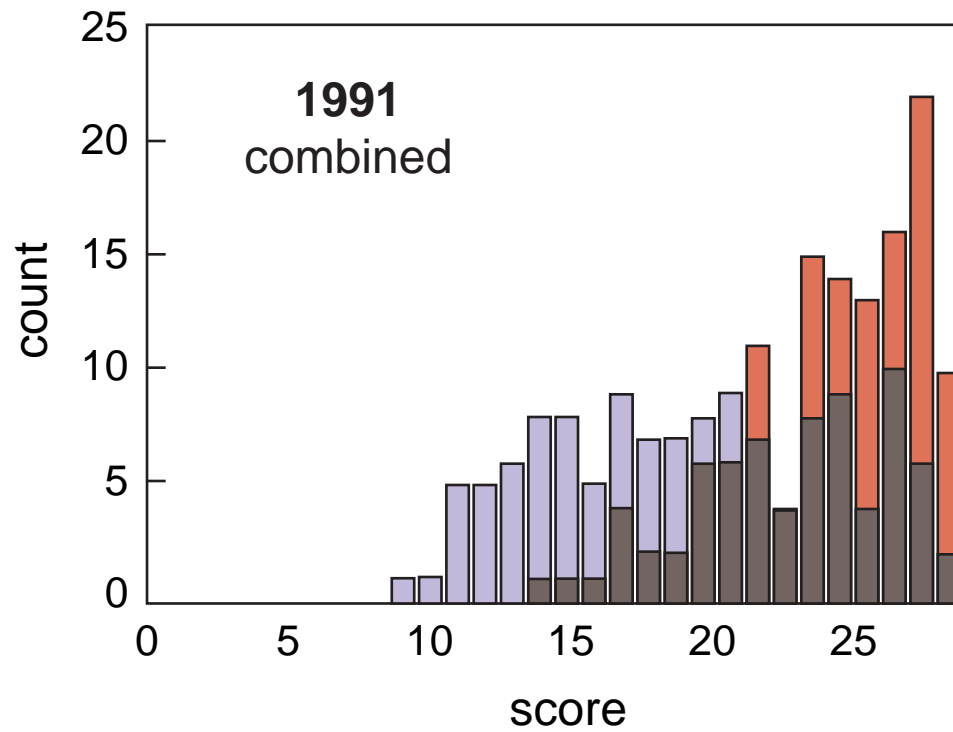
Results



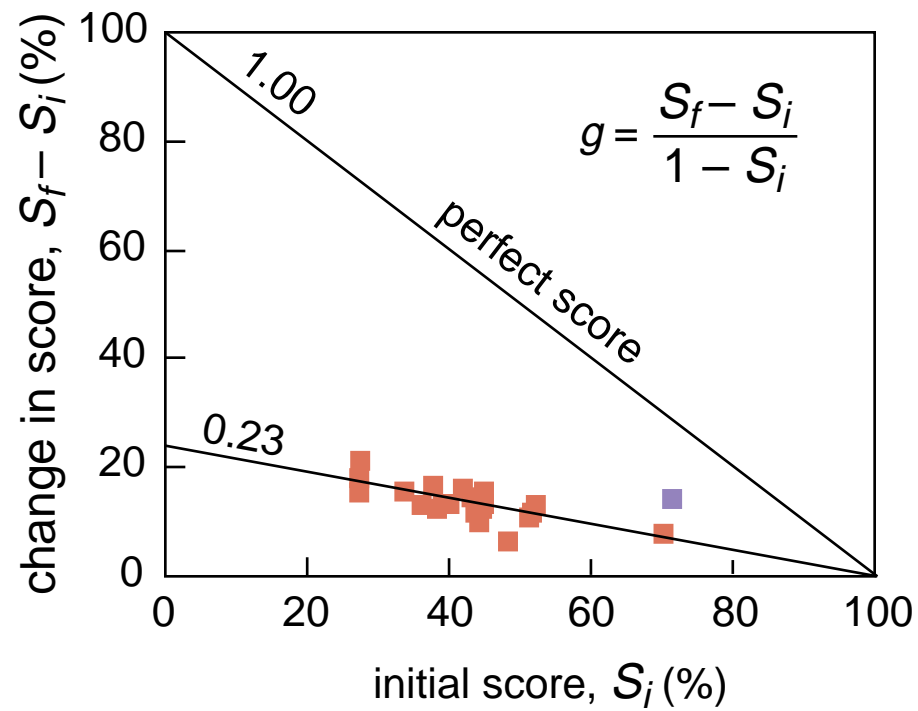
Results



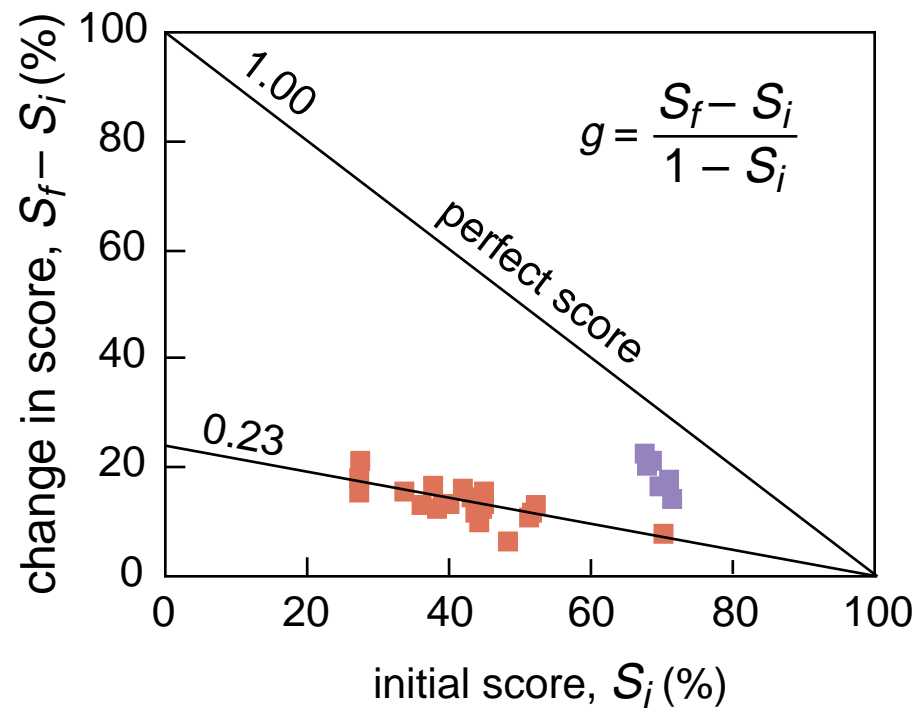
Results



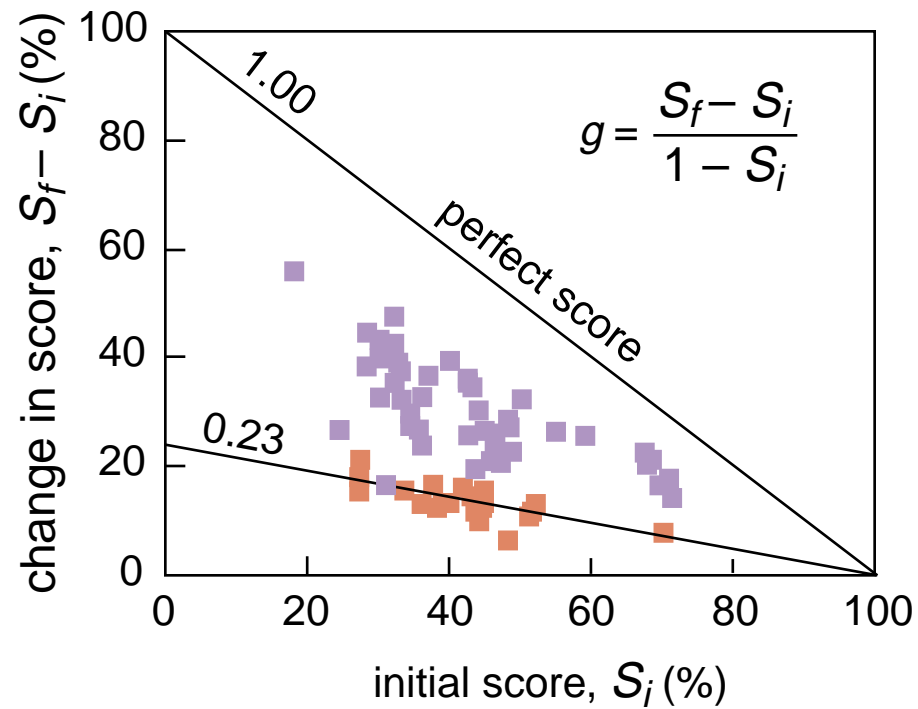
Results



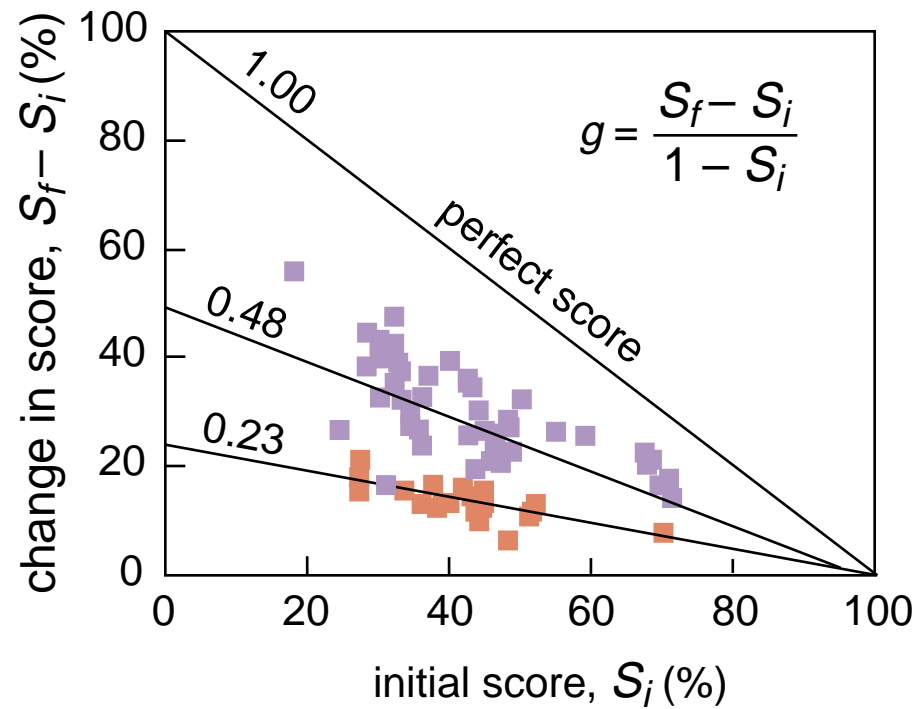
Results



Results



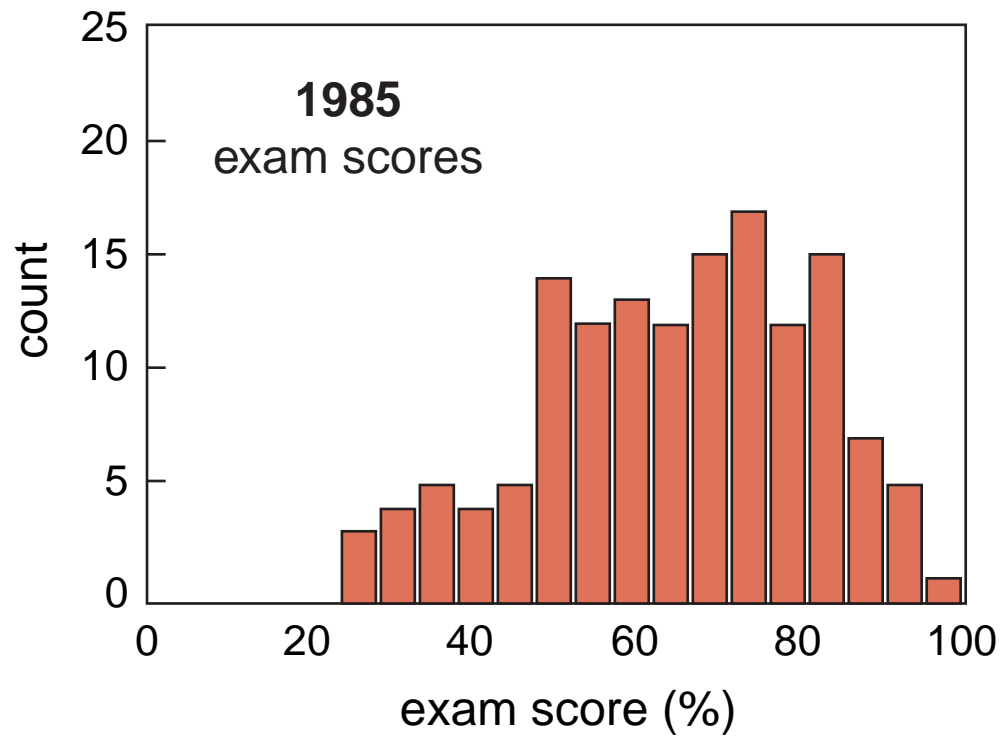
Results



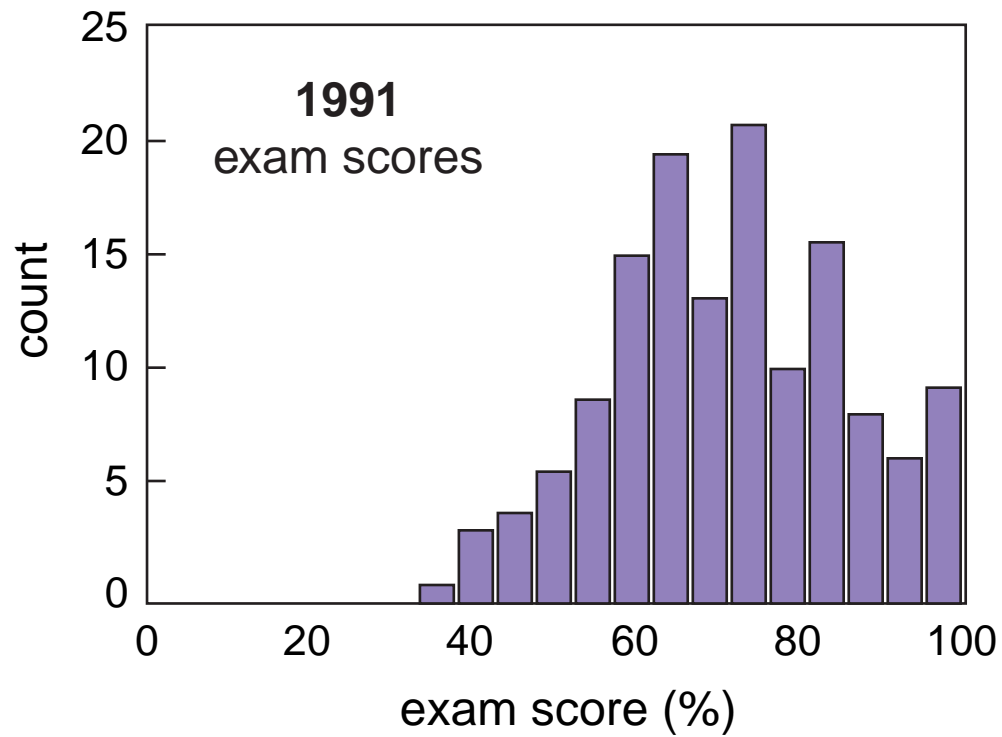
Results

What about problem solving...?

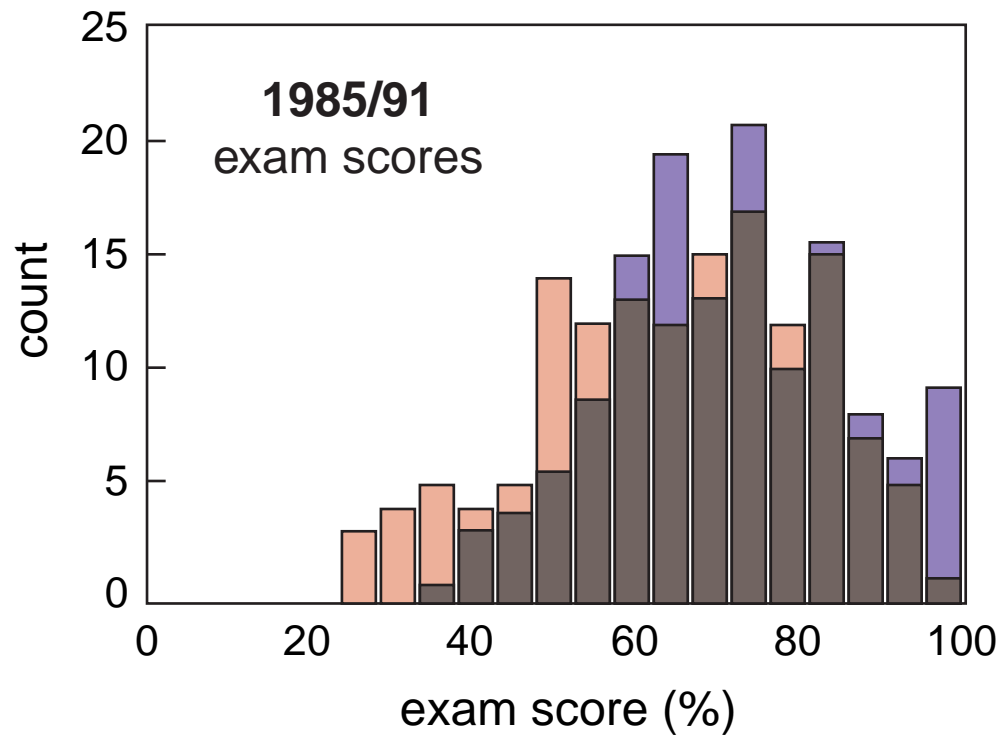
Results



Results



Results



Why it works for students

- ▶ focuses students on understanding

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Why it works for students

- ▶ focuses students on understanding
- ▶ gets students thinking

Why it works for students

- ▶ focuses students on understanding
- ▶ gets students thinking
- ▶ uncovers misunderstandings

Why it works for students

- ▶ focuses students on understanding
- ▶ gets students thinking
- ▶ uncovers misunderstandings
- ▶ builds confidence

Why it works for instructors

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Why it works for instructors

- ▶ **modification, not drastic change**

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Why it works for instructors

- ▶ **modification, not drastic change**
- ▶ **adaptable**

Why it works for instructors

- ▶ **modification, not drastic change**
- ▶ **adaptable**
- ▶ **resources (<http://galileo.harvard.edu>)**

Results

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

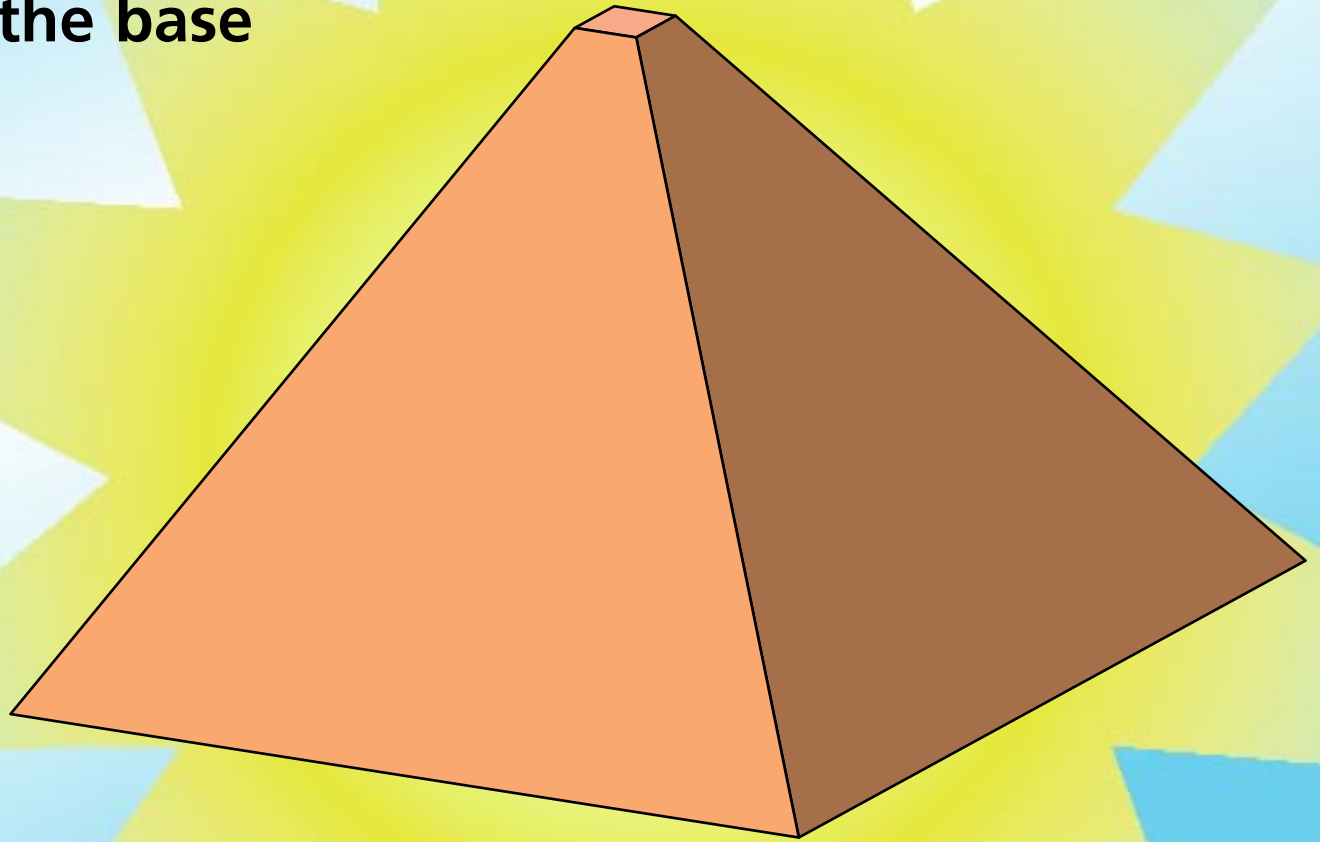
Results

So better understanding leads to better problem solving!

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

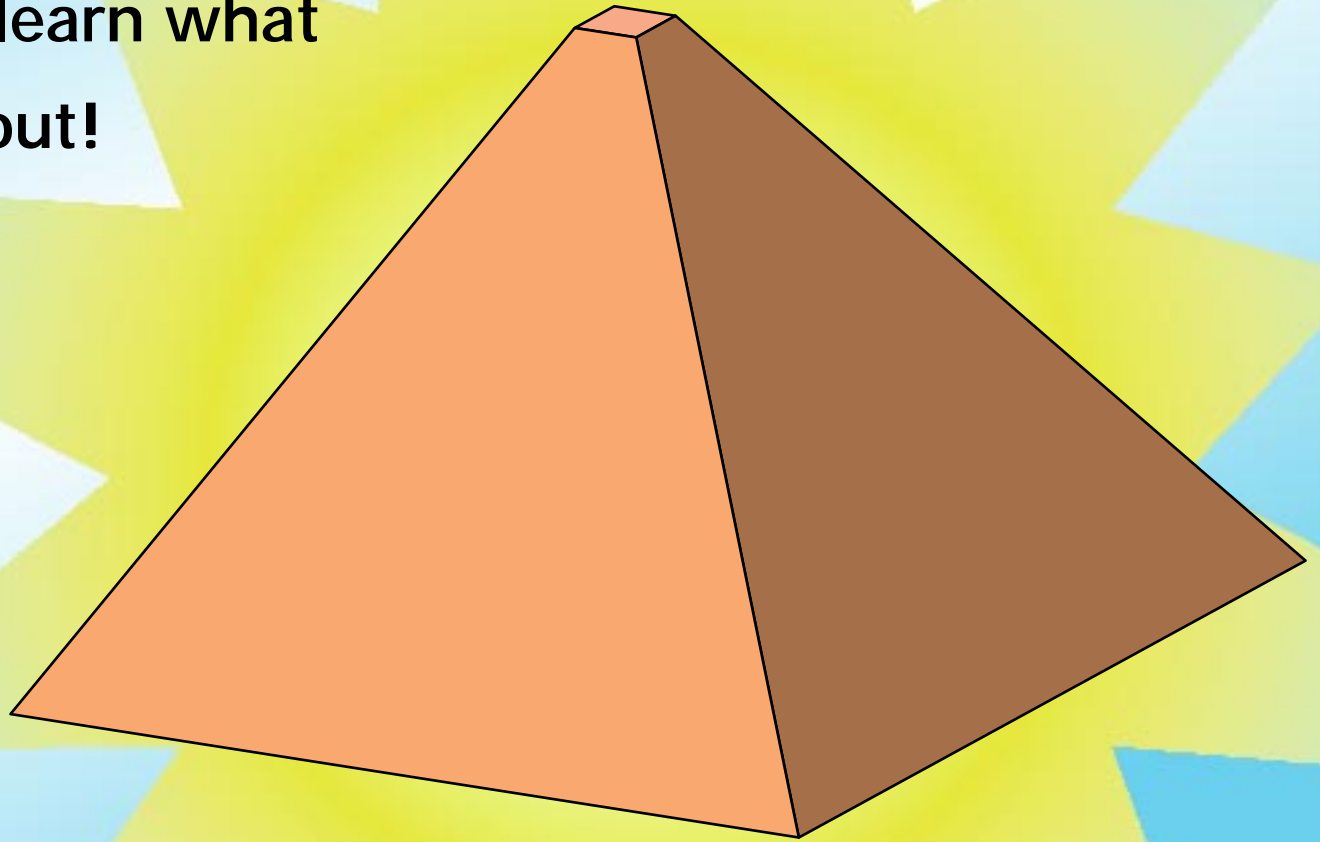
Conclusion

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



Conclusion

Let's help them learn what science is all about!



Conclusion

Challenges:

- ▶ **skepticism**
- ▶ **growing pains**

Conclusion

Rewards:

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

Funding

National Science Foundation

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

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