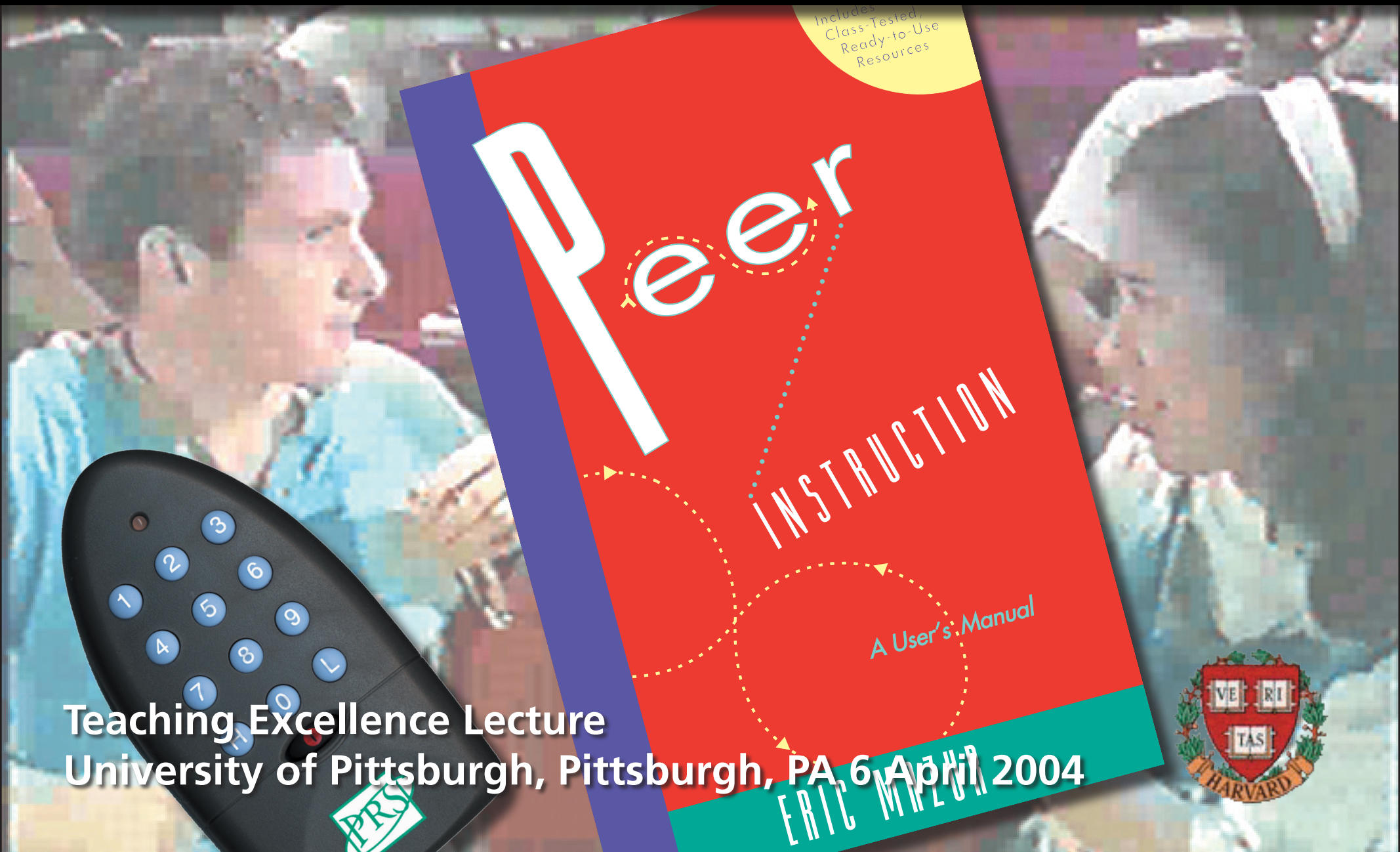
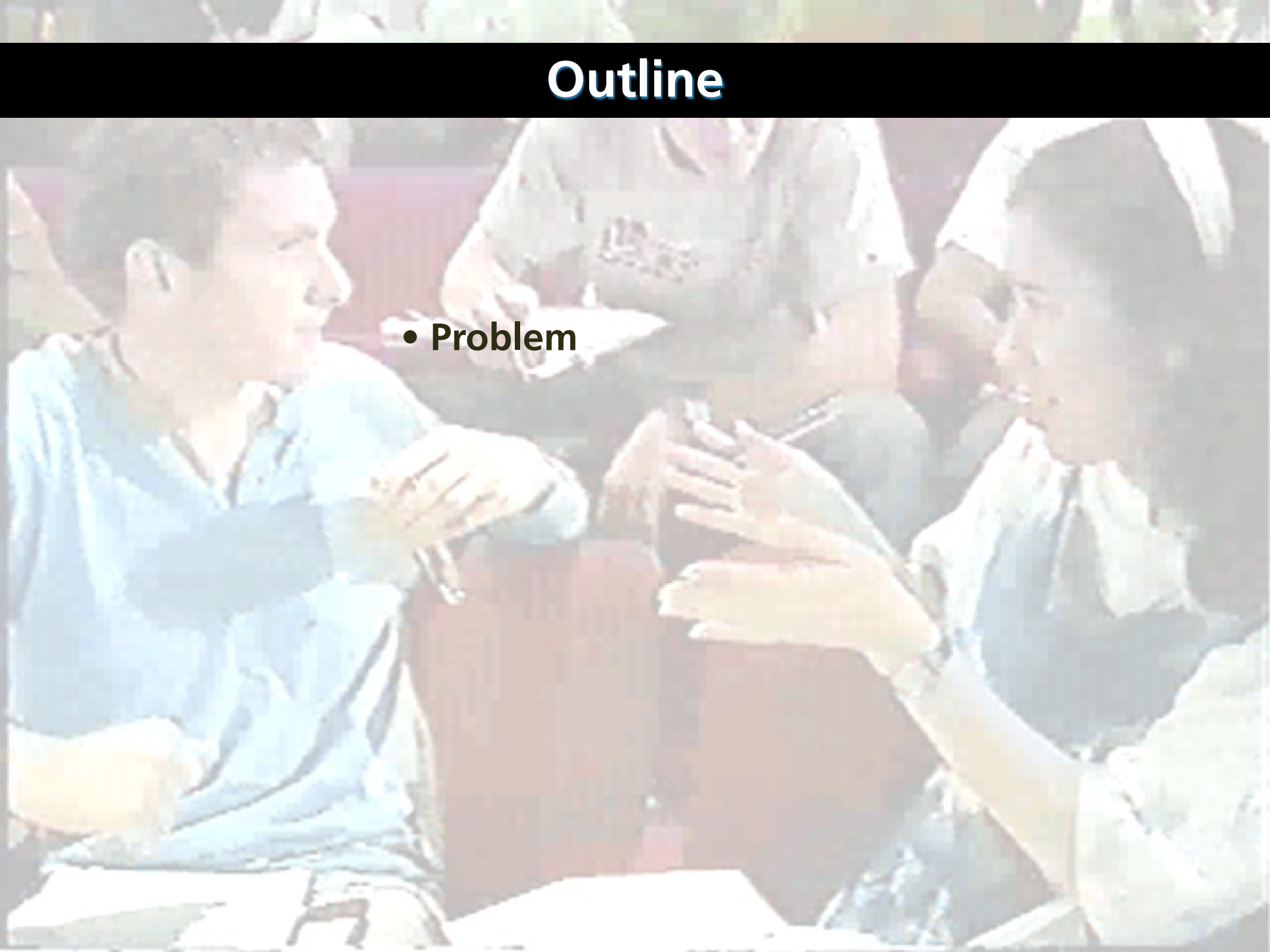
Memorization or Understanding: Are we teaching the right thing?



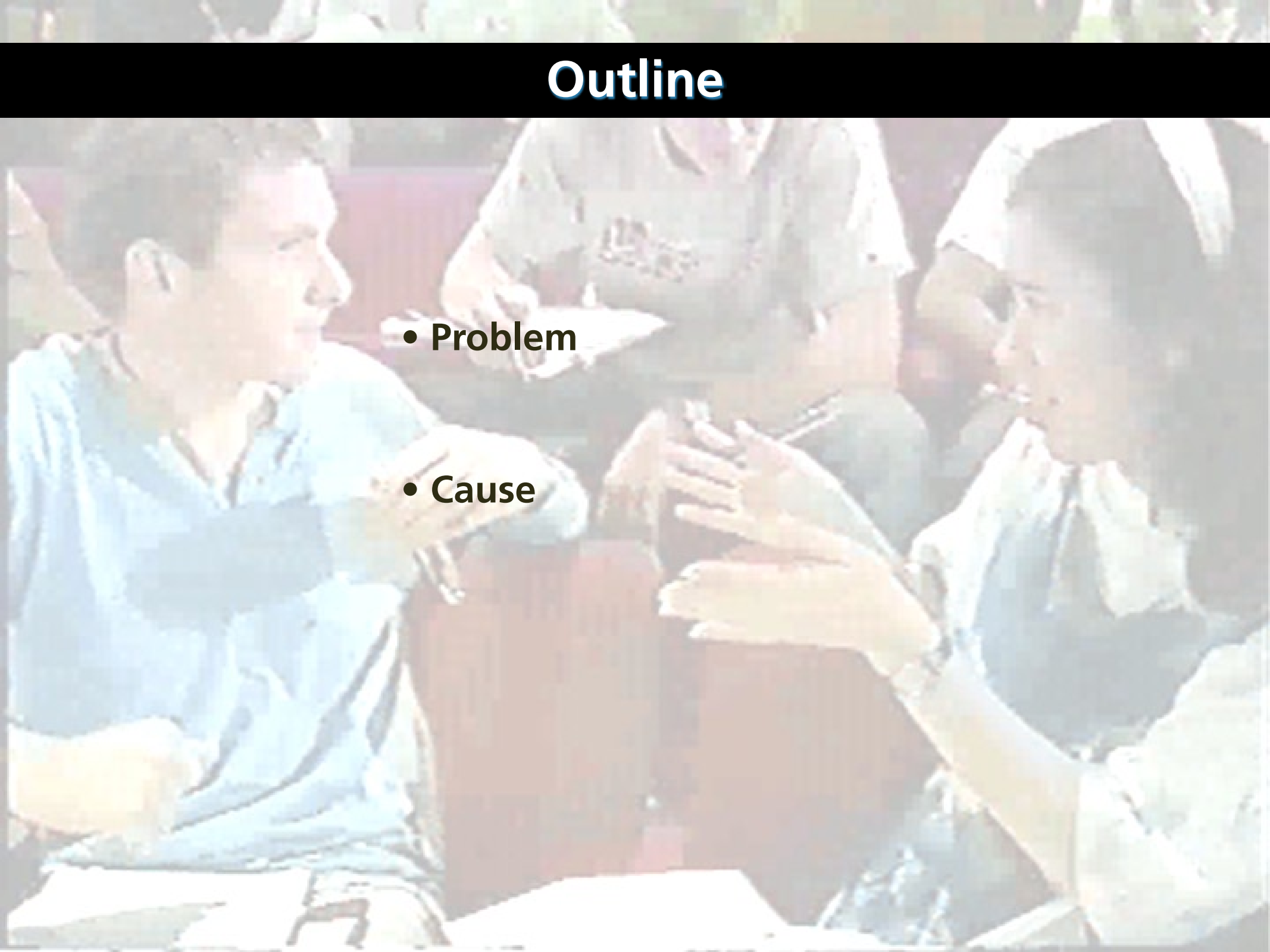
Teaching Excellence Lecture
University of Pittsburgh, Pittsburgh, PA 6 April 2004

Outline



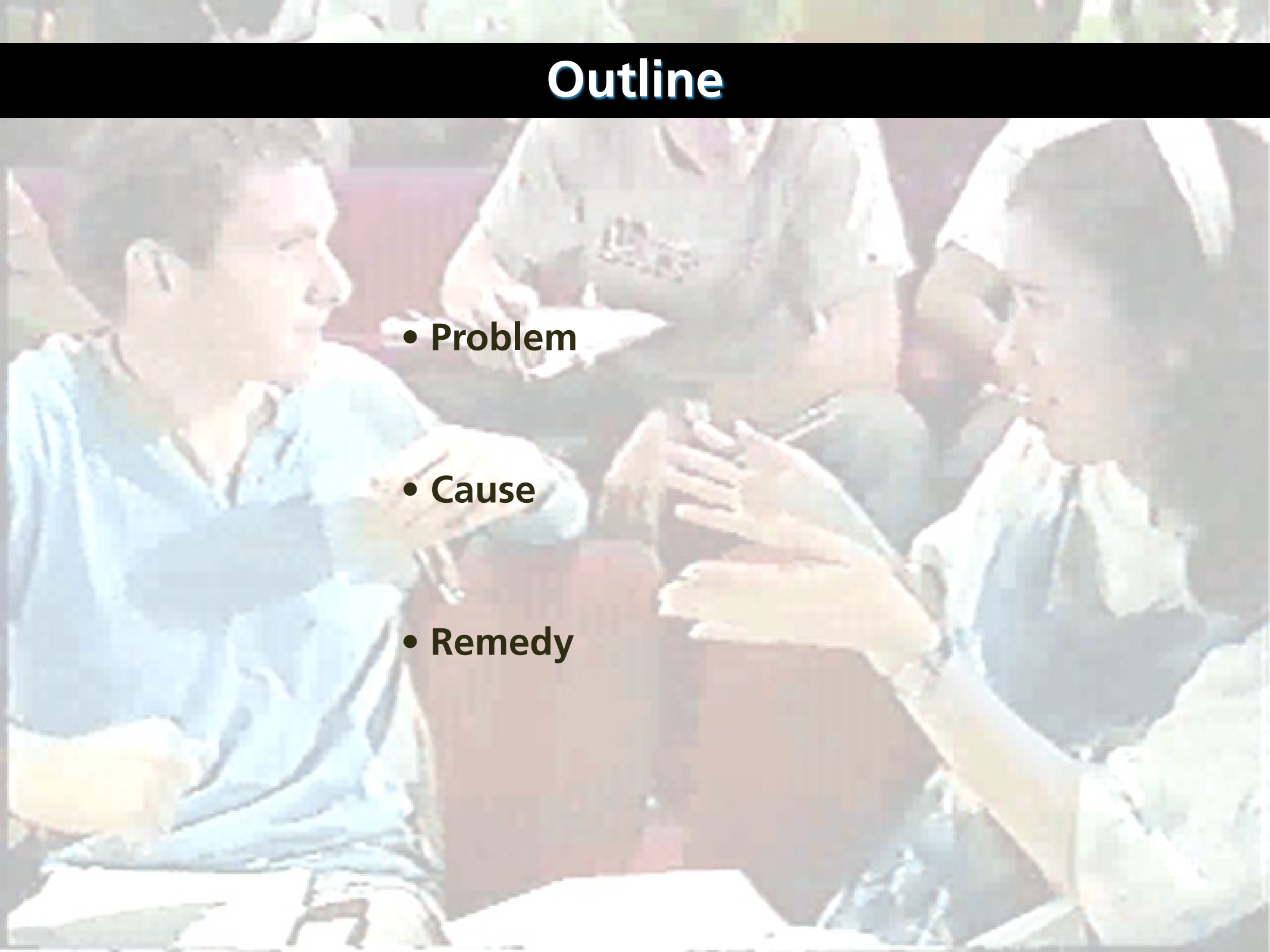
- Problem

Outline



- Problem
- Cause

Outline



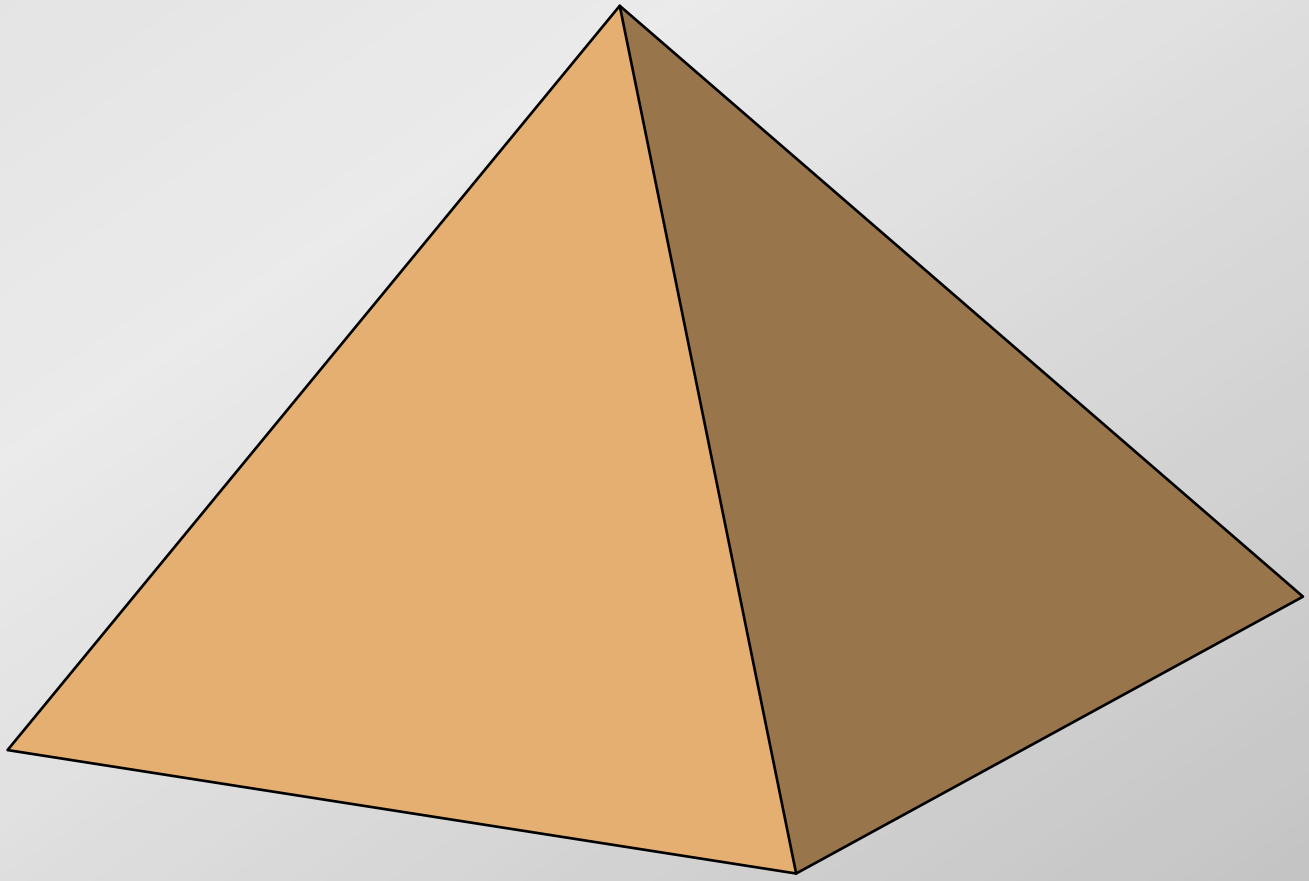
- Problem
- Cause
- Remedy

We have a problem

340,000 students take

introductory physics

each year



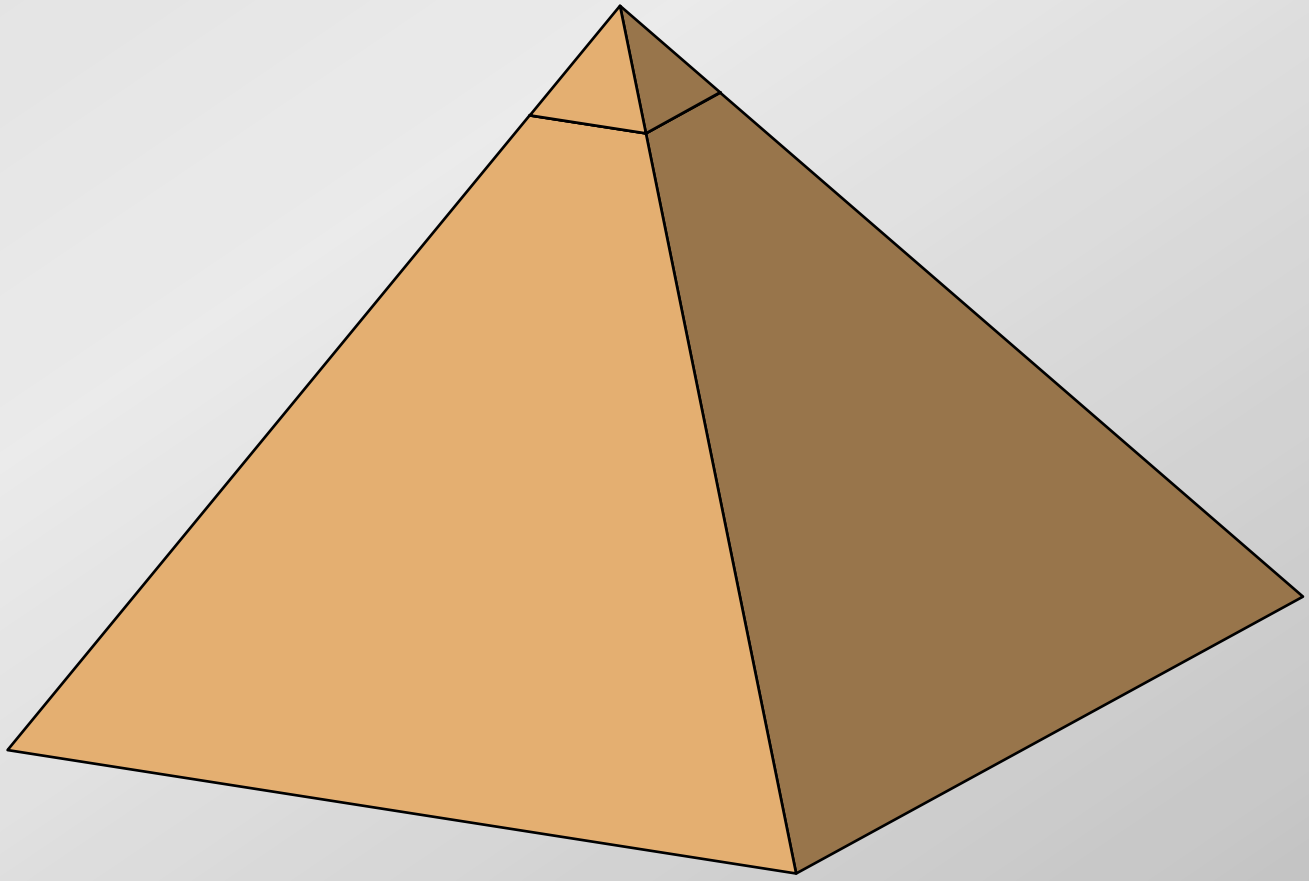
AIP Report R-151.39 (2003)

We have a problem

about 1% of these get

a bachelor's degree

in physics



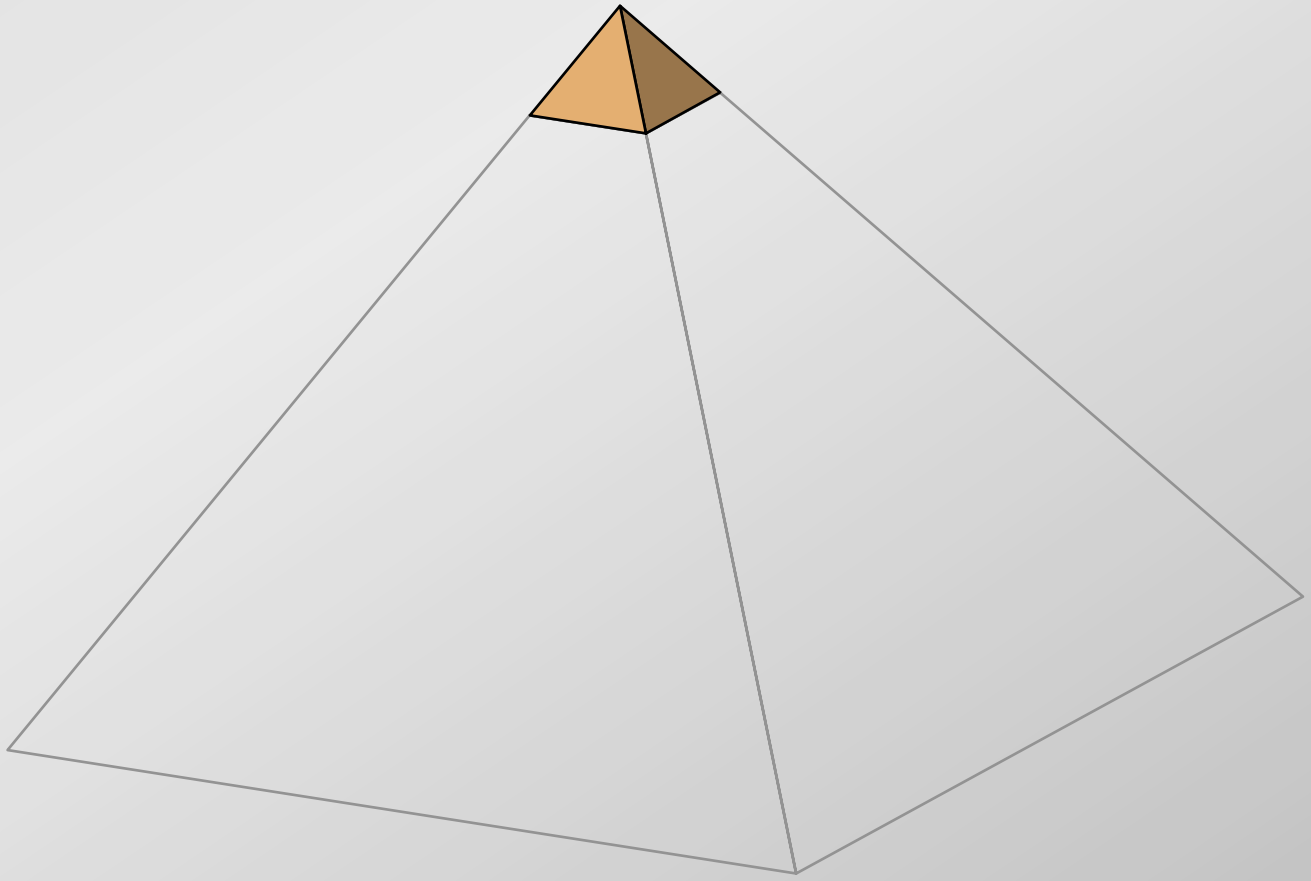
AIP Report R-151.39 (2003)

We have a problem

Of the 4,100 students with

a bachelor's degree

in physics…

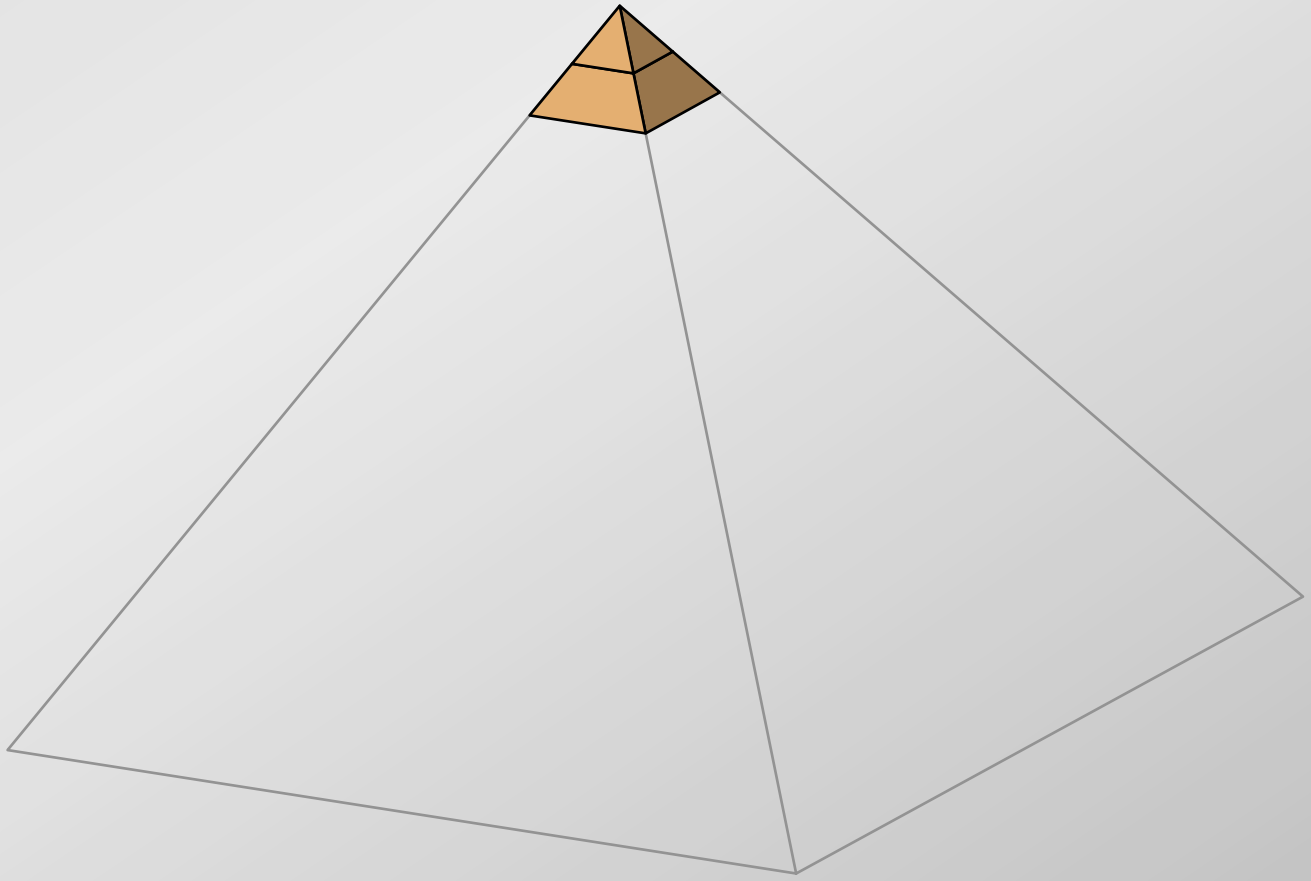


AIP Report R-151.39 (2003)

We have a problem

about 28% go on to get a

Ph.D. in physics…



AIP Report R-151.39 (2003)

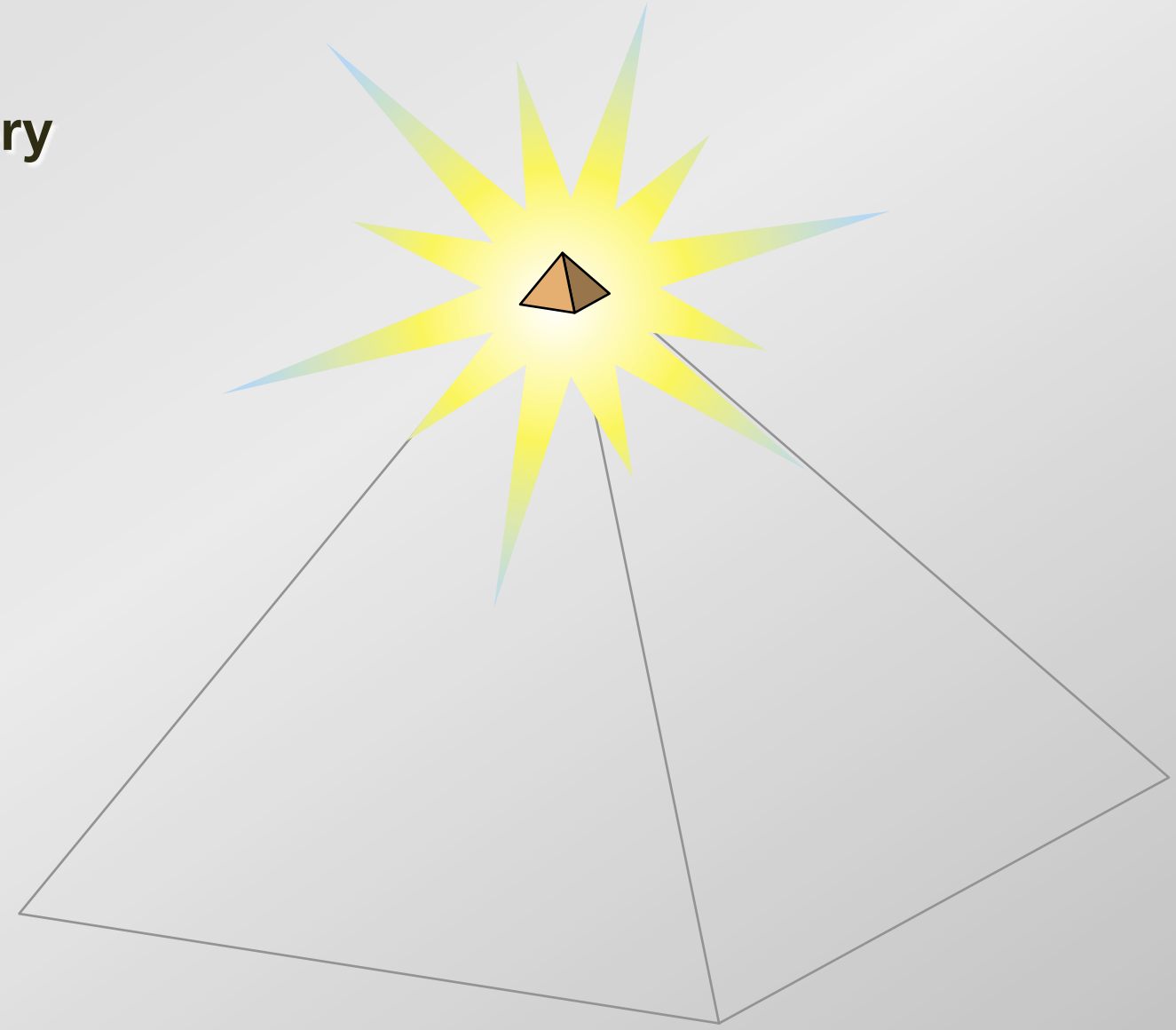
We have a problem

That's one out of every

300 students in our

introductory

courses!

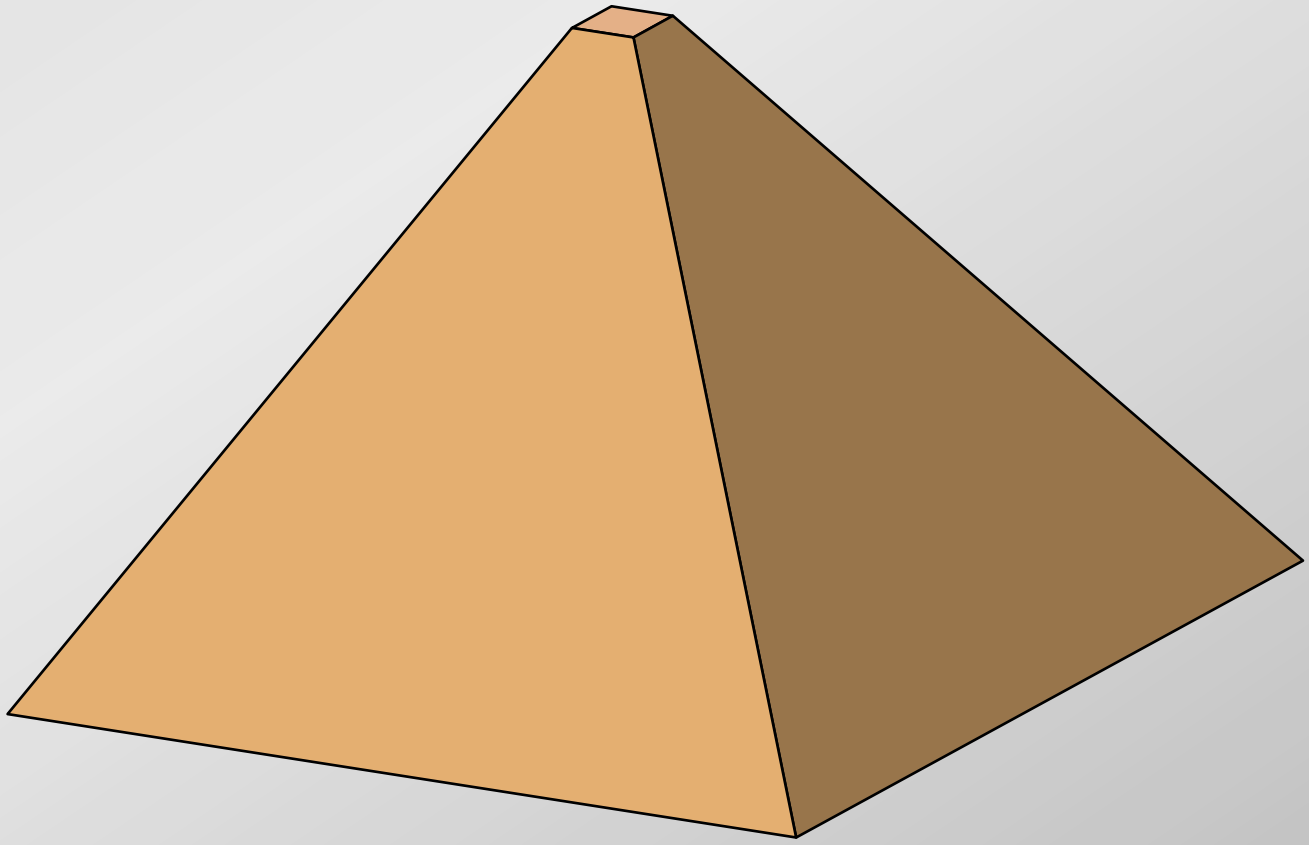


AIP Report R-151.39 (2003)

We have a problem

What about the

other 299…?



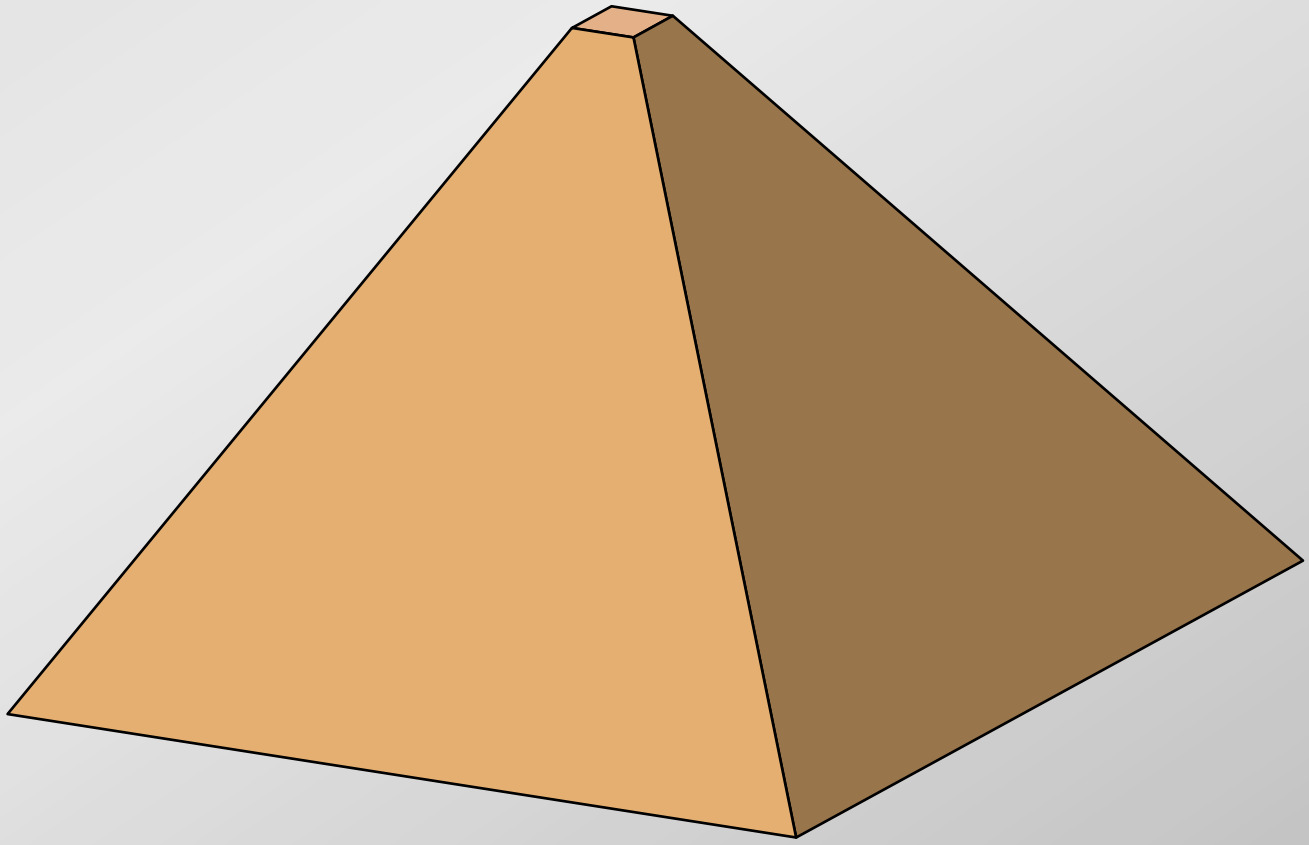
AIP Report R-151.39 (2003)

We have a problem

What do we know

about these

students?



AIP Report R-151.39 (2003)

We have a problem

Some disturbing symptons:

- 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…

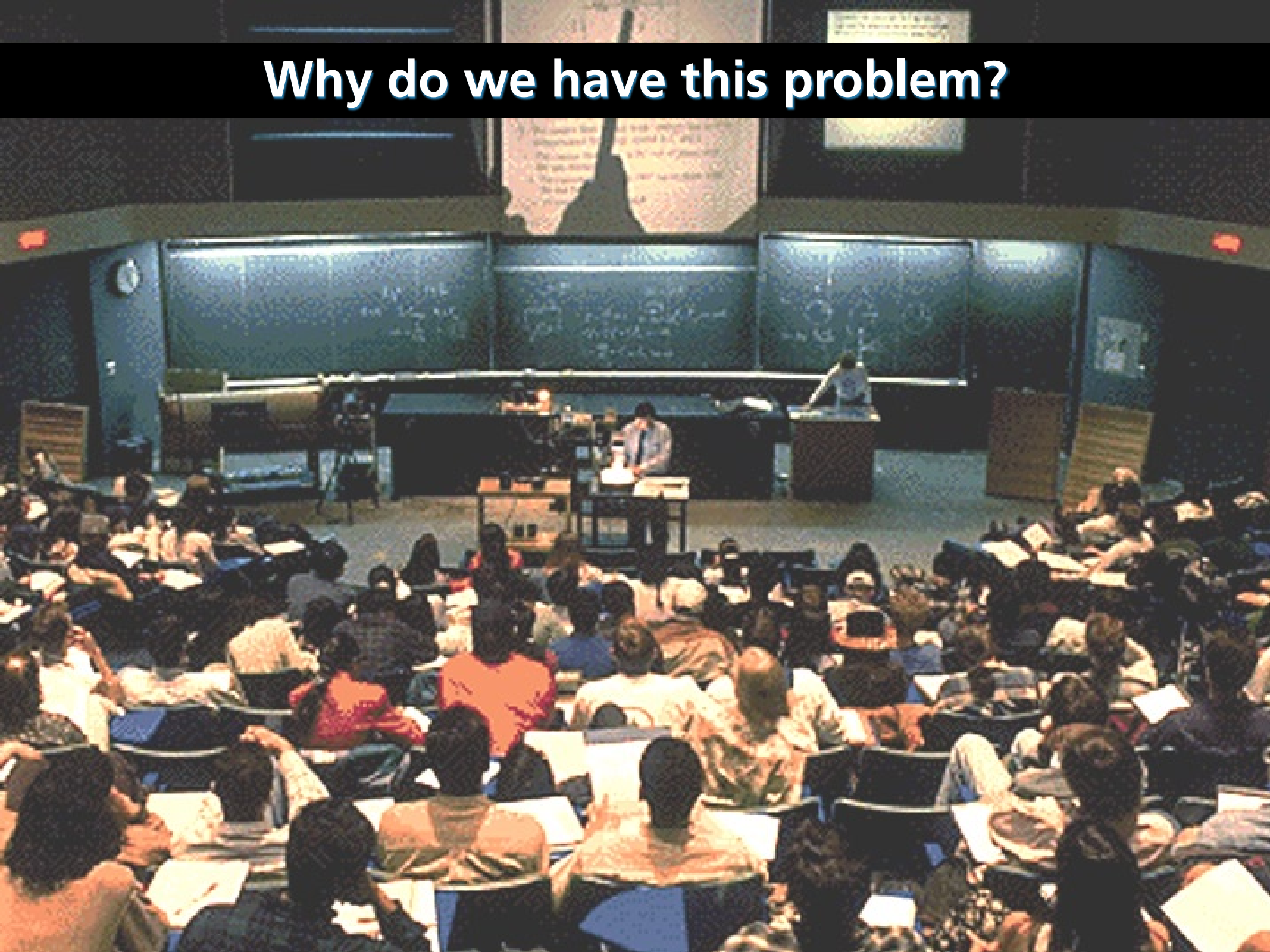
A waste of my time, a waste of the teacher's time, and a waste of space…

You know, I took *physics*.

For *what*?"

Why do we have this problem?

Why do we have this problem?



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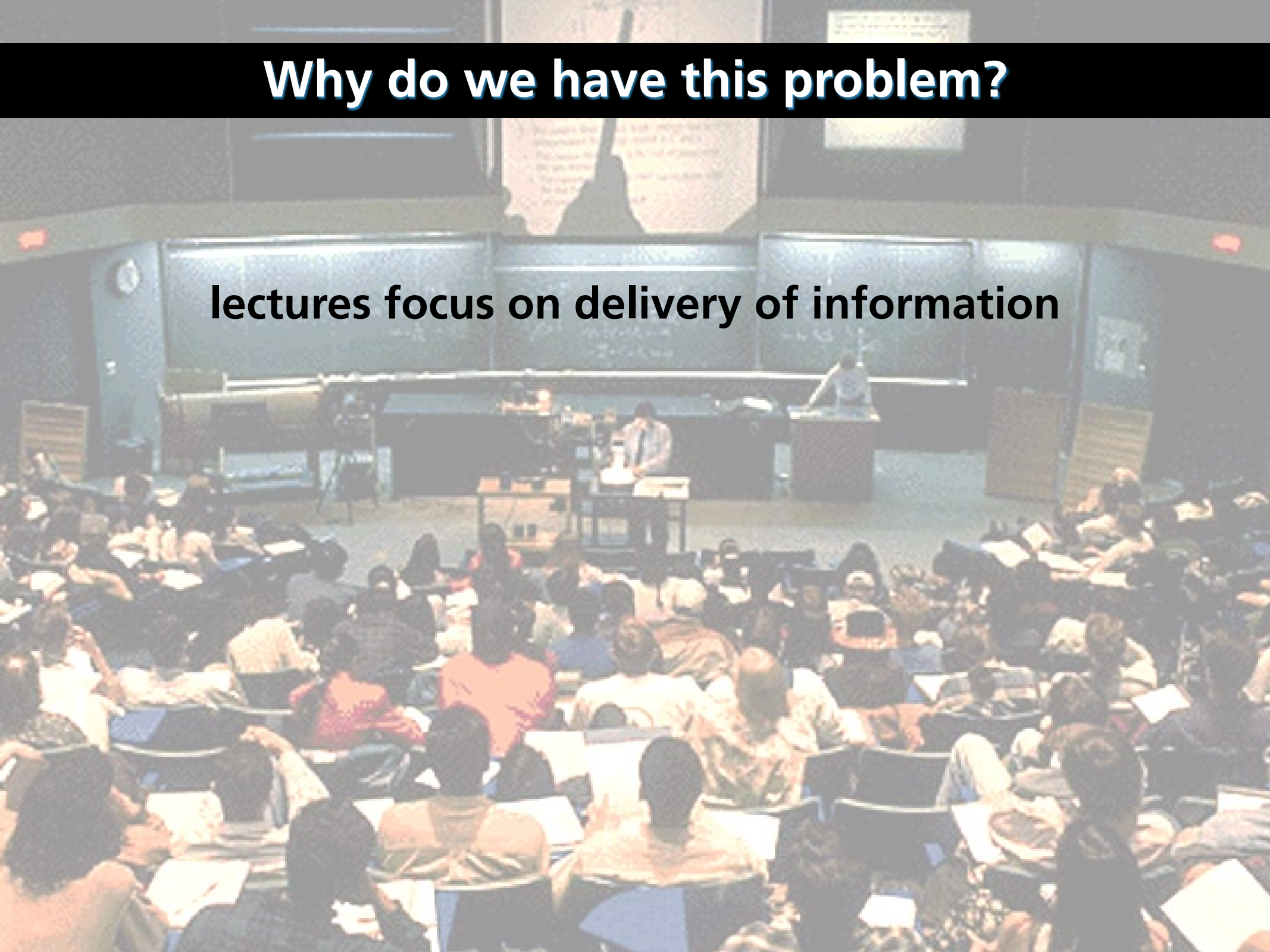
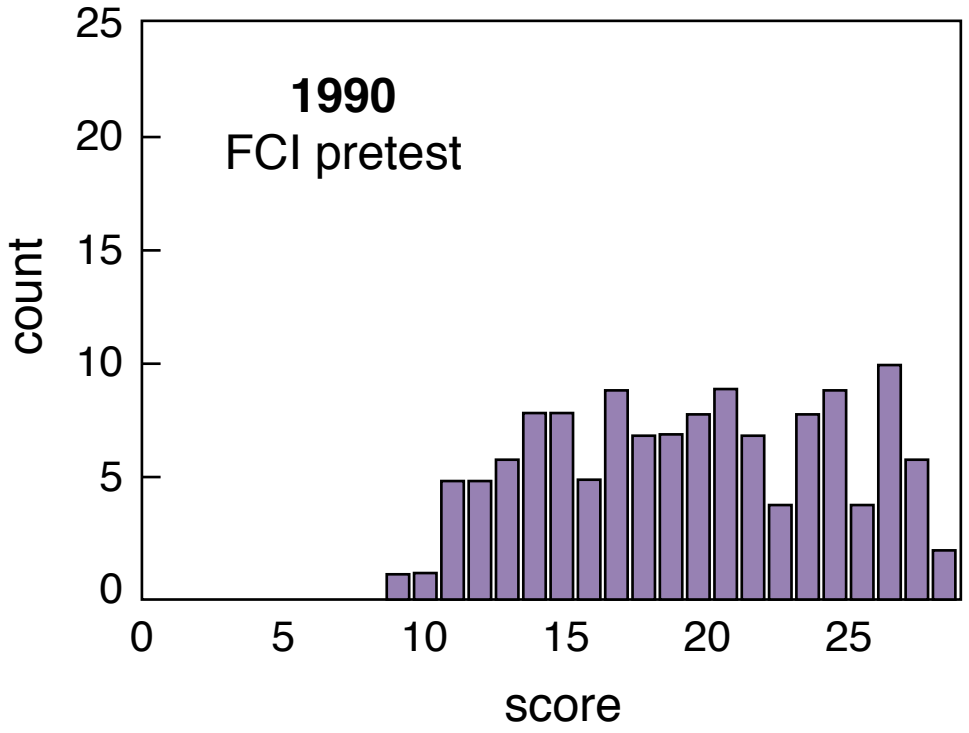


lectures focus on delivery of information

Why do we have this problem?

education is not just information transfer



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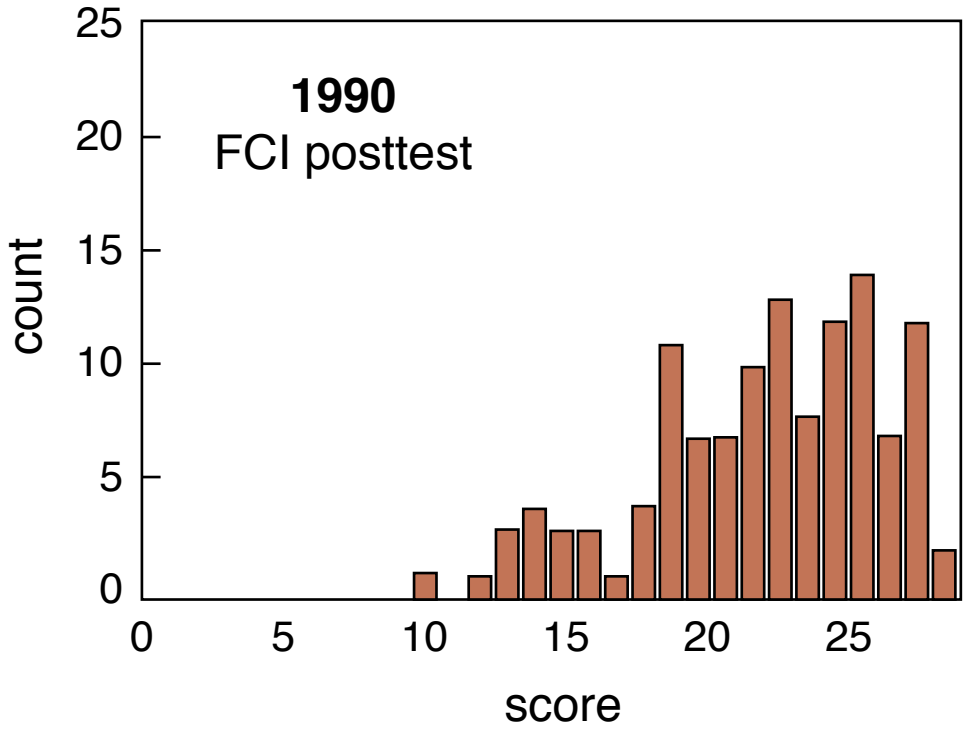

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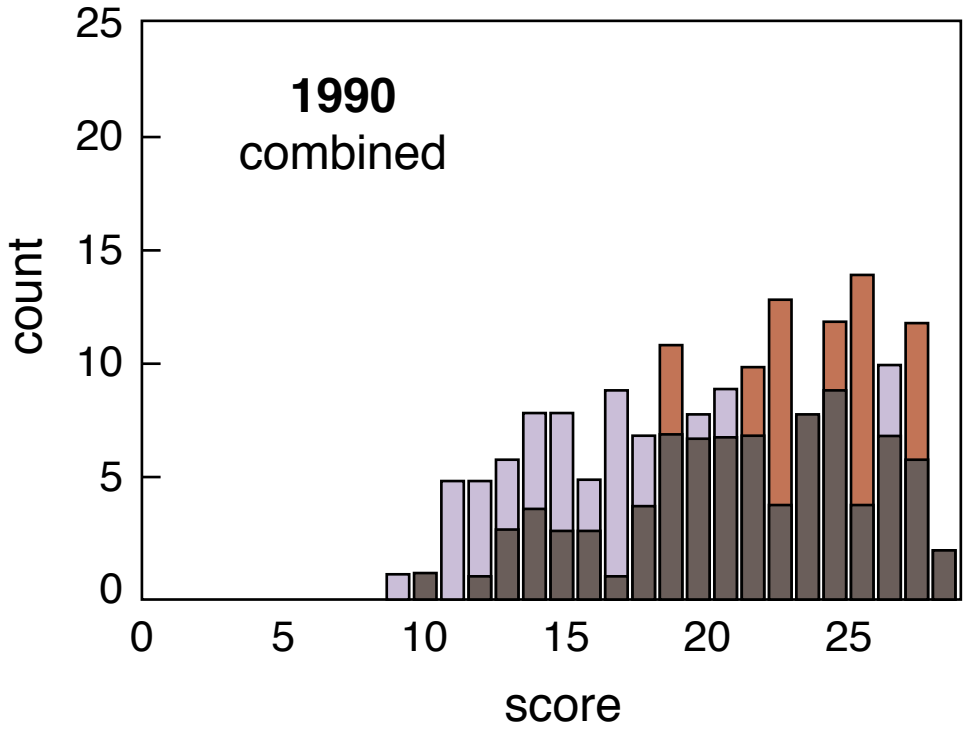

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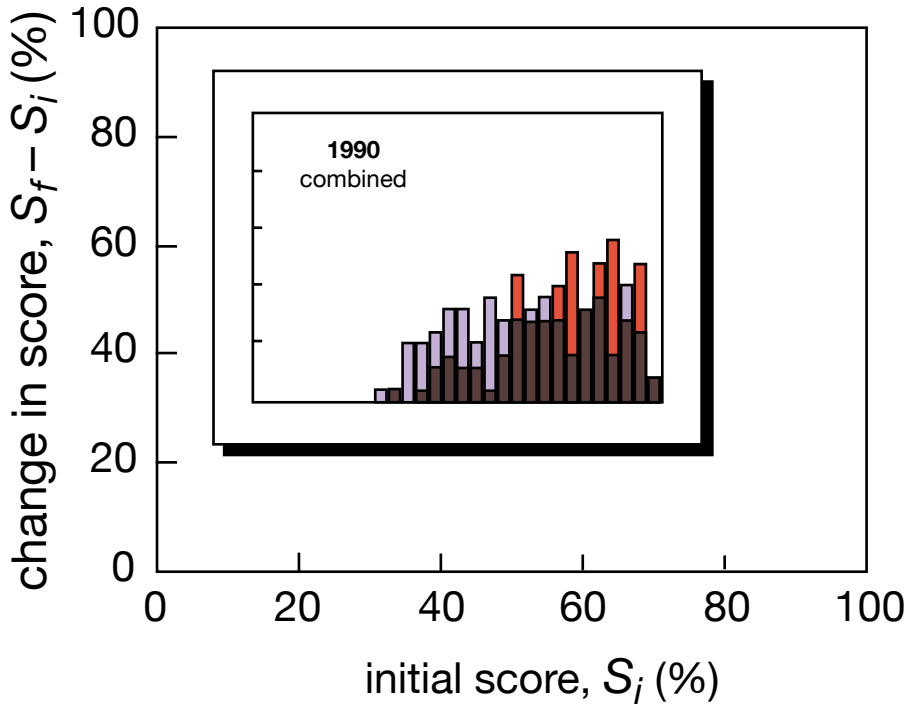

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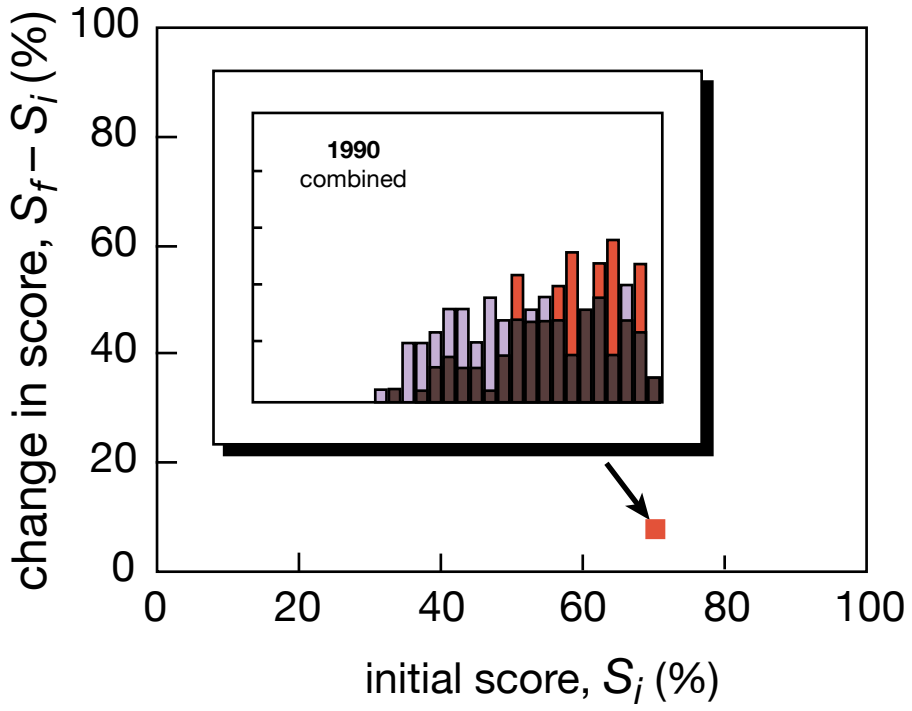

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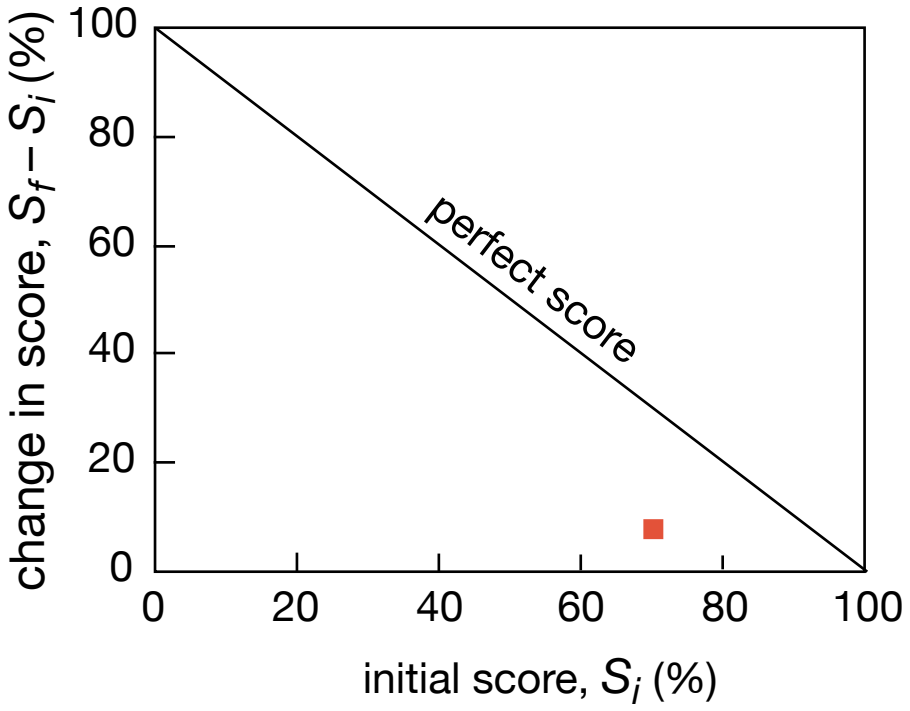

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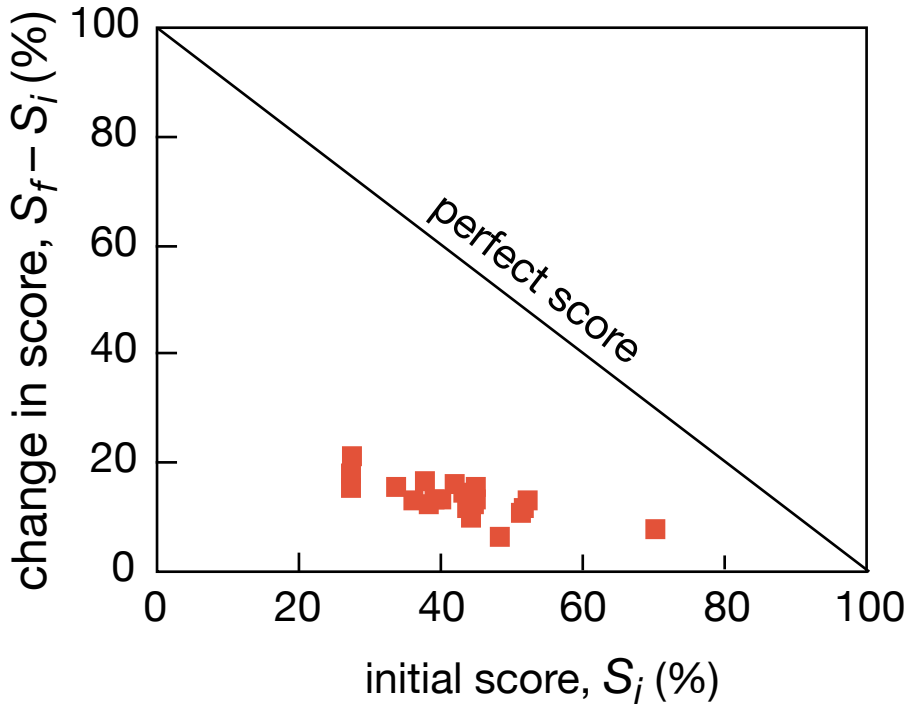
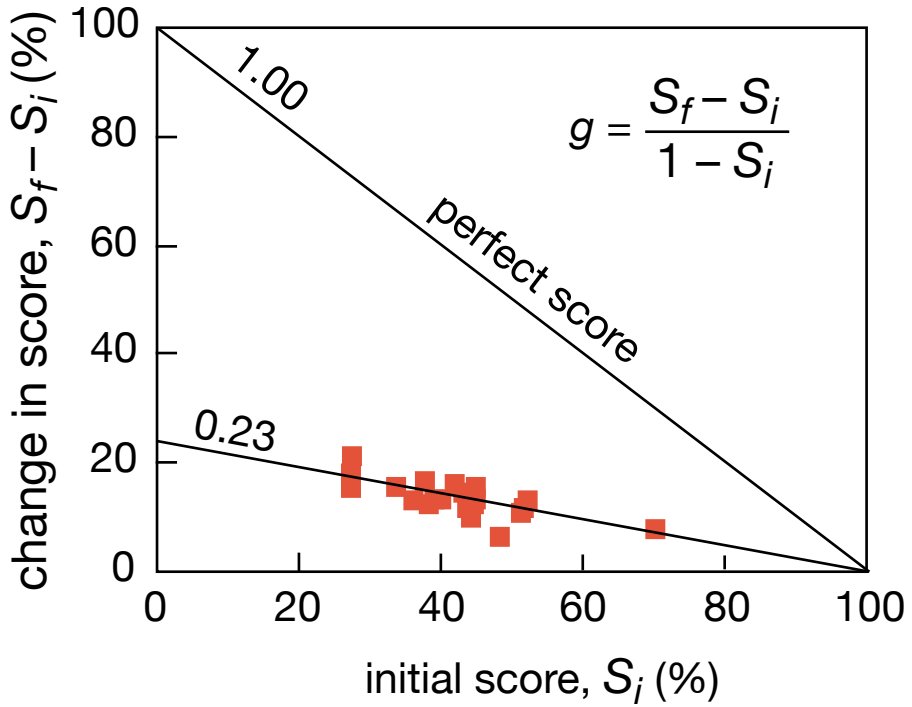


R.R. Hake, *Am. J. Phys.* 66, 64 (1998)

Why do we have this problem?

only one quarter of maximum gain realized



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

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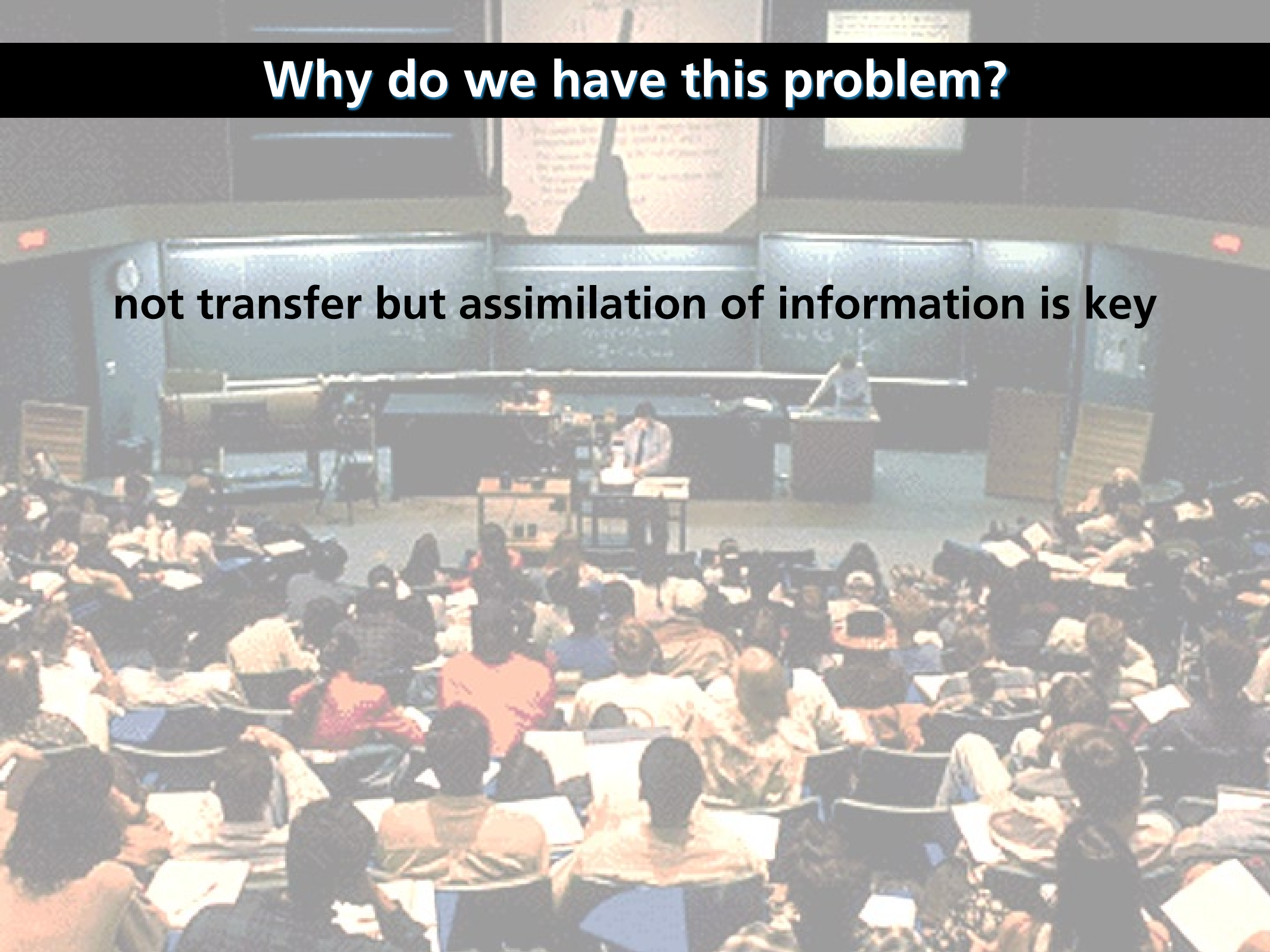
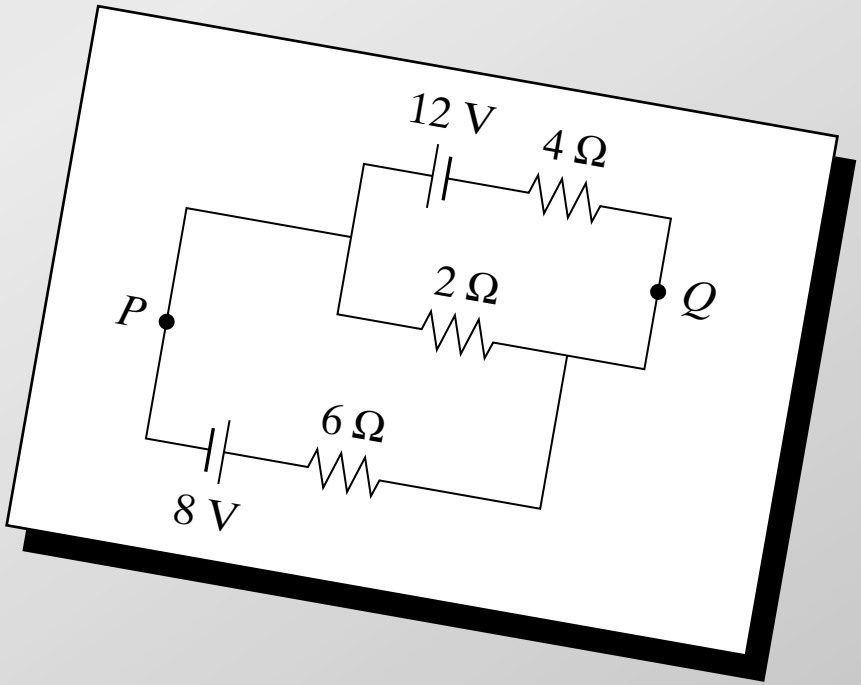


not transfer but assimilation of information is key

Why do we have this problem?

conventional problems reinforce bad study habits



Why do we have this problem?

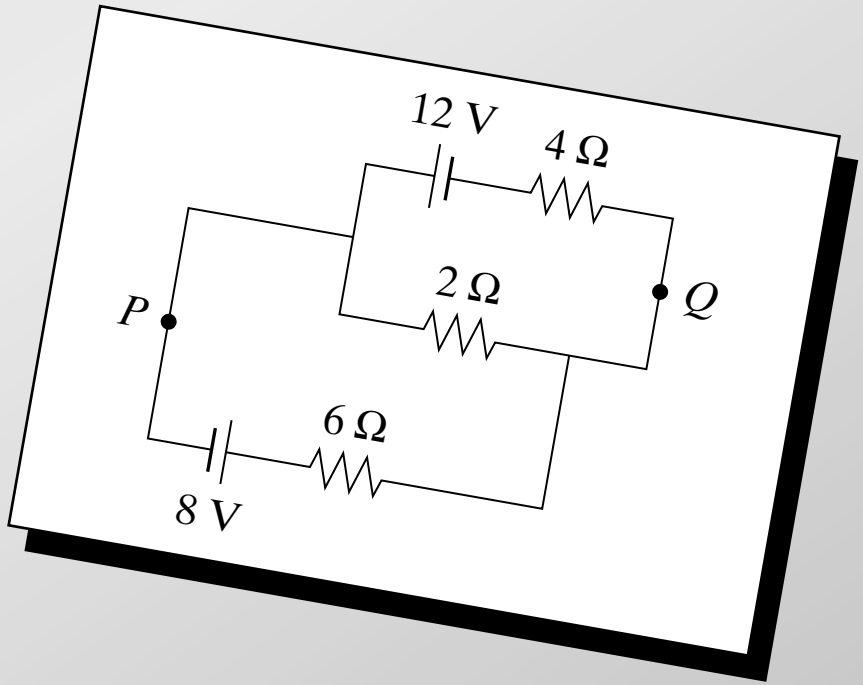
conventional problems reinforce bad study habits

Calculate:

(*a*) current in 2-Ω resistor

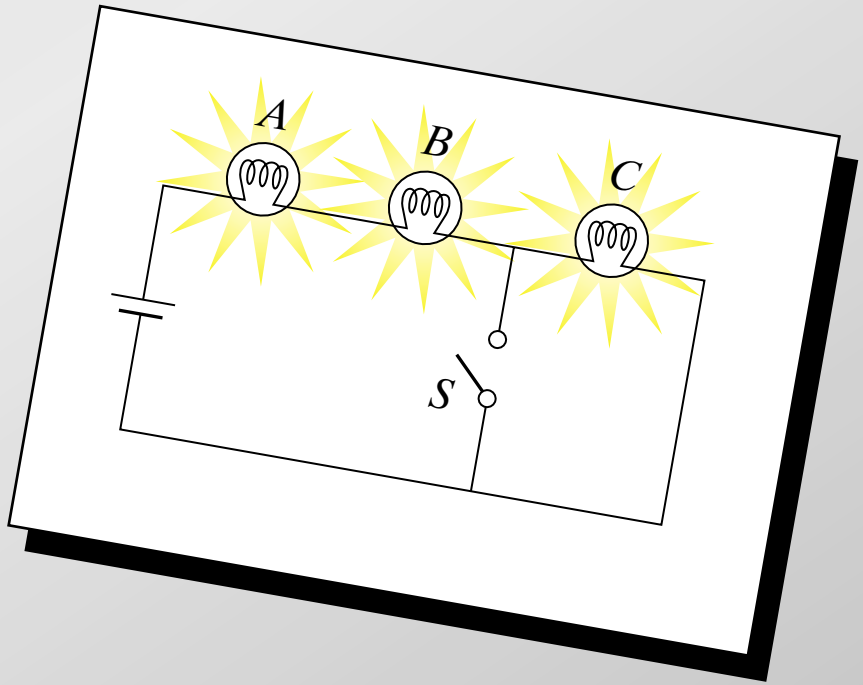
(*b*) potential difference

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?

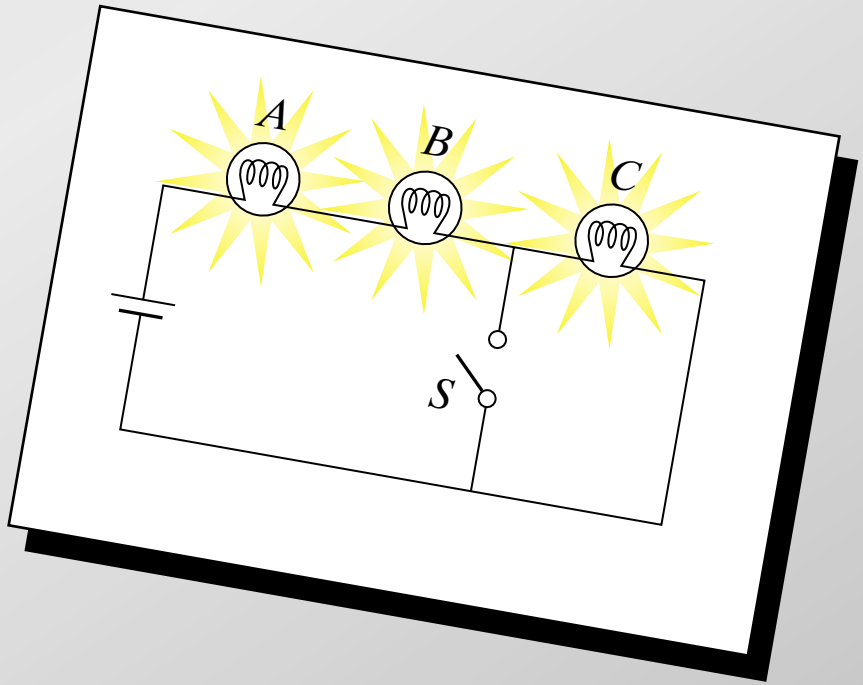
(*b*) intensity of C?

(*c*) current through battery?

(*d*) potential difference across

A, *B*, and *C*?

(*e*) the total power dissipated?



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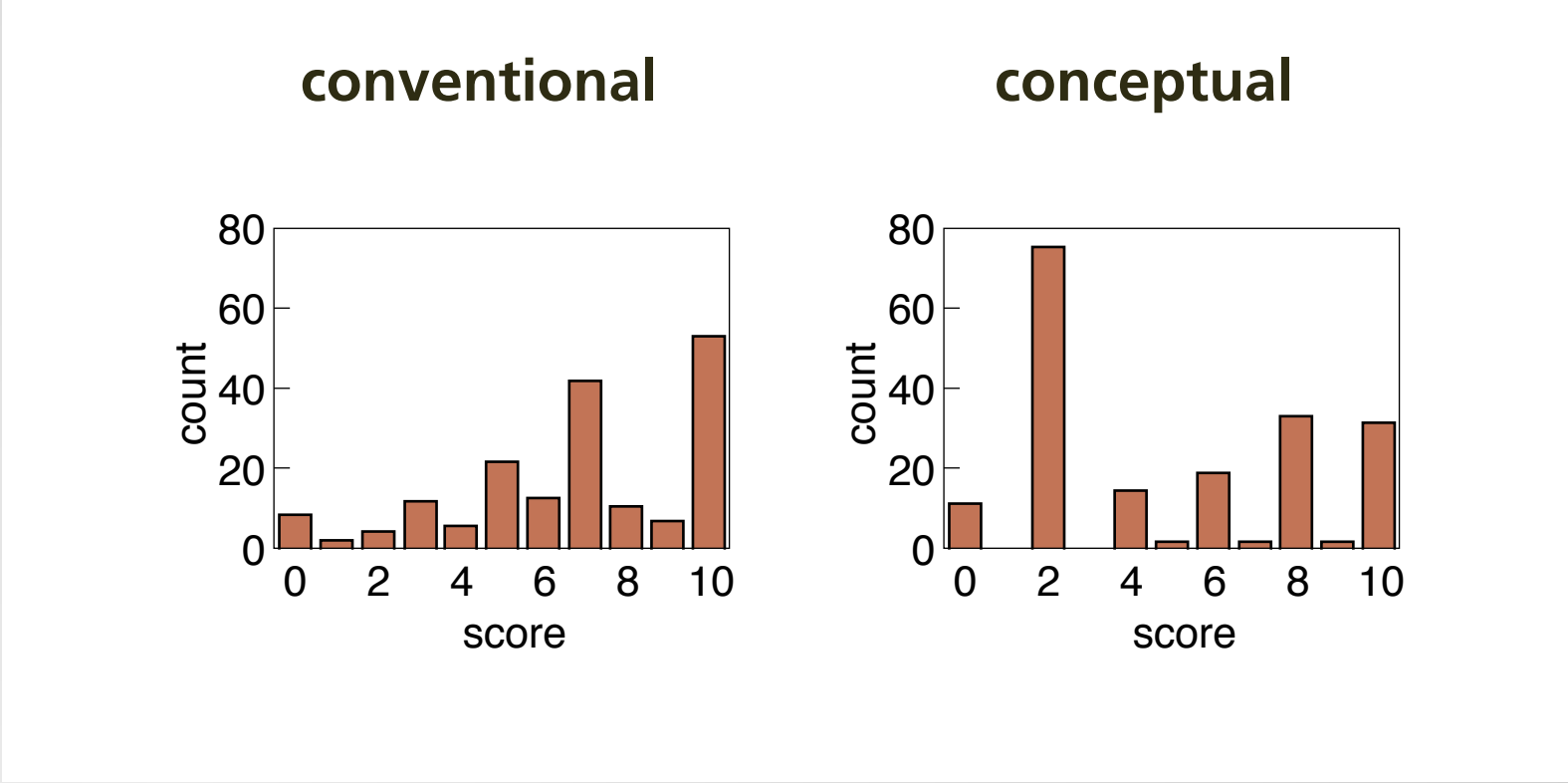

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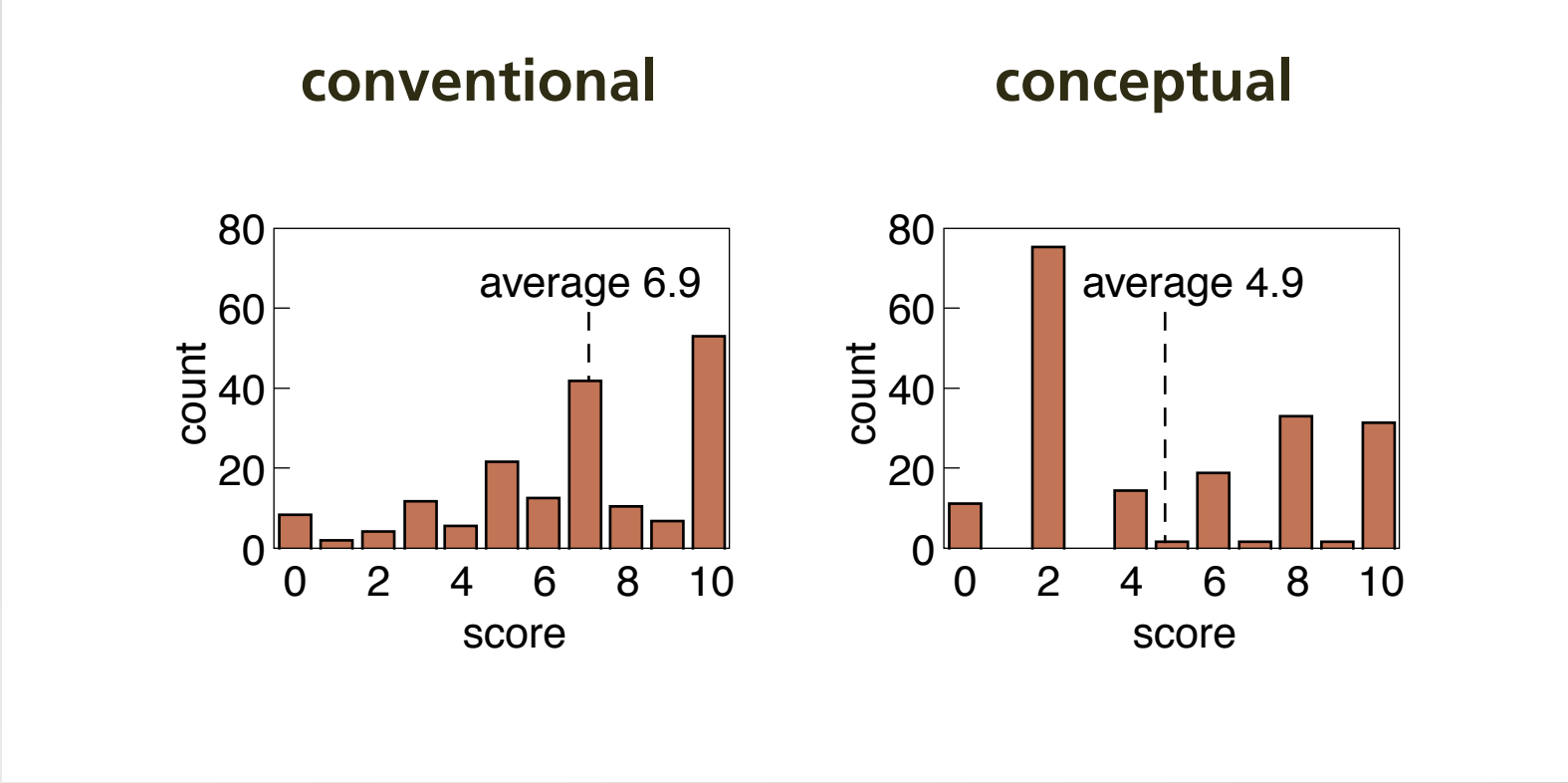

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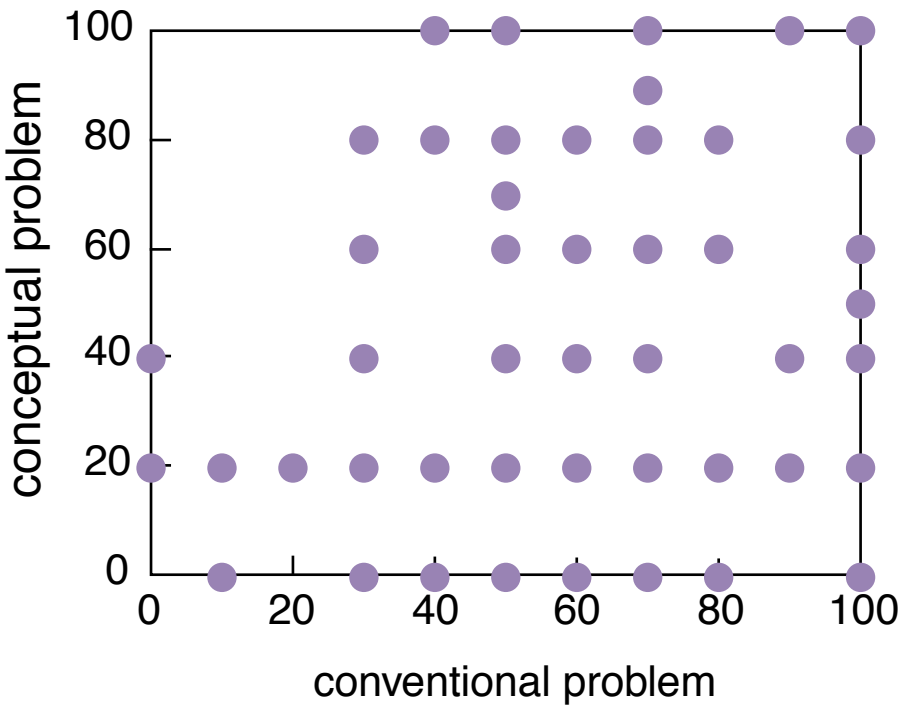

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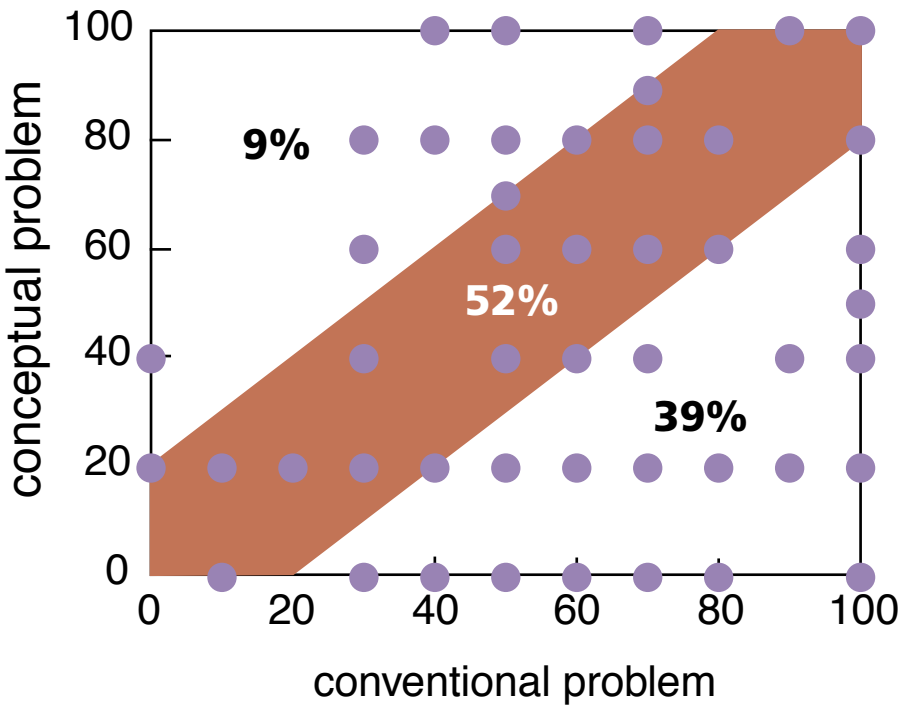


So what should we do?

Peer Instruction

Give students more responsibility for gathering information…

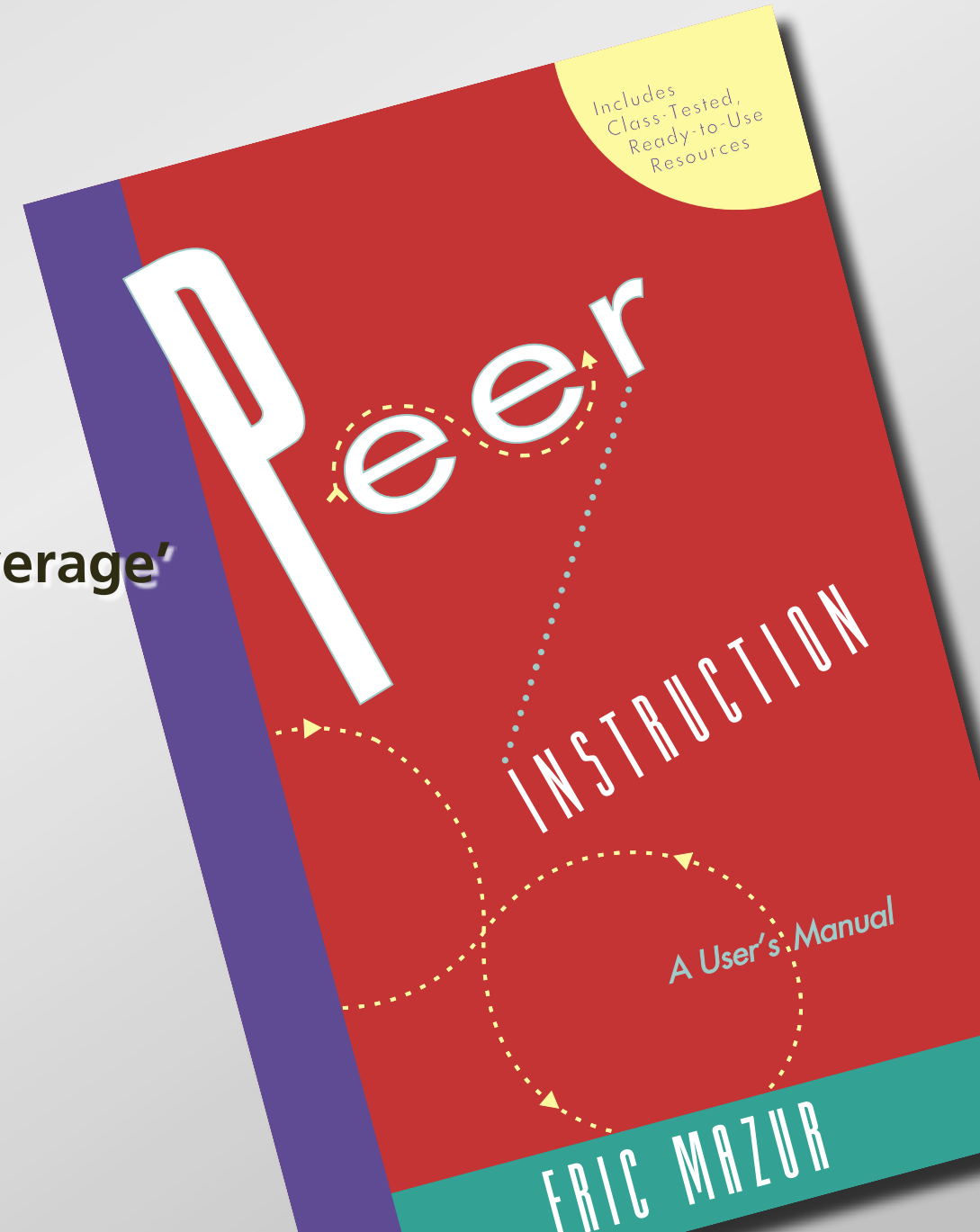
Peer Instruction

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

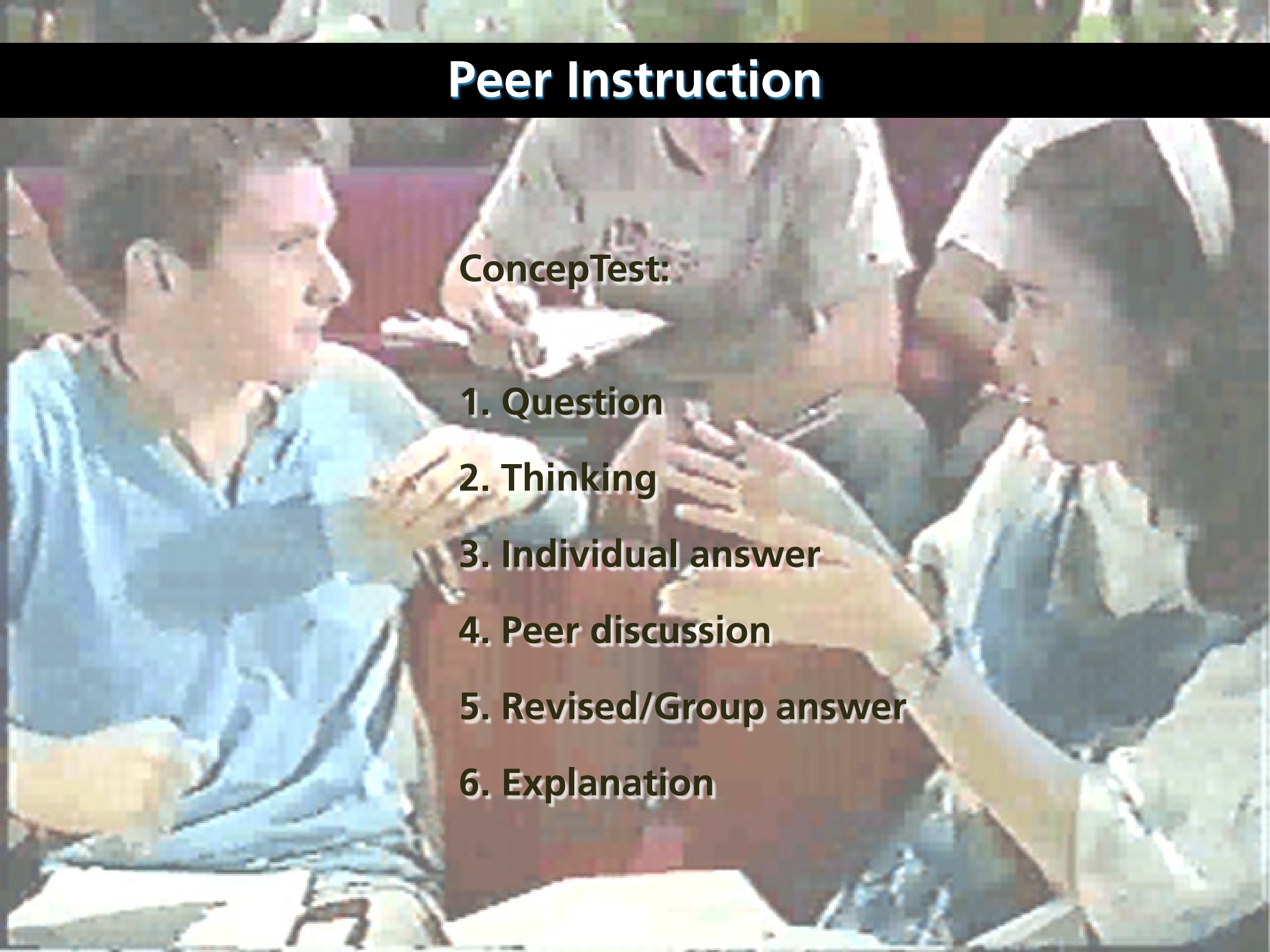
Peer Instruction

Main features:

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



Peer Instruction



ConcepTest:

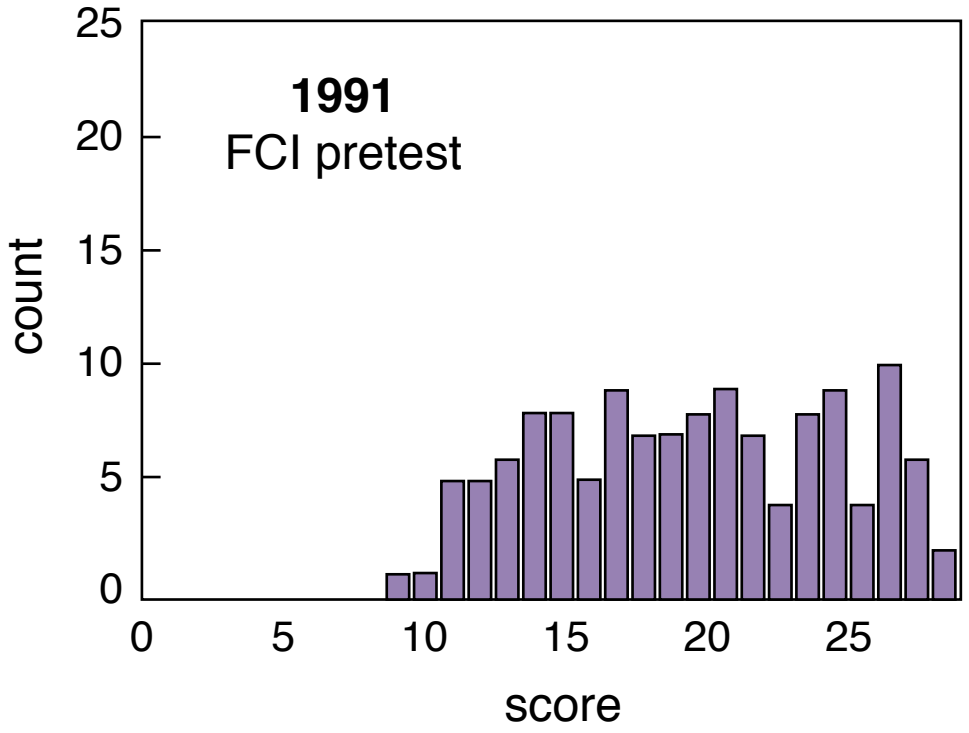
1. Question
2. Thinking
3. Individual answer
4. Peer discussion
5. Revised/Group answer
6. Explanation

Peer Instruction

is it any good?

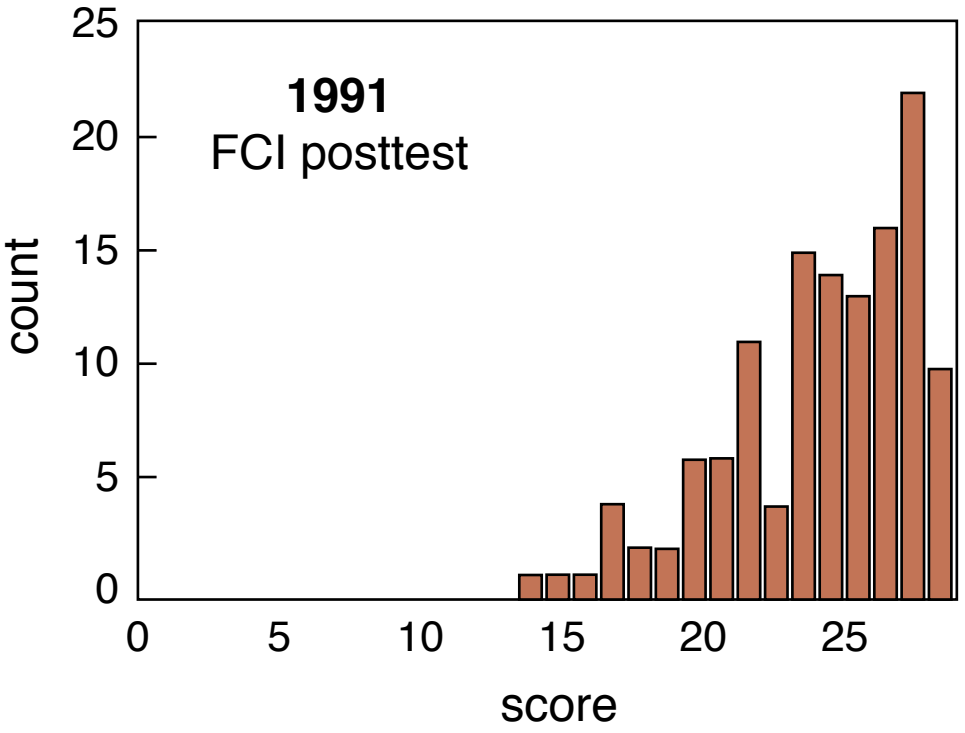
Peer Instruction

first year of implementing PI



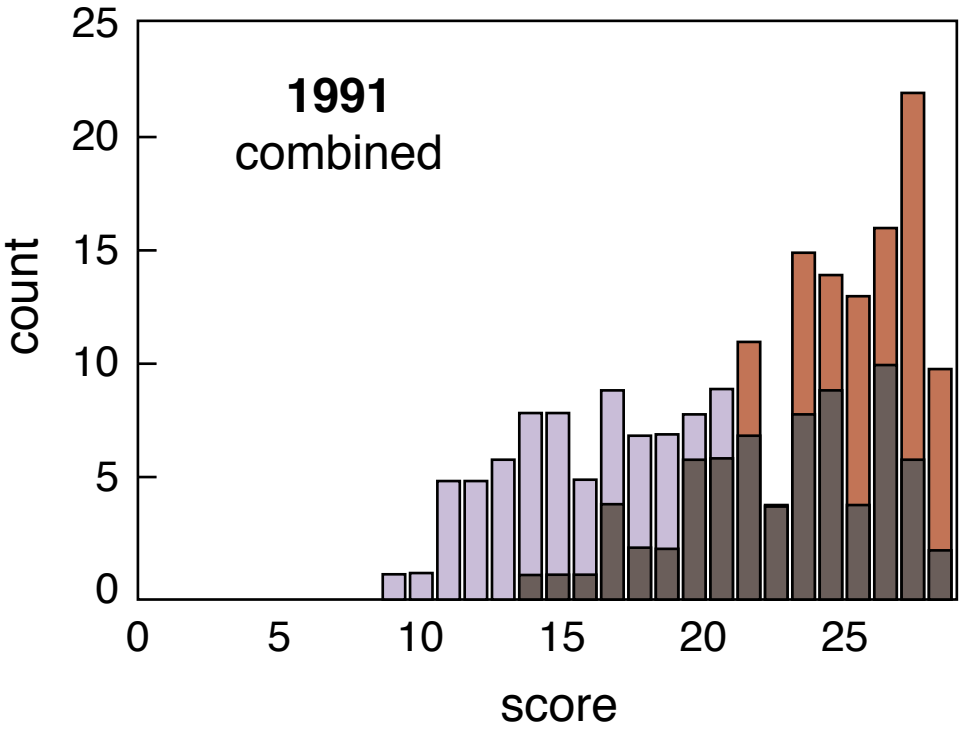
Peer Instruction

first year of implementing PI

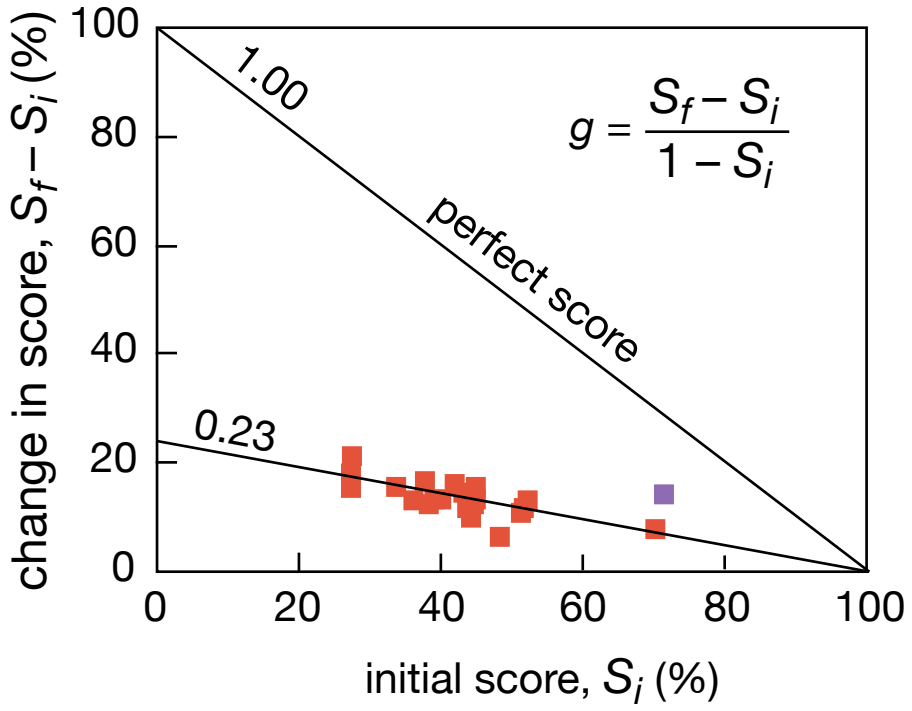


Peer Instruction

first year of implementing PI



Peer Instruction



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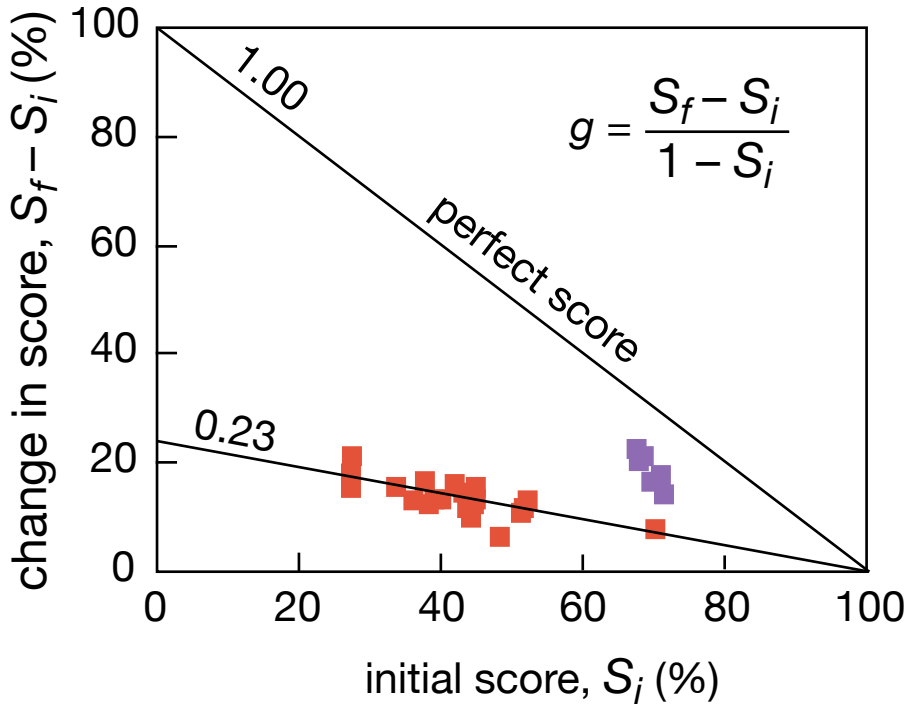

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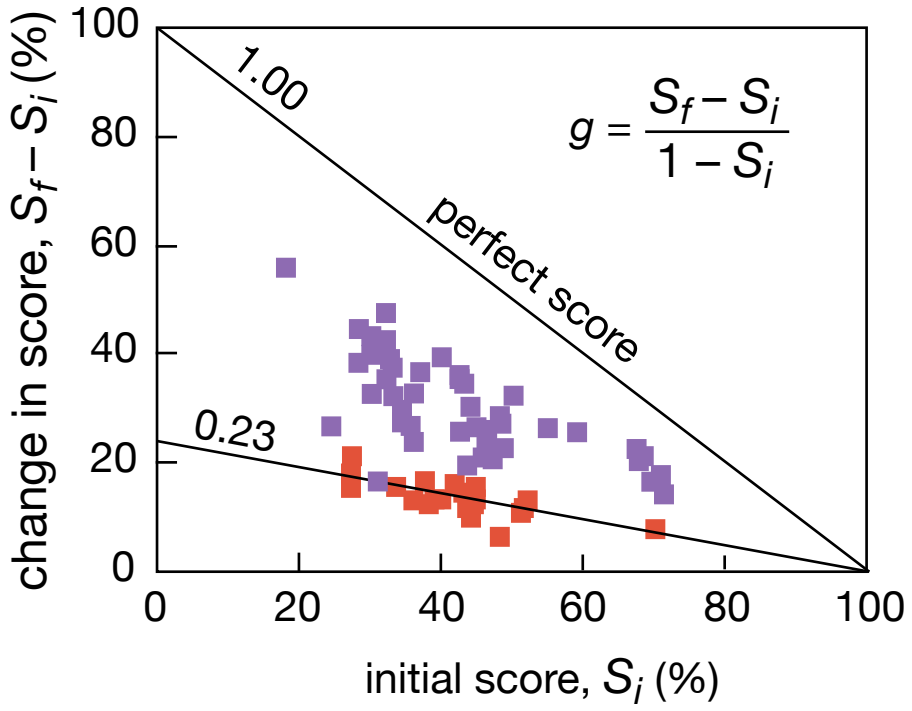
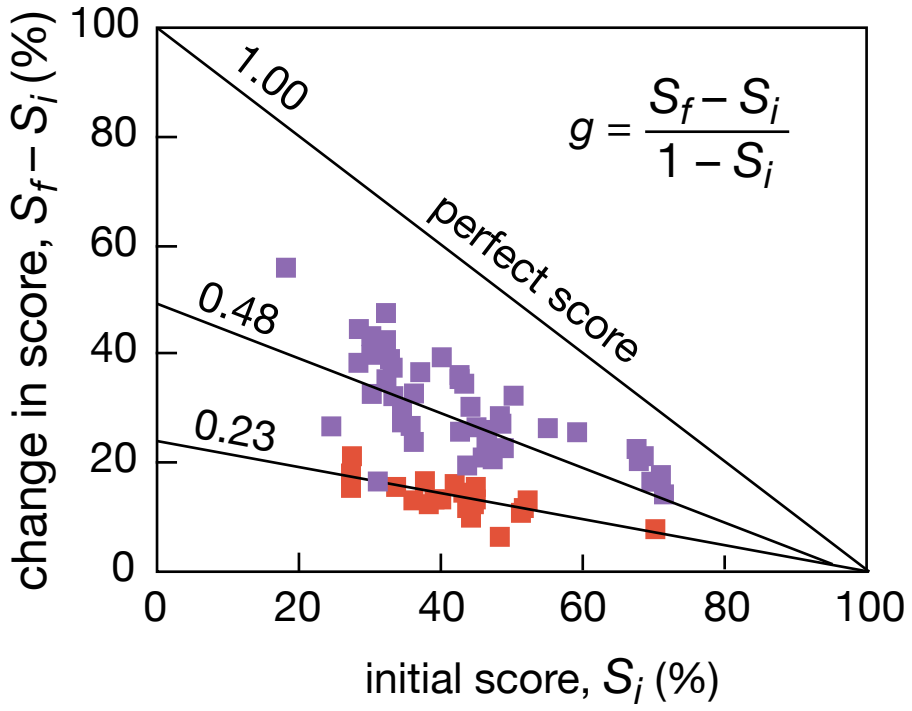


R.R. Hake, *Am. J. Phys.* 66, 64 (1998)

Peer Instruction



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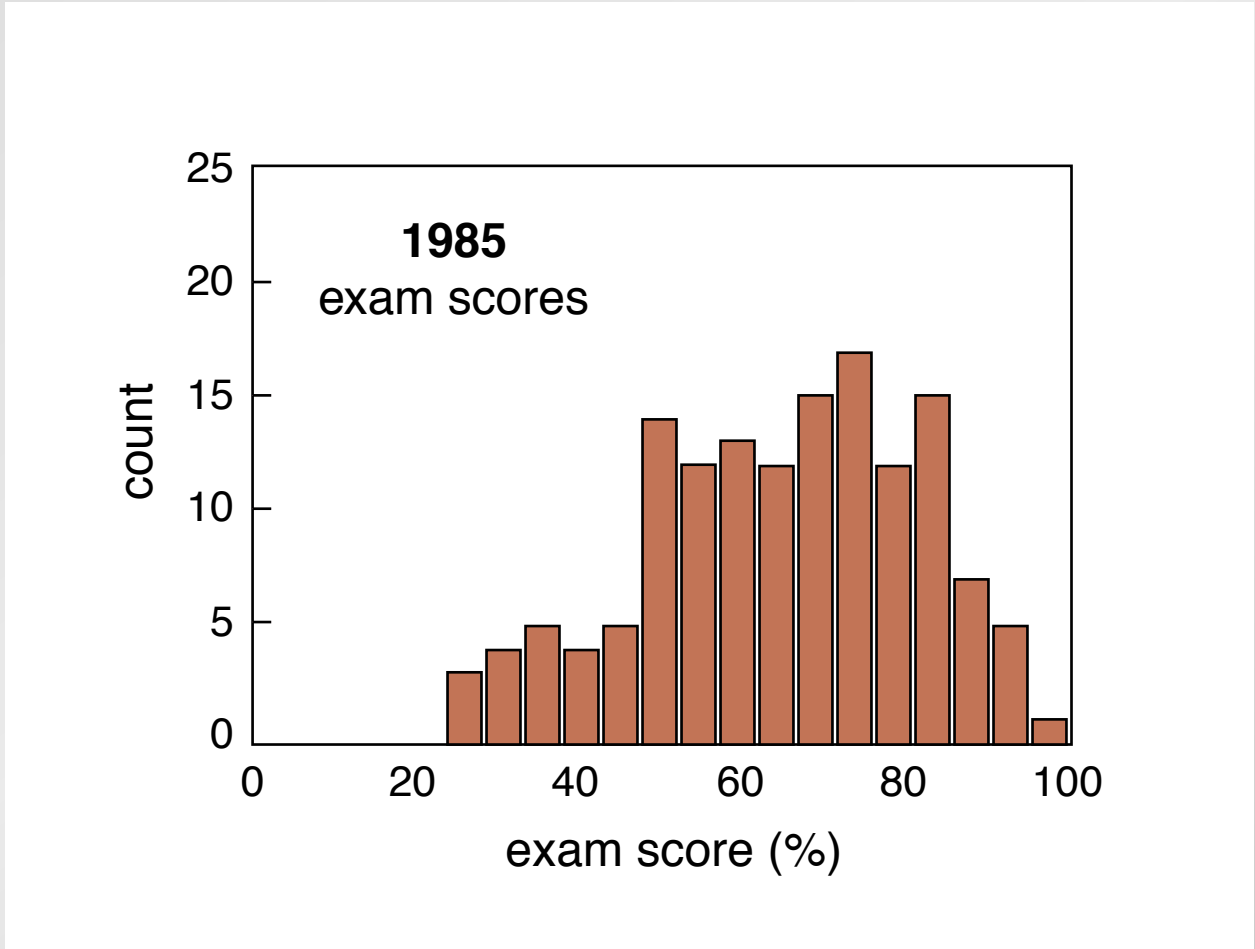
Peer Instruction

what about problem solving?

Peer Instruction



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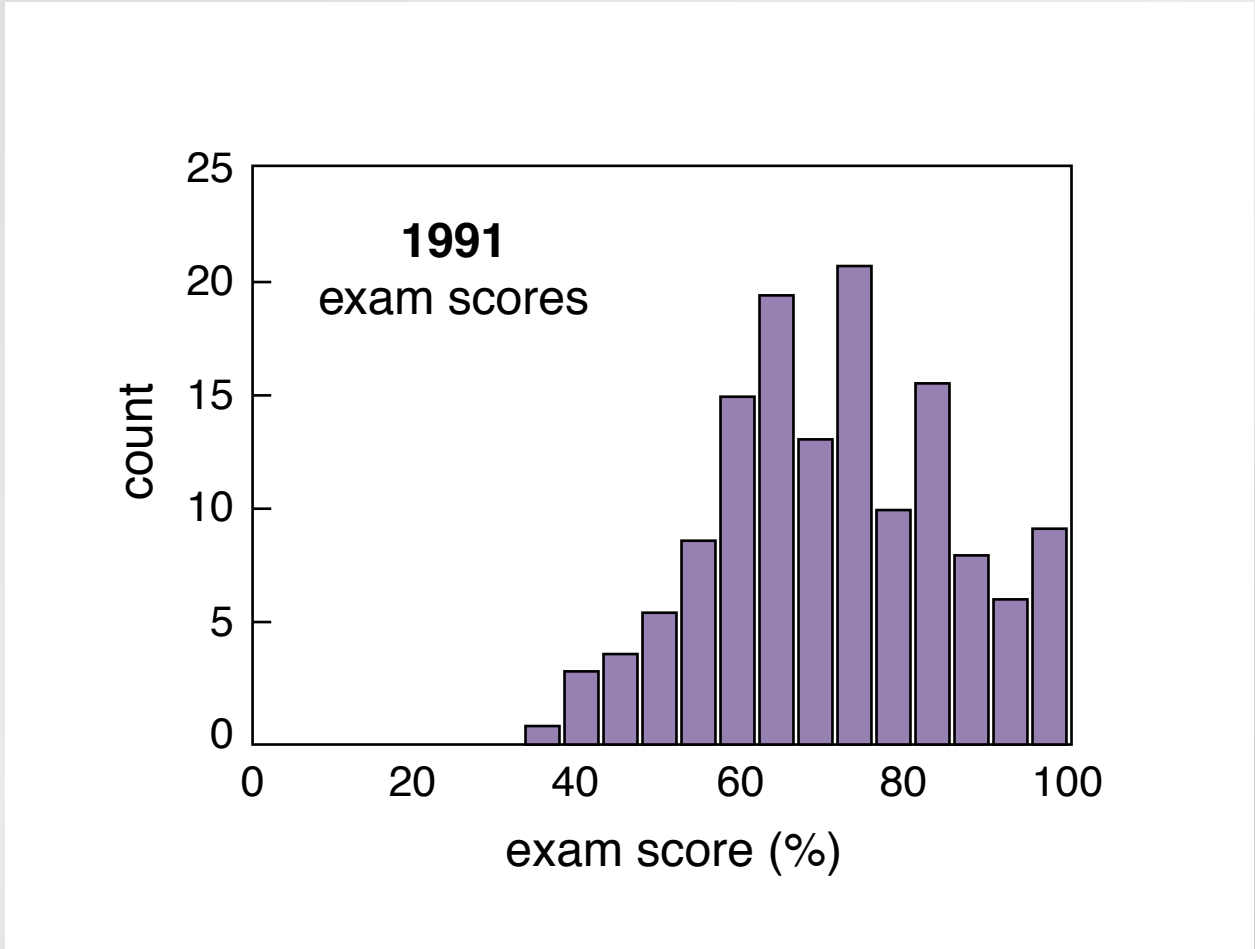

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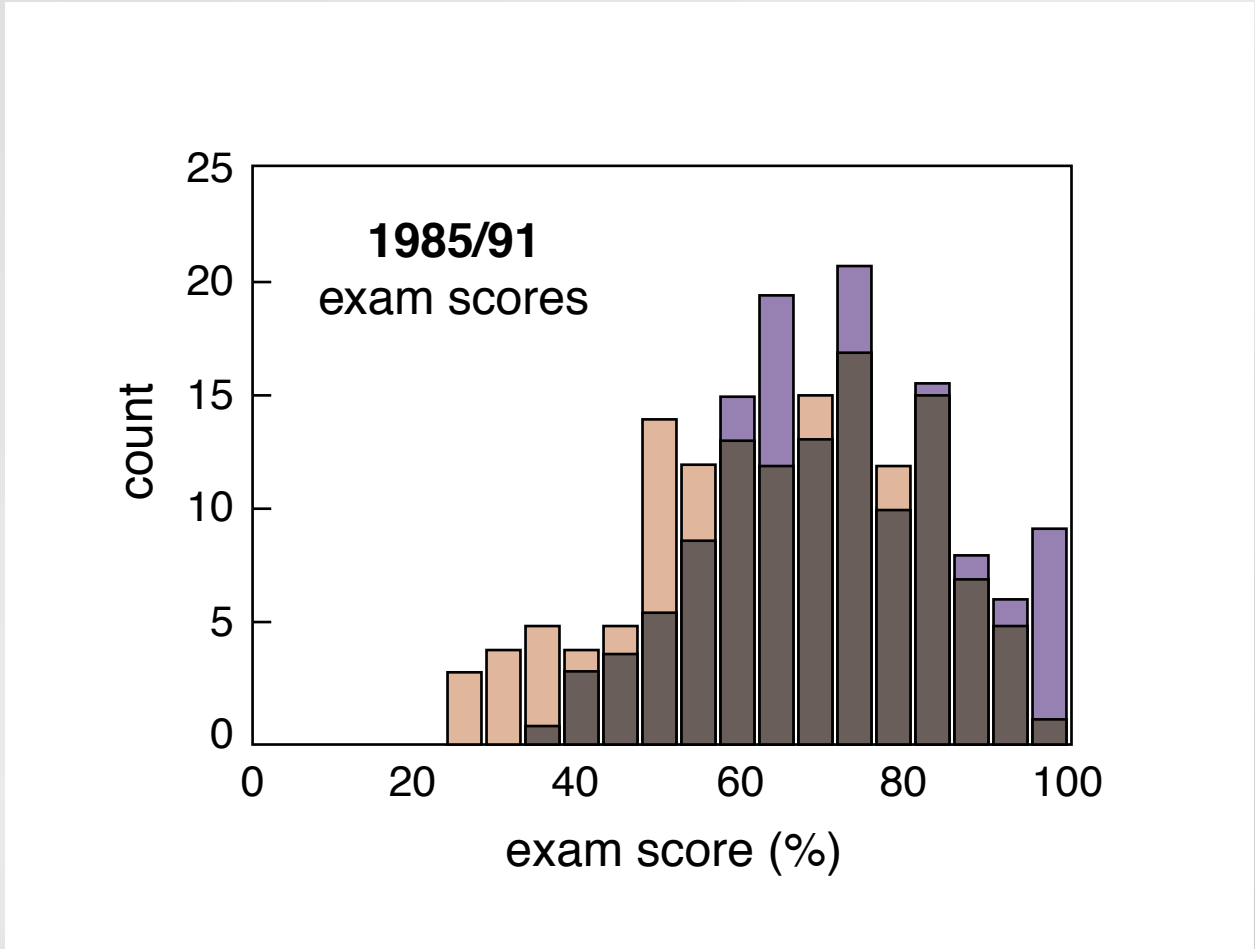


Peer Instruction

So better understanding leads to better problem solving!

Peer Instruction

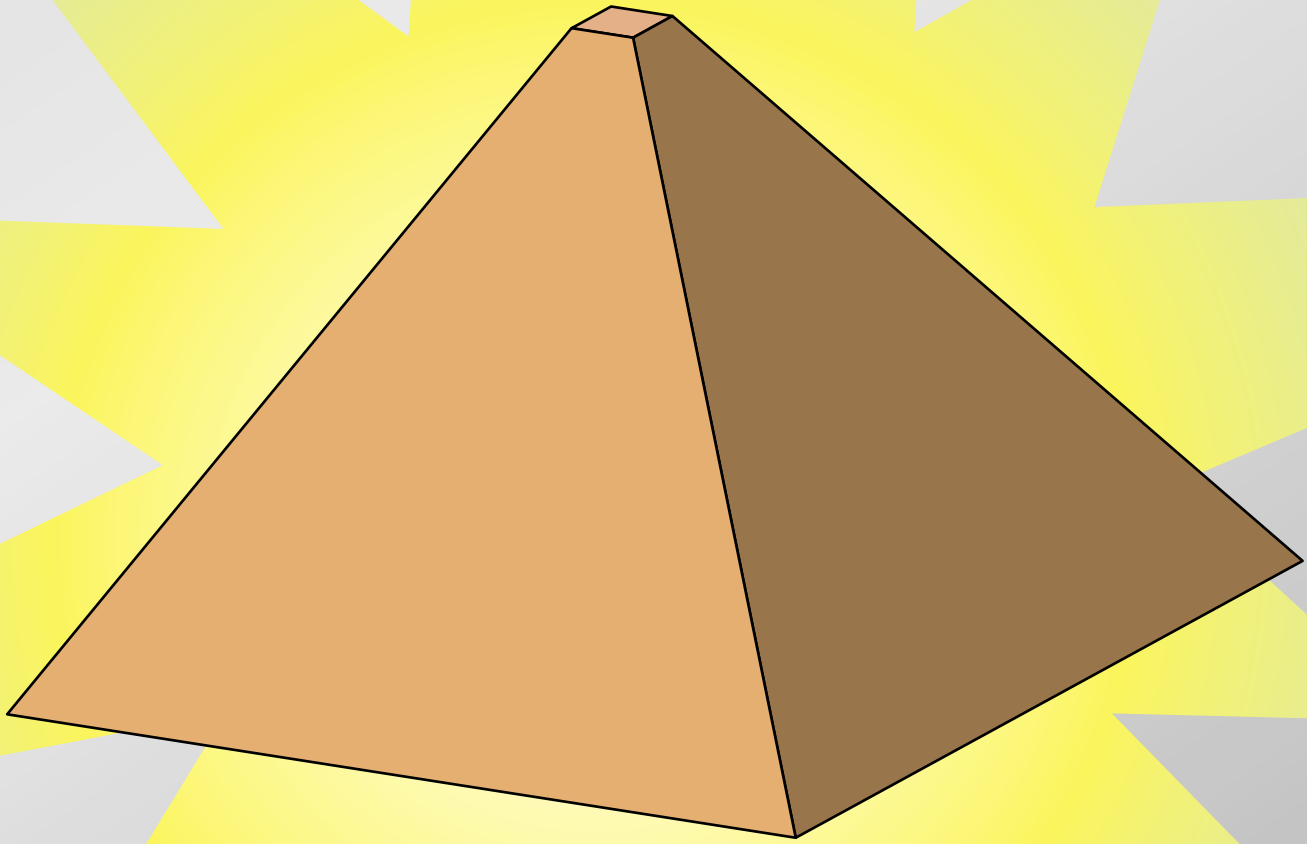
So better understanding leads to better problem solving!

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

Conclusion

Let's not forget the base

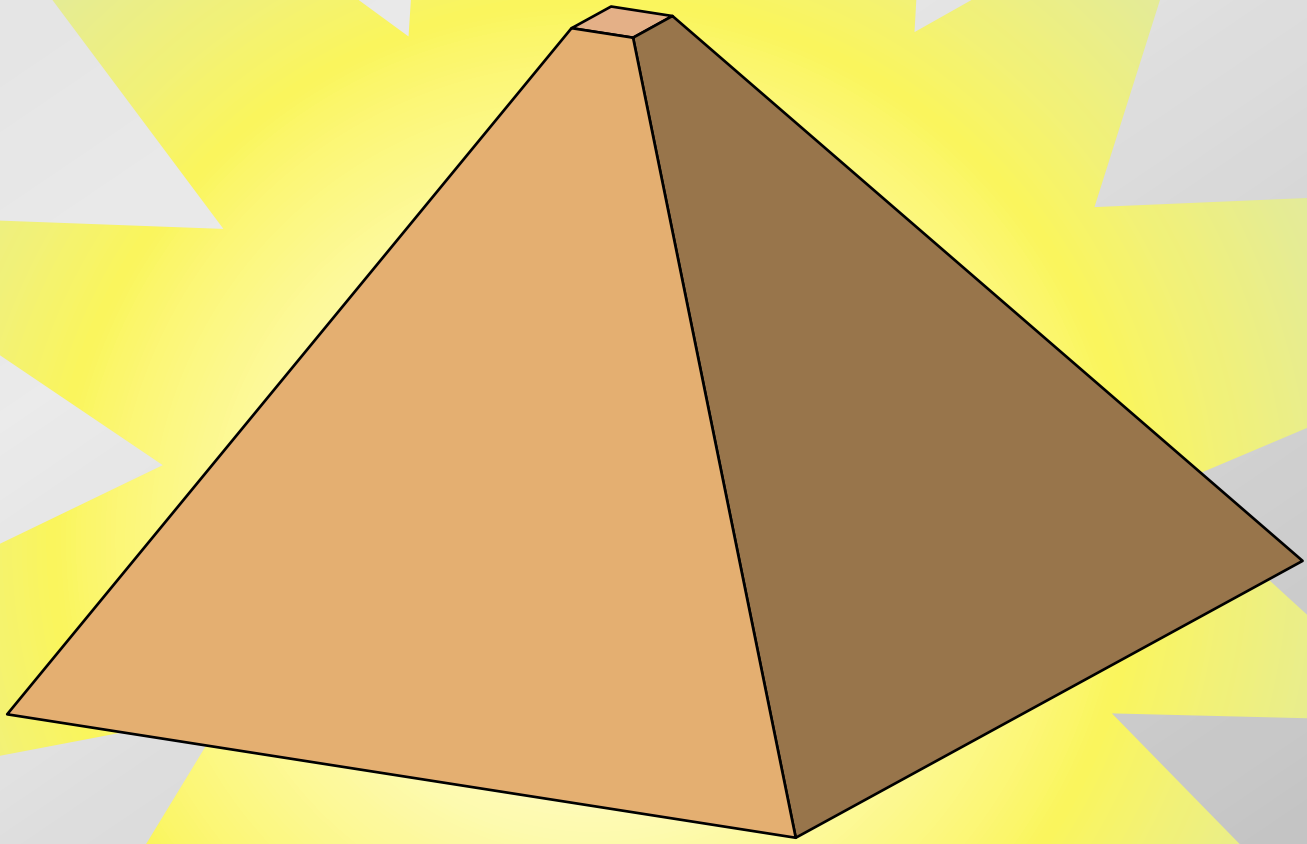
of the pyramid



Conclusion

Let's given them something

of value!



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