PEER INSTRUCTION:
TURNING A LECTURE INTO A SEMINAR

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Harvard University

Wesleyan University
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Outline

- **Why change lectures?**

Outline

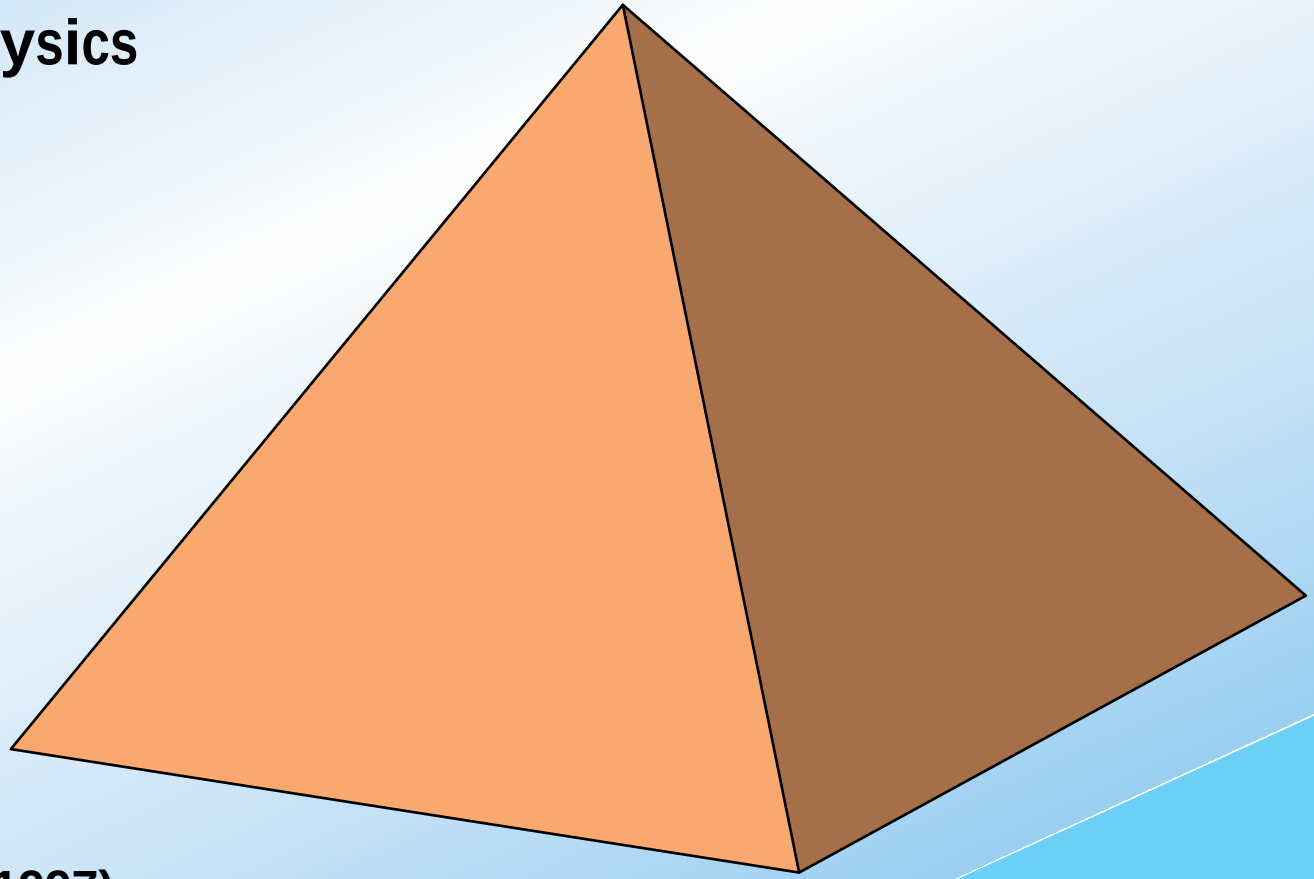
- **Why change lectures?**
- **How should we change?**

Outline

- **Why change lectures?**
- **How should we change?**
- **What are the benefits?**

Some context

380,000 students take introductory physics each year…



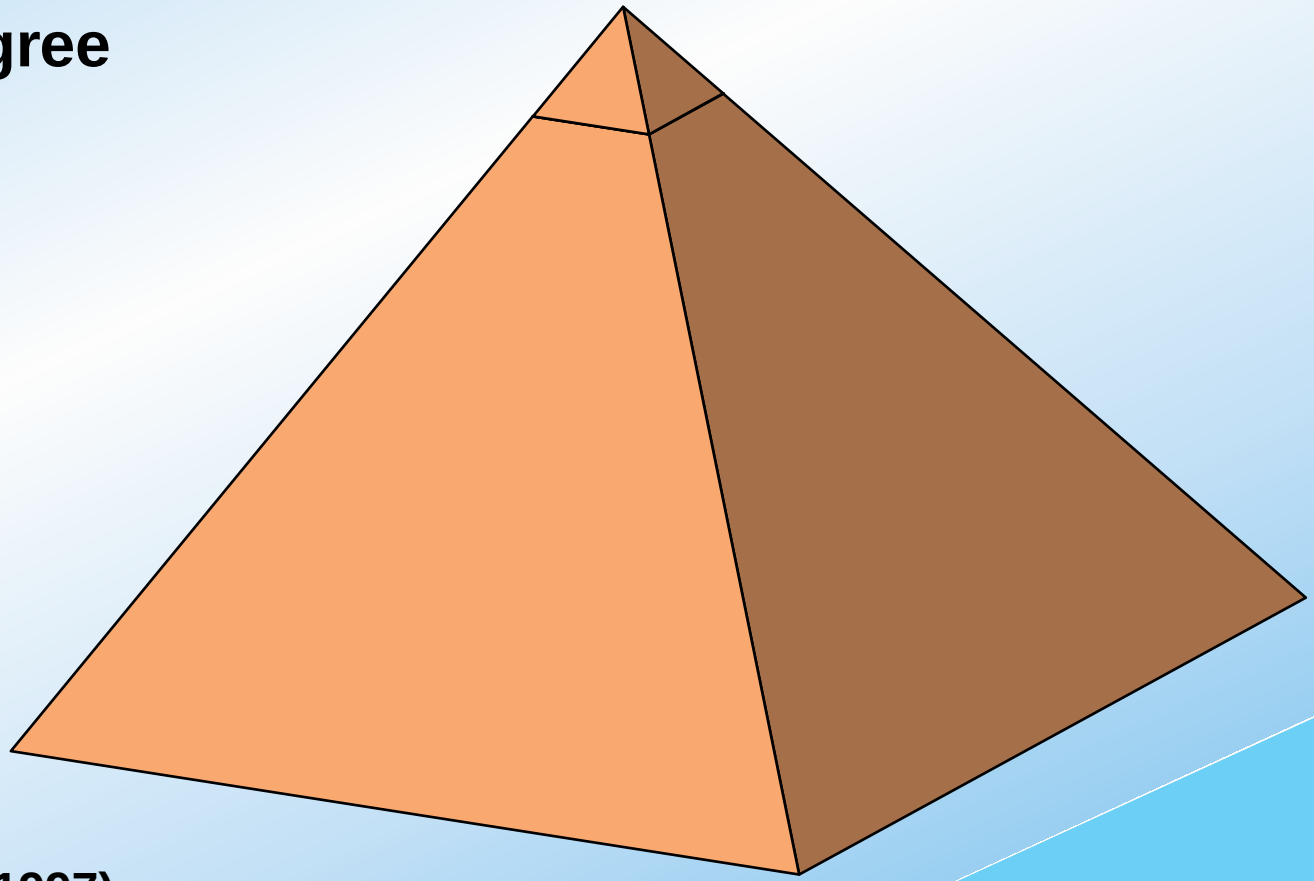
AIP Report R-151.33 **(1997)**

Some context

about 1% of these get

a bachelor's degree

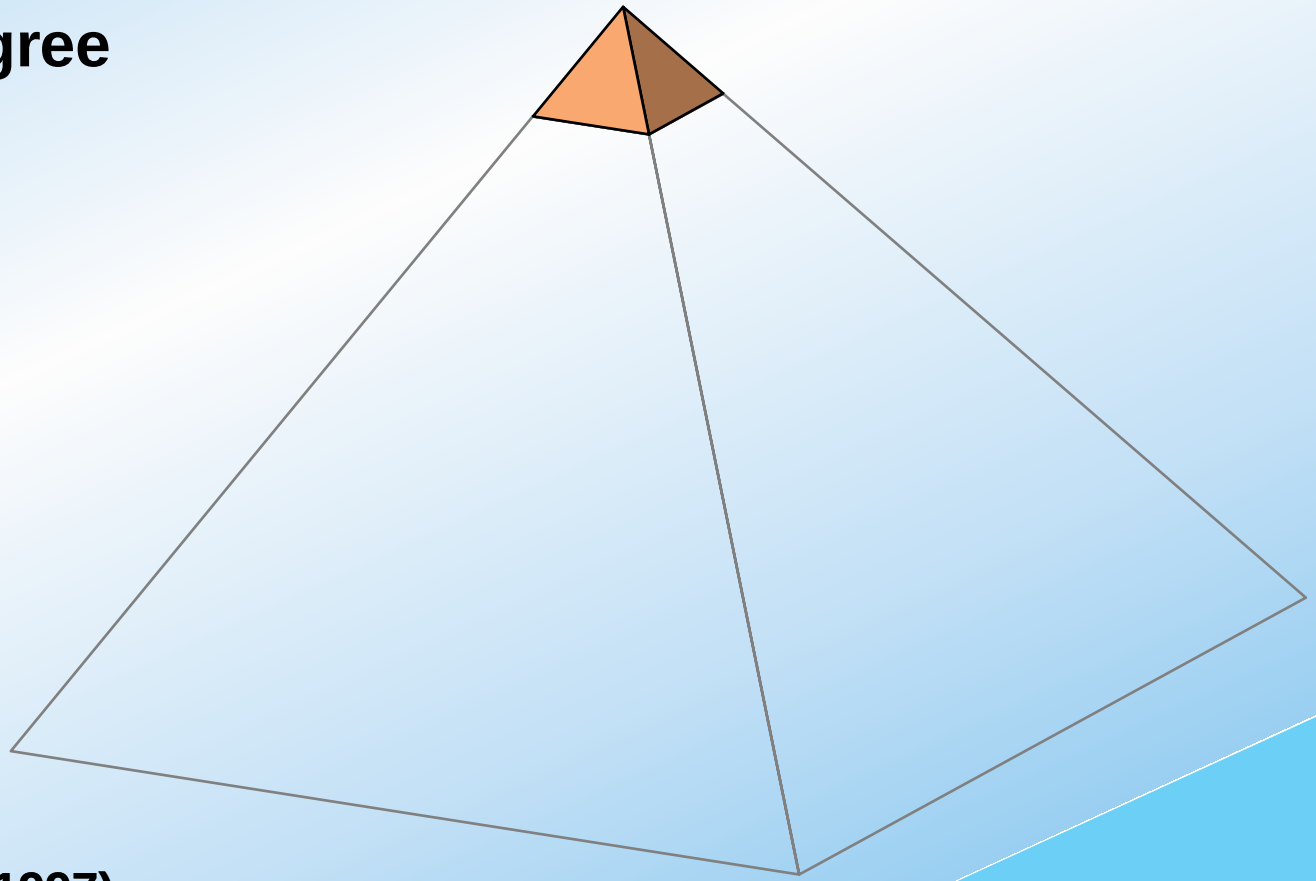
in physics



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

Some context

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

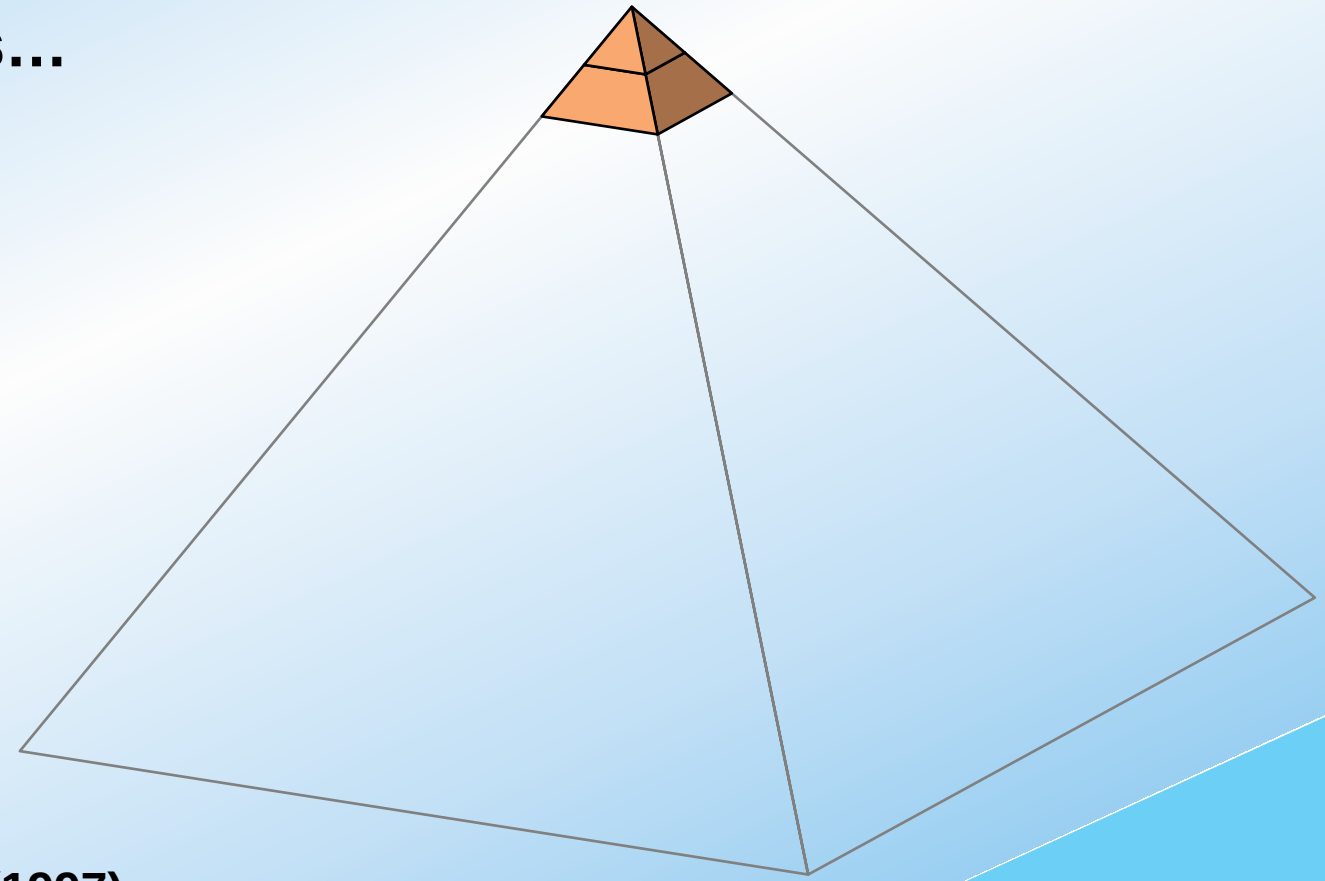


AIP Report R-151.33 **(1997)**

Some context

about 35% go on to get a

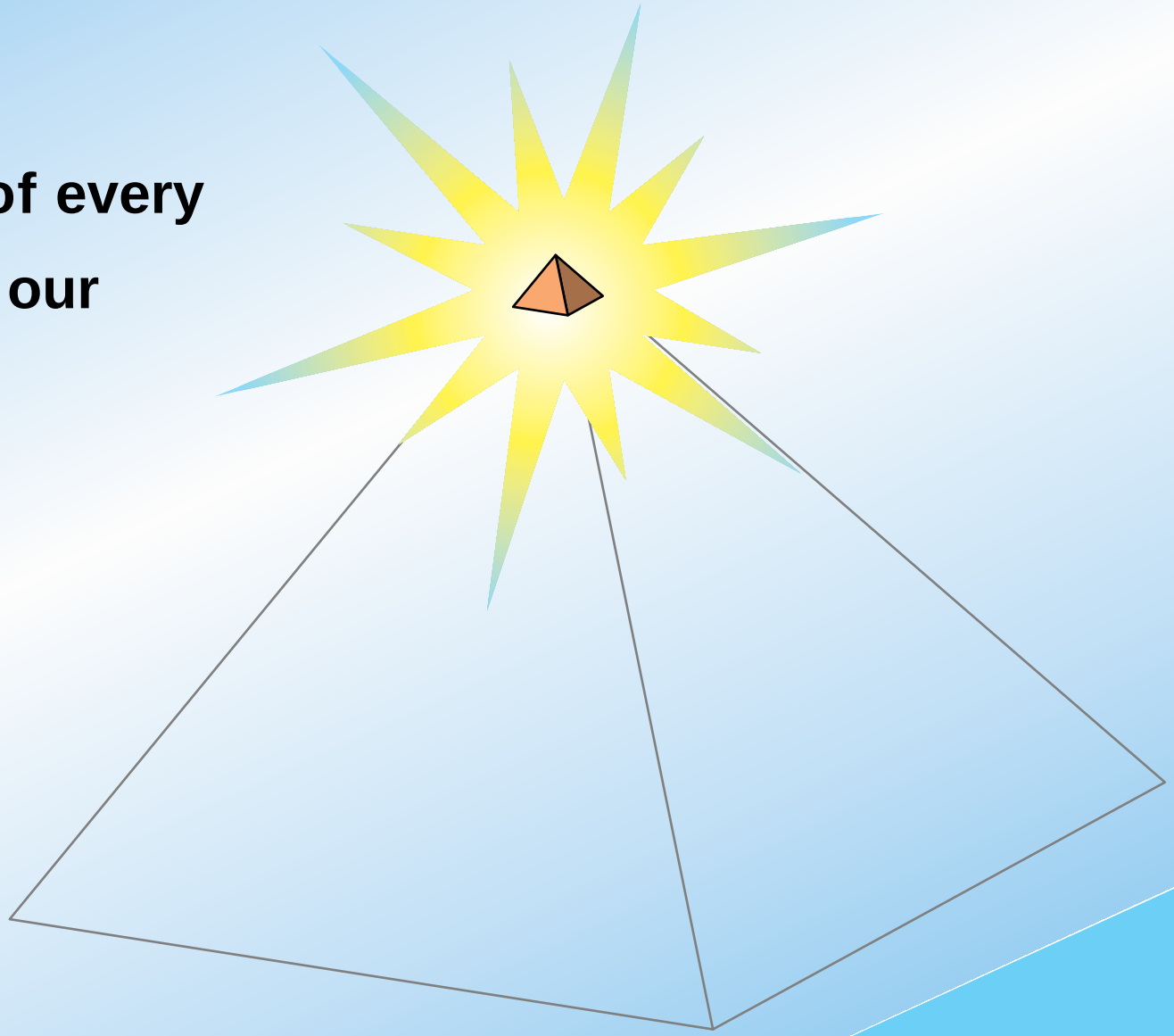
Ph.D. in physics…



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

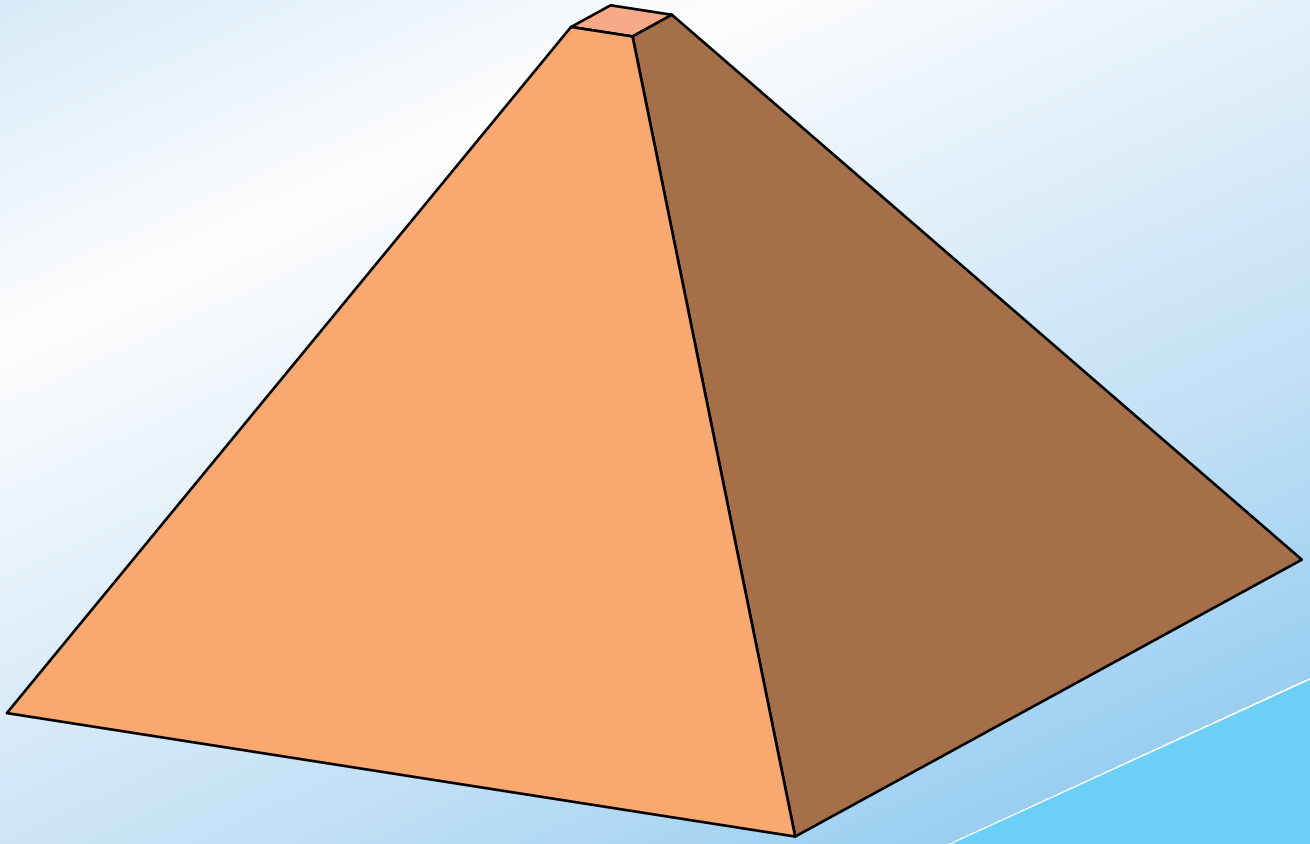
Some context

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



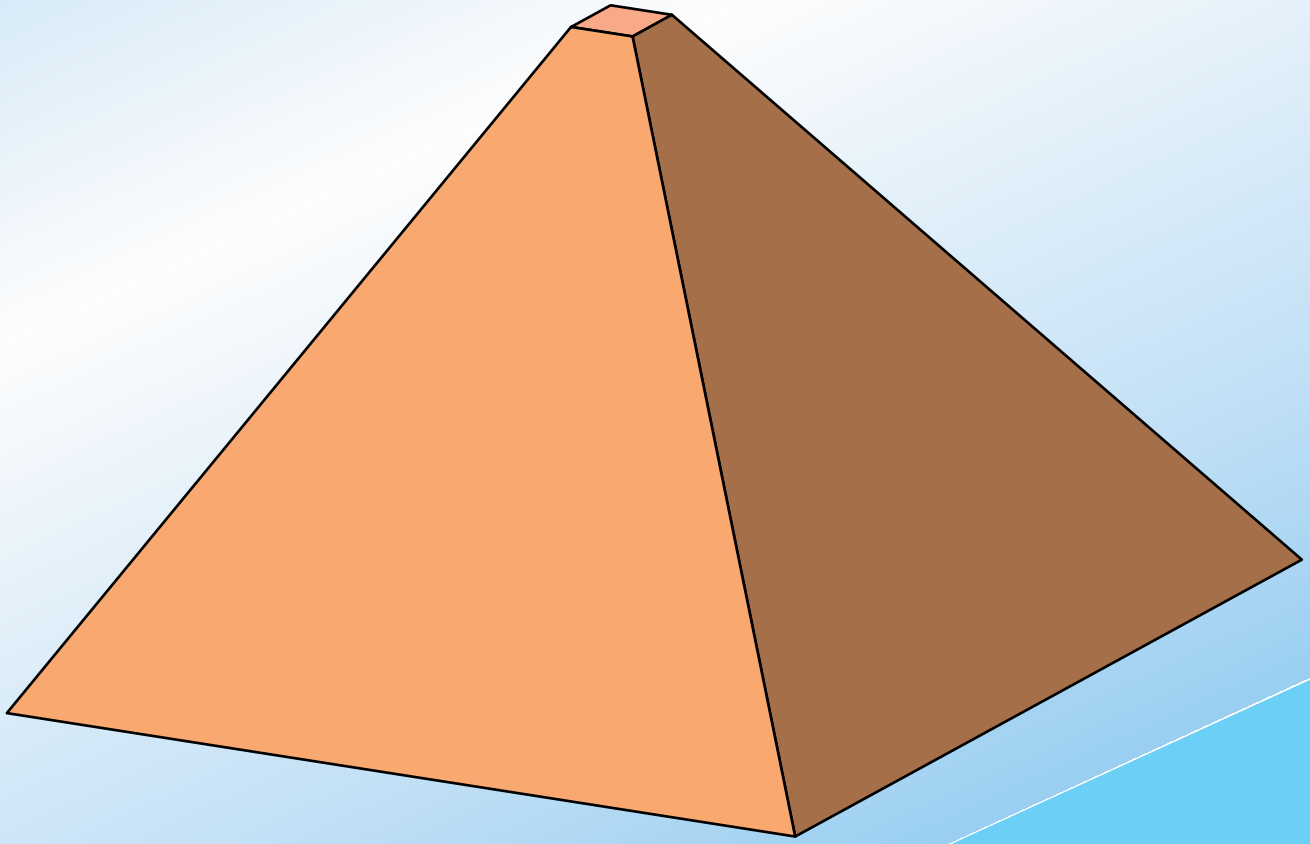
Some context

What about the other 259…?



Some context

What do we know about these students?



Why change?

Common student experiences:

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

Why change?

Lectures focus on transfer of information...

Why change?

Lectures focus on transfer of information...

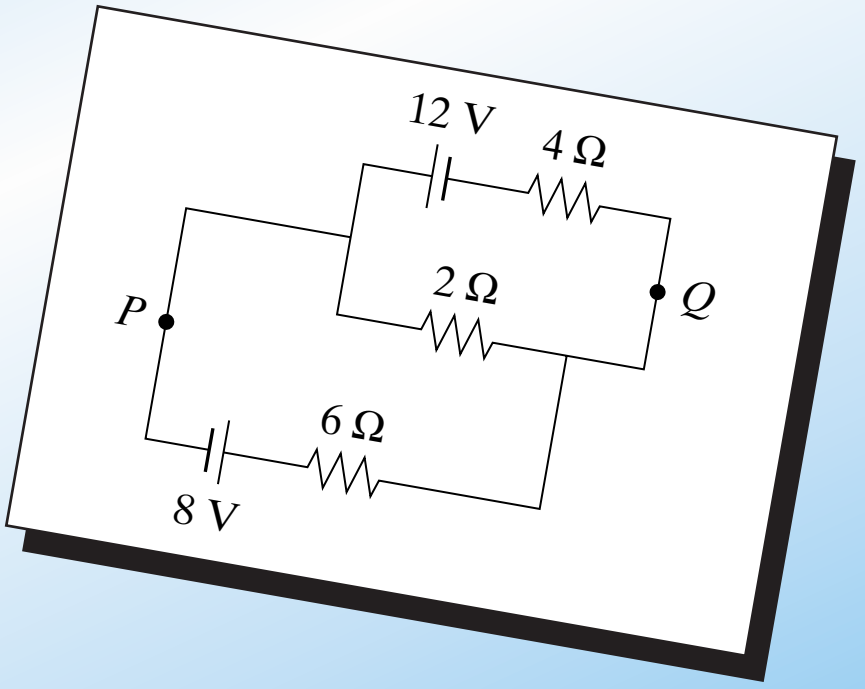
...but physics is more than just information!

Why change?

Conventional problems reinforce bad study habits

Why change?

Conventional problems reinforce bad study habits



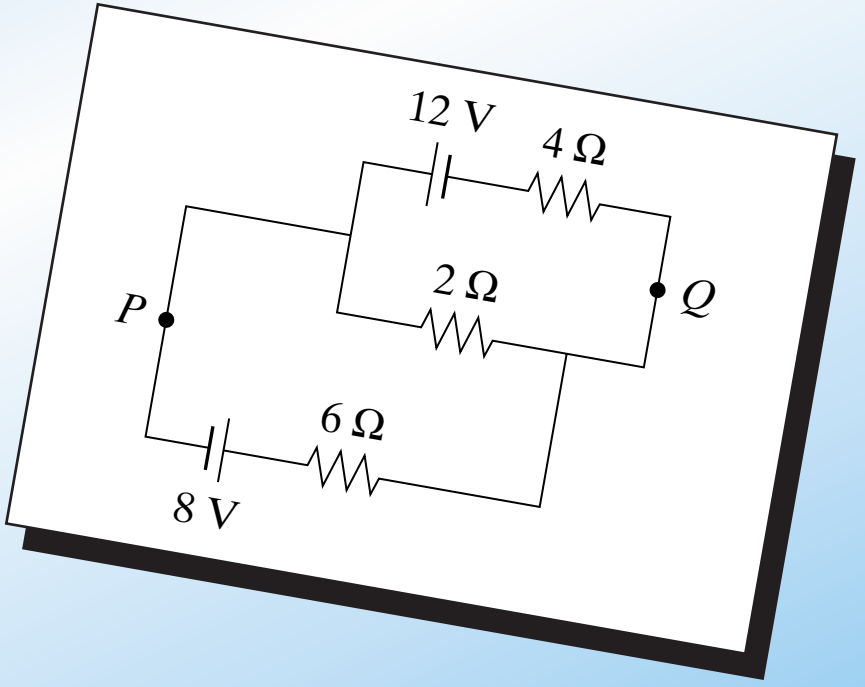
Why change?

Conventional problems reinforce bad study habits

Calculate:

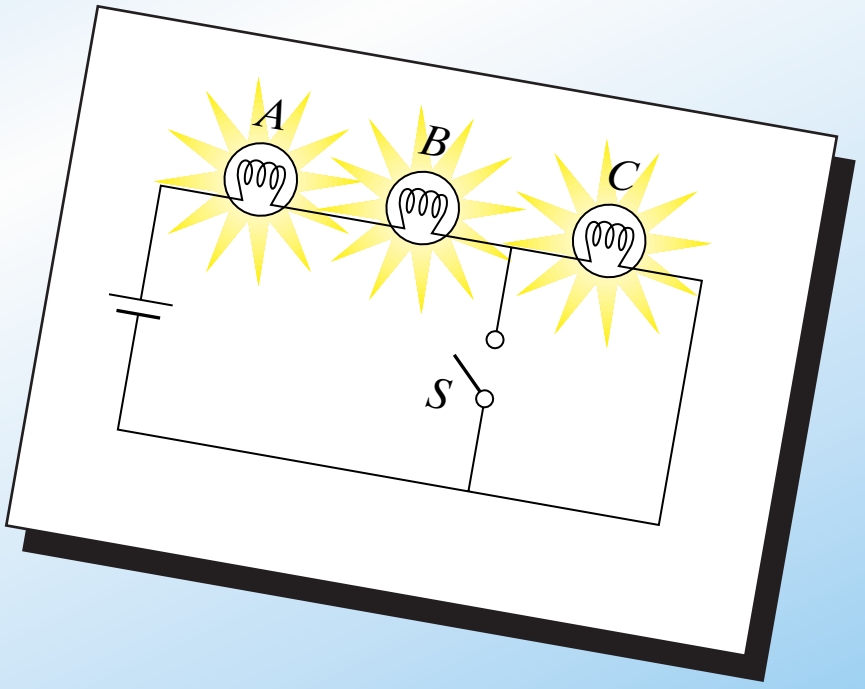
(*a*) the current in the 2-Ω resistor, and

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



Why change?

Are basic principles understood?

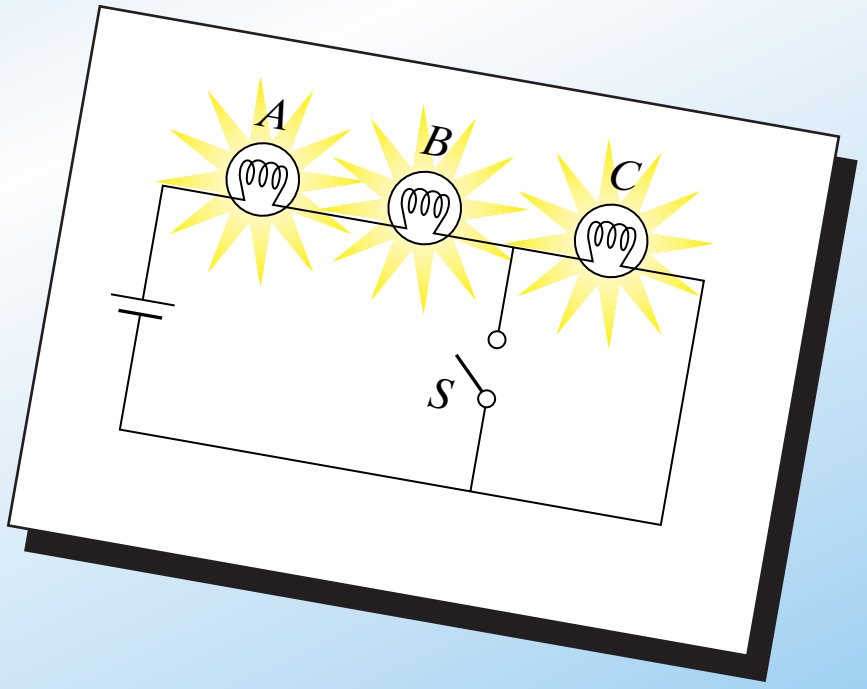


Why change?

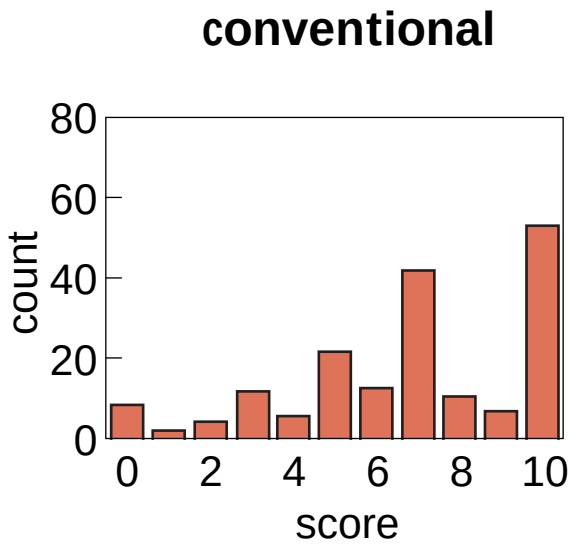
Are basic principles understood?

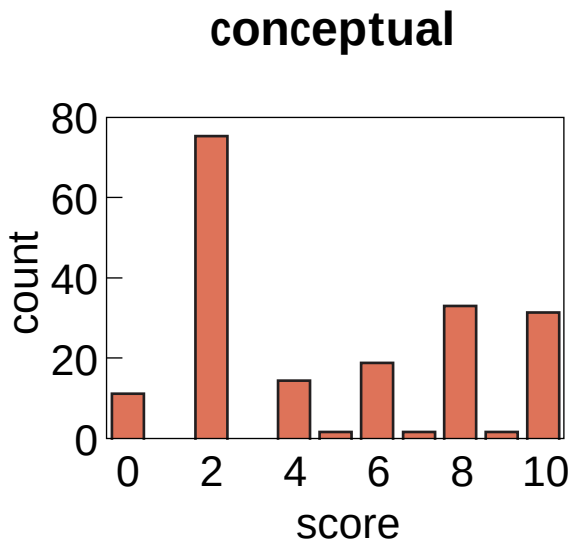
When *S* is closed, what happens to the:

(*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?

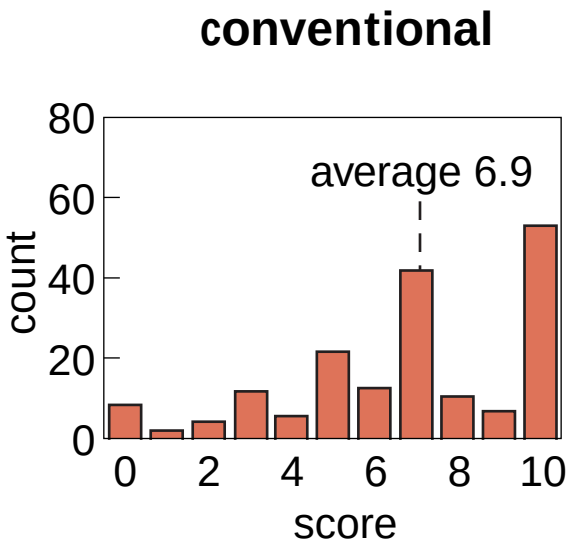


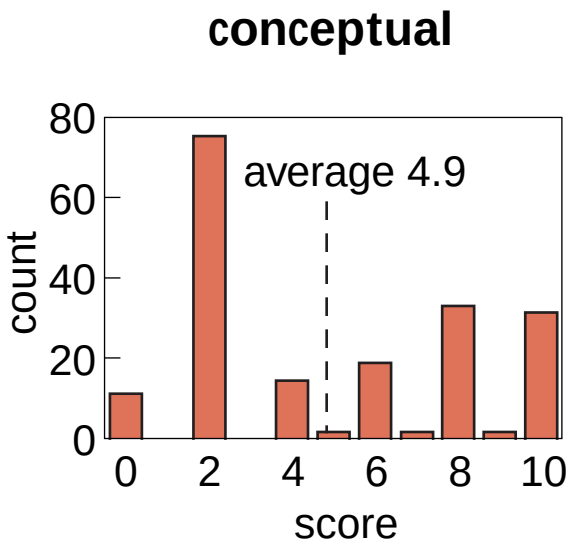
Why change?


conventional
count
80
60
40
20
0
0
2
4
6
8
10
score

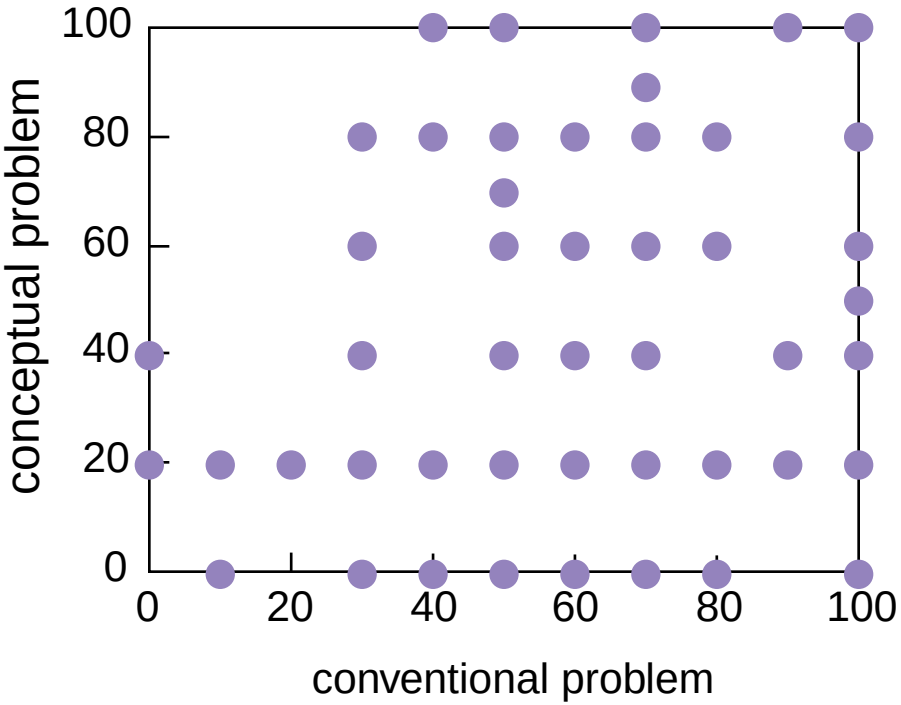

conceptual
count
80
60
40
20
0
0
2
4
6
8
10
score

Why change?

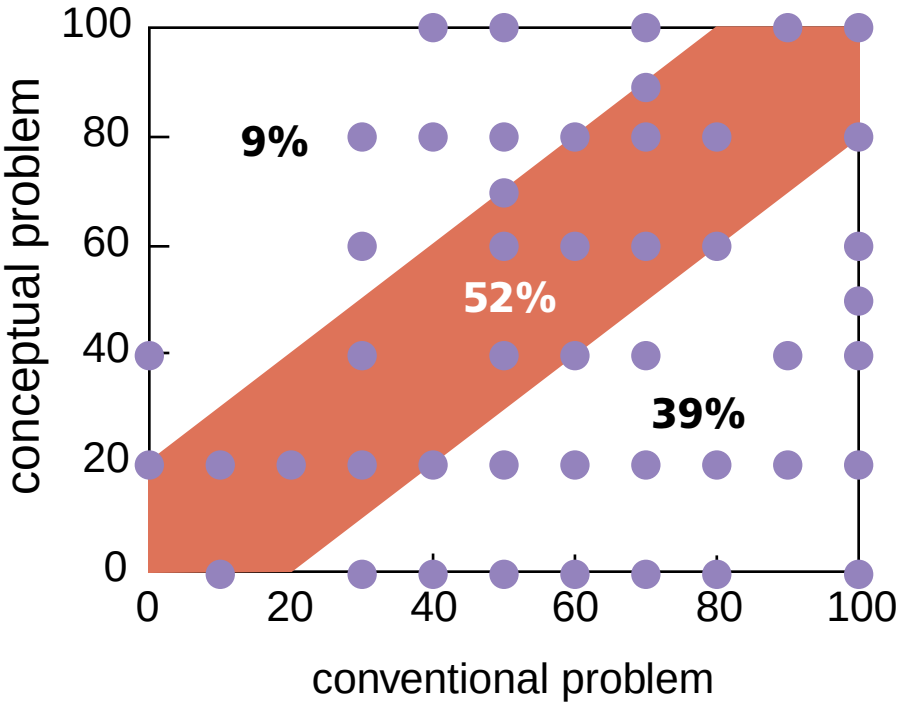

conventional
80
60
40
20
0
count
average 6.9
0
2
4
6
8
10
score


conceptual
80
60
40
20
0
count
average 4.9
0
2
4
6
8
10
score

Why change?


100
80
60
40
20
0
conceptual problem
0
20
40
60
80
100
conventional problem

Why change?


100
80
60
40
20
0
conceptual problem
9%
52%
39%
0
20
40
60
80
100
conventional problem

Why change?

Memorization rarely produces understanding

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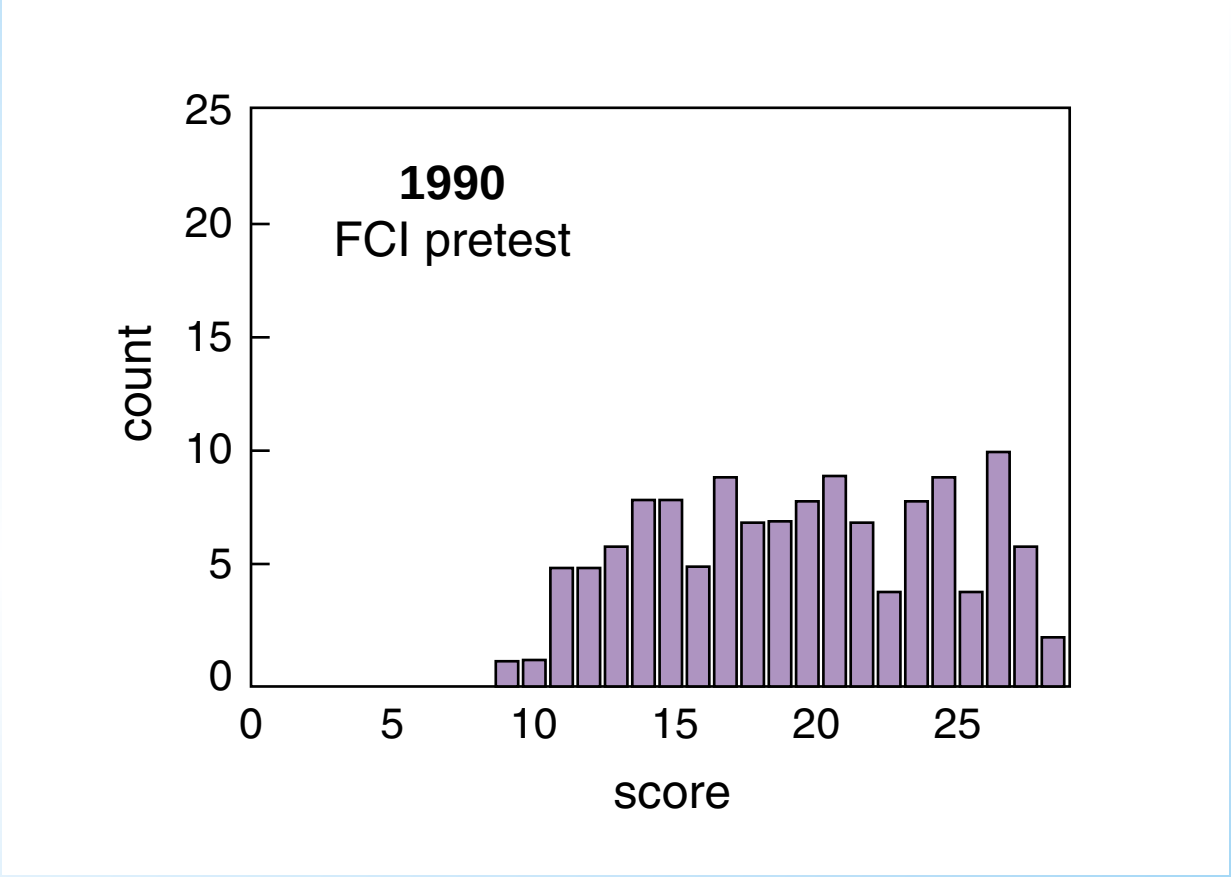
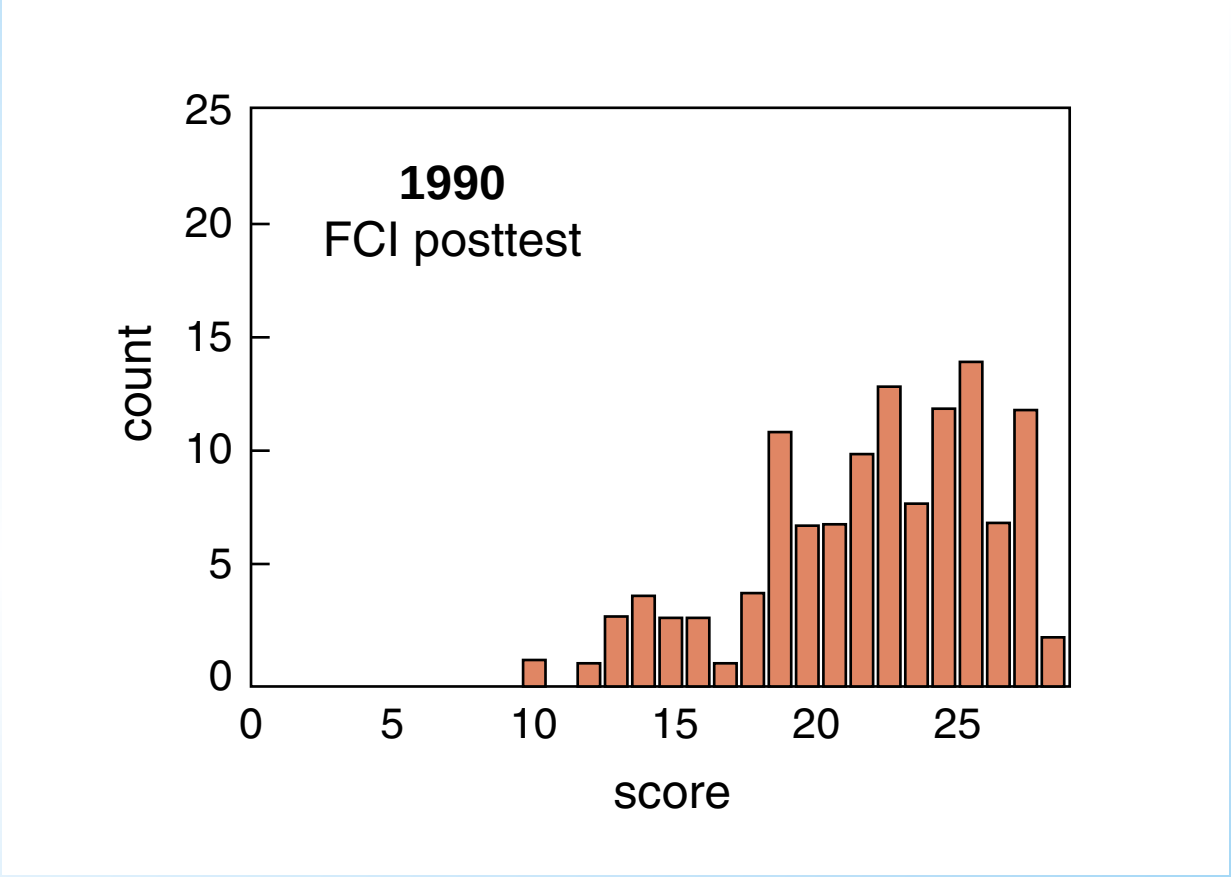
Memorization rarely produces understanding



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

Why change?

Memorization rarely produces understanding



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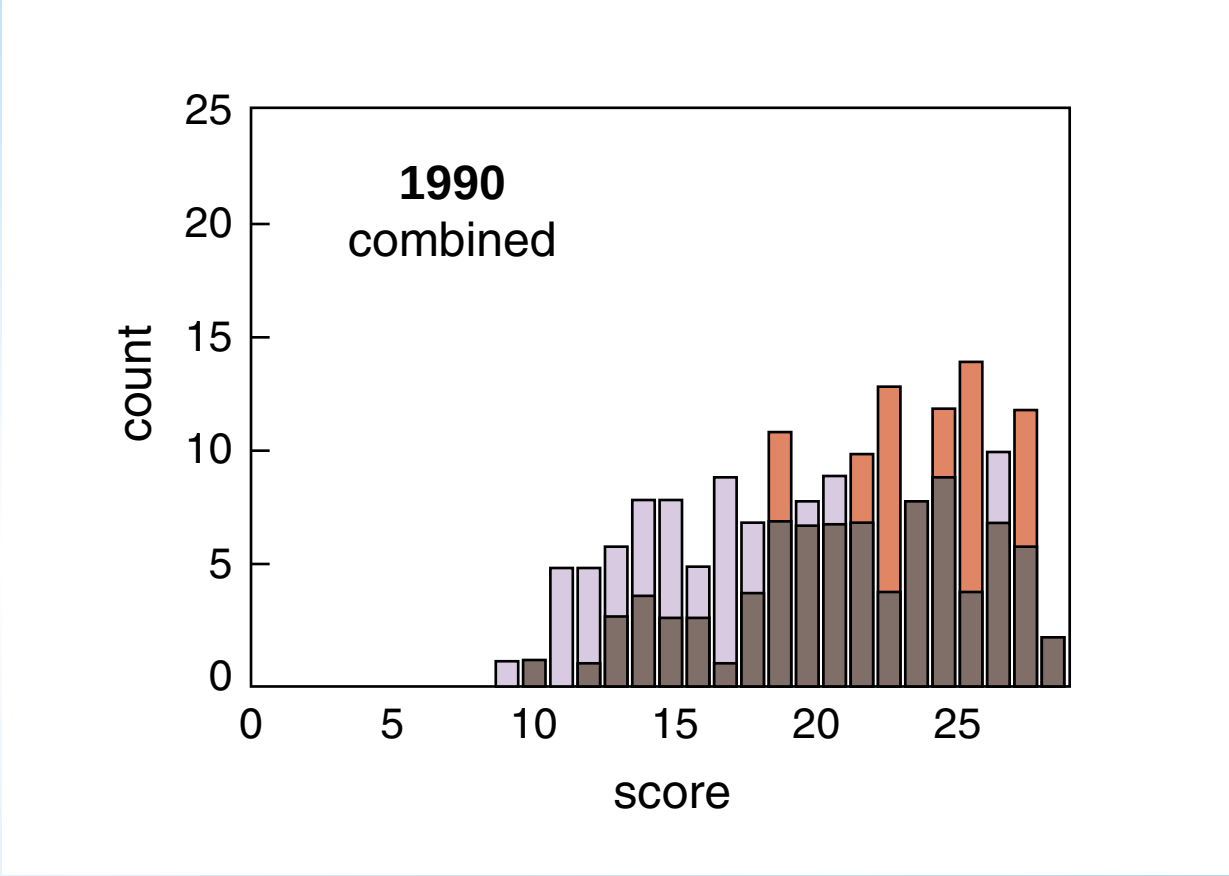
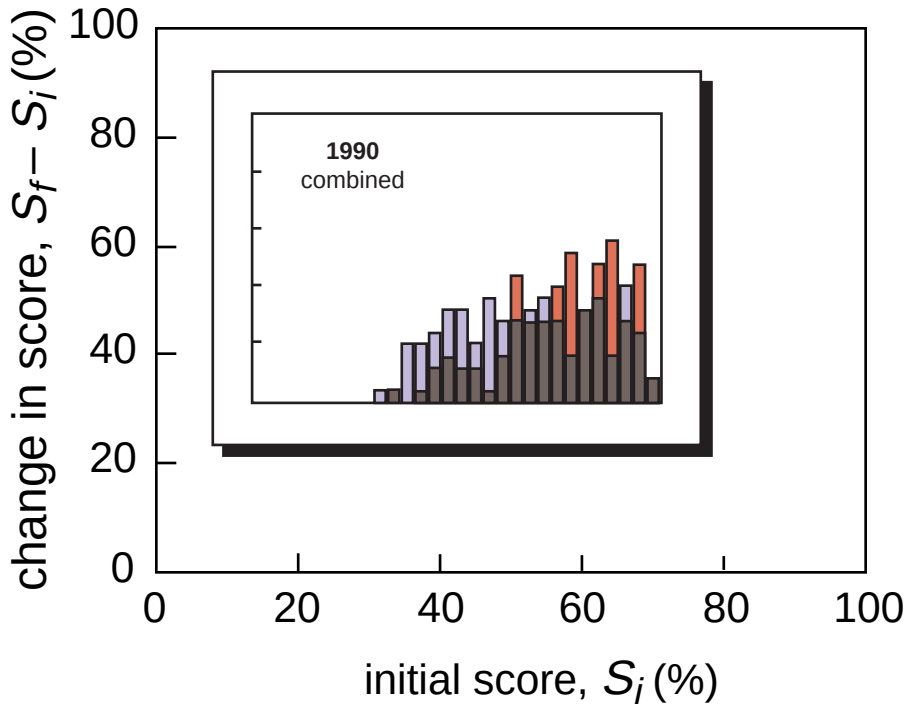
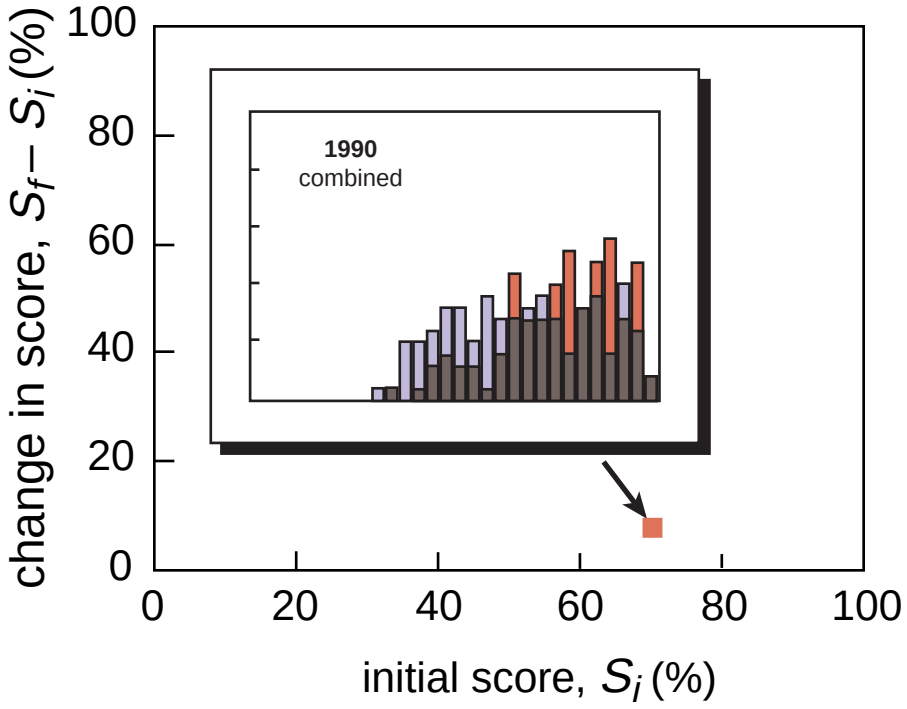


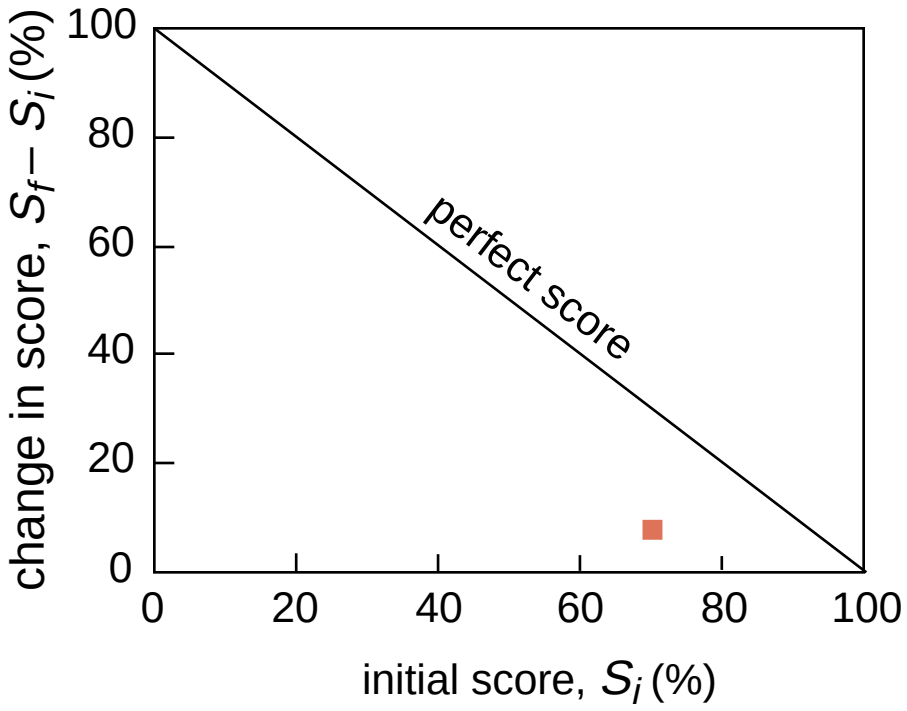
Why change?


1990
combined
change in score, $S_f - S_i$ (%)
initial score, S_i (%)
0
20
40
60
80
100

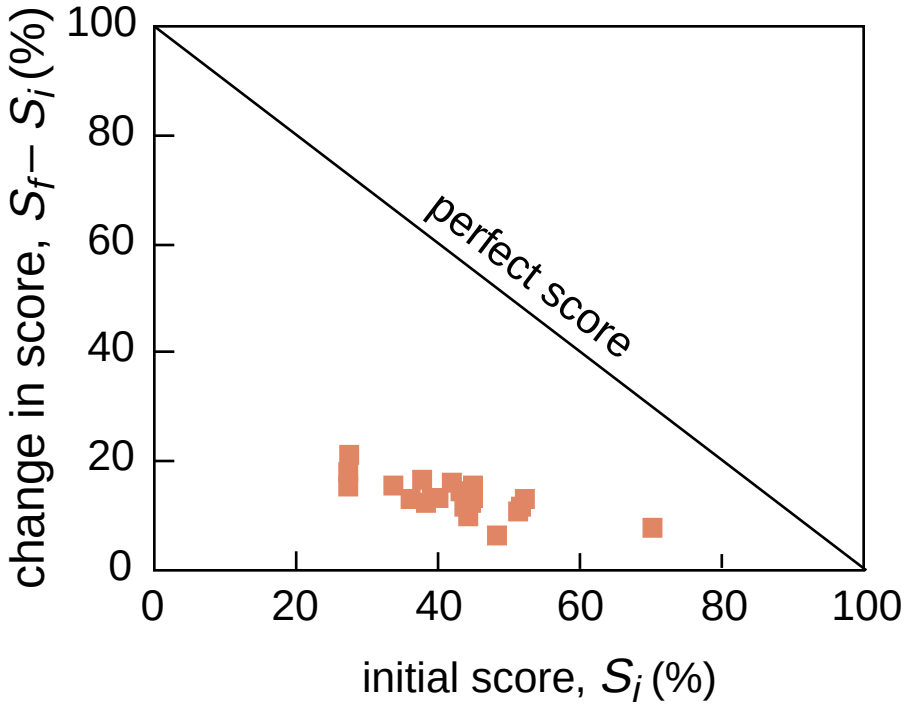
Why change?


1990
combined
change in score, $S_f - S_i$ (%)
initial score, S_i (%)
0
20
40
60
80
100

Why change?


change in score, $S_f - S_i$ (%)
100
80
60
40
20
0
0
20
40
60
80
100
perfect score
initial score, S_i (%)

Why change?



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

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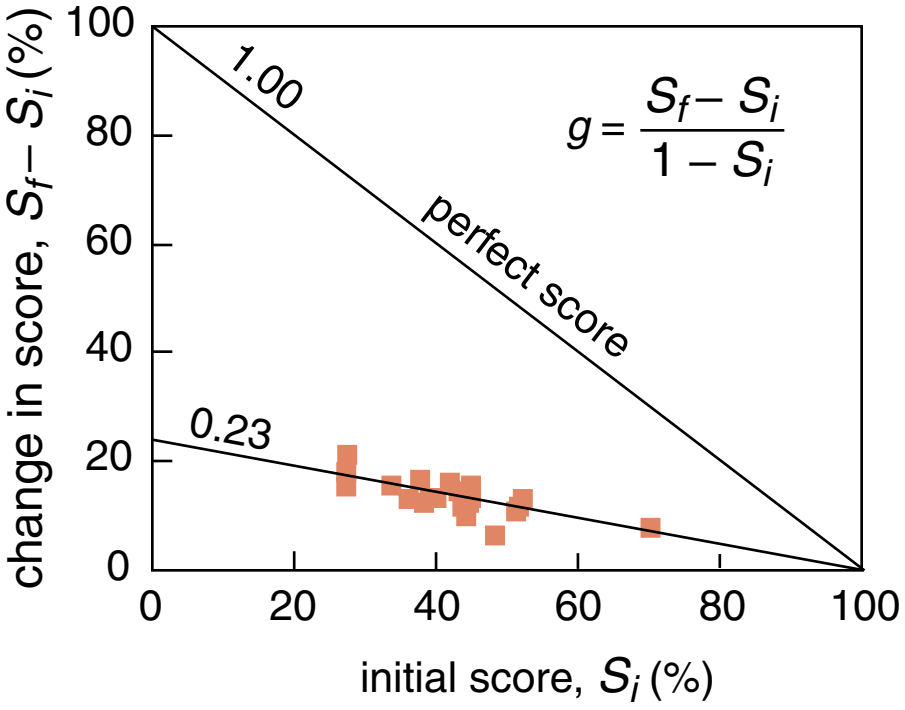

R.R. Hake, Am. J. Phys. 66, 64 (1998)


So what should we do?

Peer Instruction

Give students a more active picture of 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

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- **Use class to deepen and broaden understanding**

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- **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**

Essential elements

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

Reading

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

Reading

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

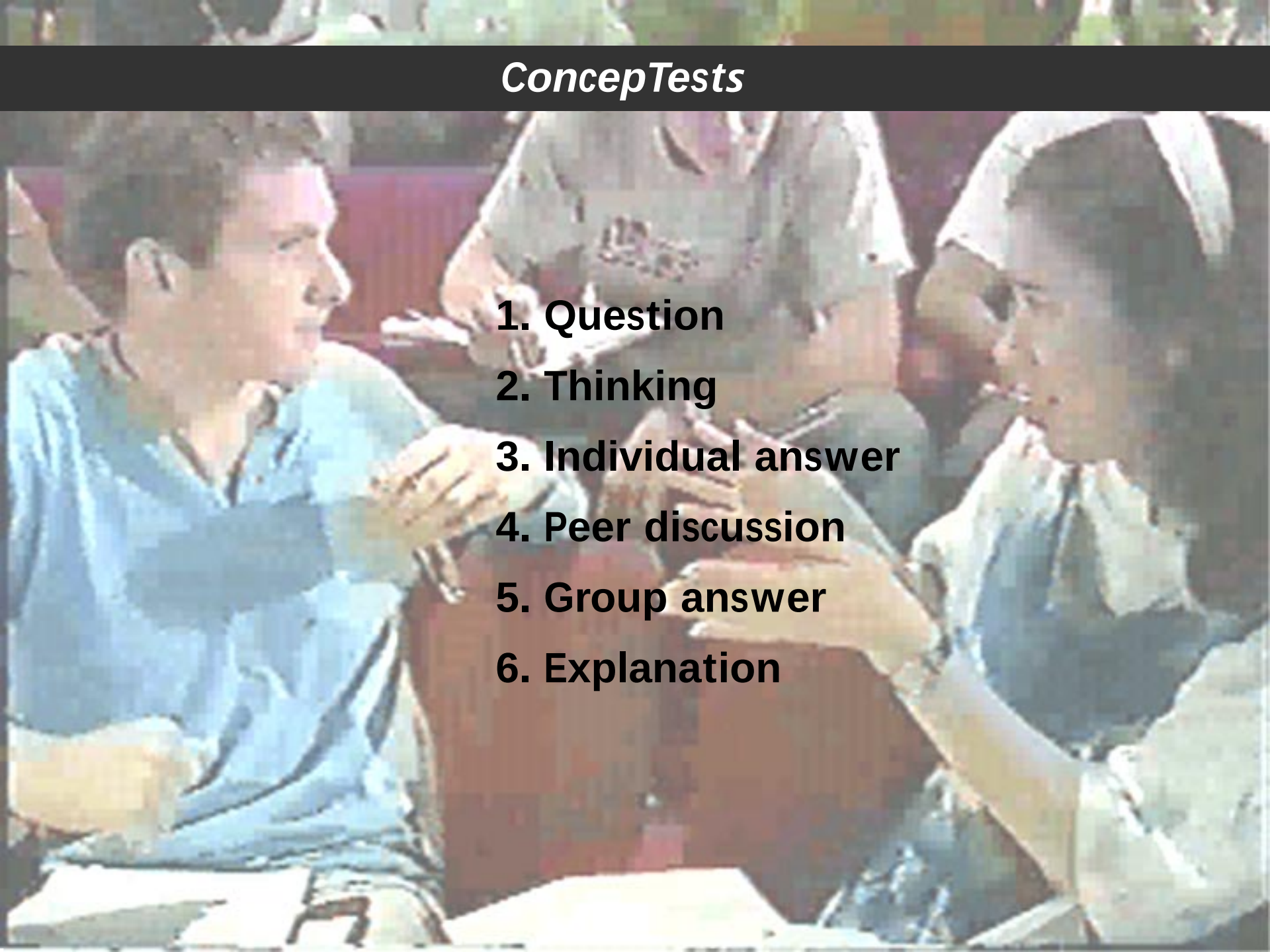
Reading

- **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**

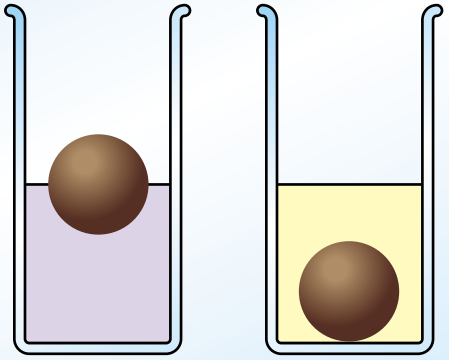
ConcepTests



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

Sample ConcepTest

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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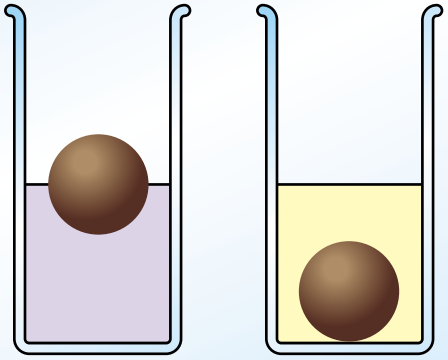
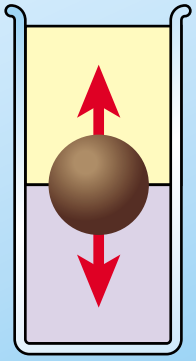


If we slowly pour oil on top of the water so it completely covers the object, the object

1. moves up.

2. stays in the same place.

3. moves down.



Encouraging participation

- **Suitable ConcepTests**

Encouraging participation

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

Encouraging participation

- **Suitable ConcepTests**
- **Rewards for participation**
- **Noncompetitive grading**

Encouraging participation

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

Is it any good?

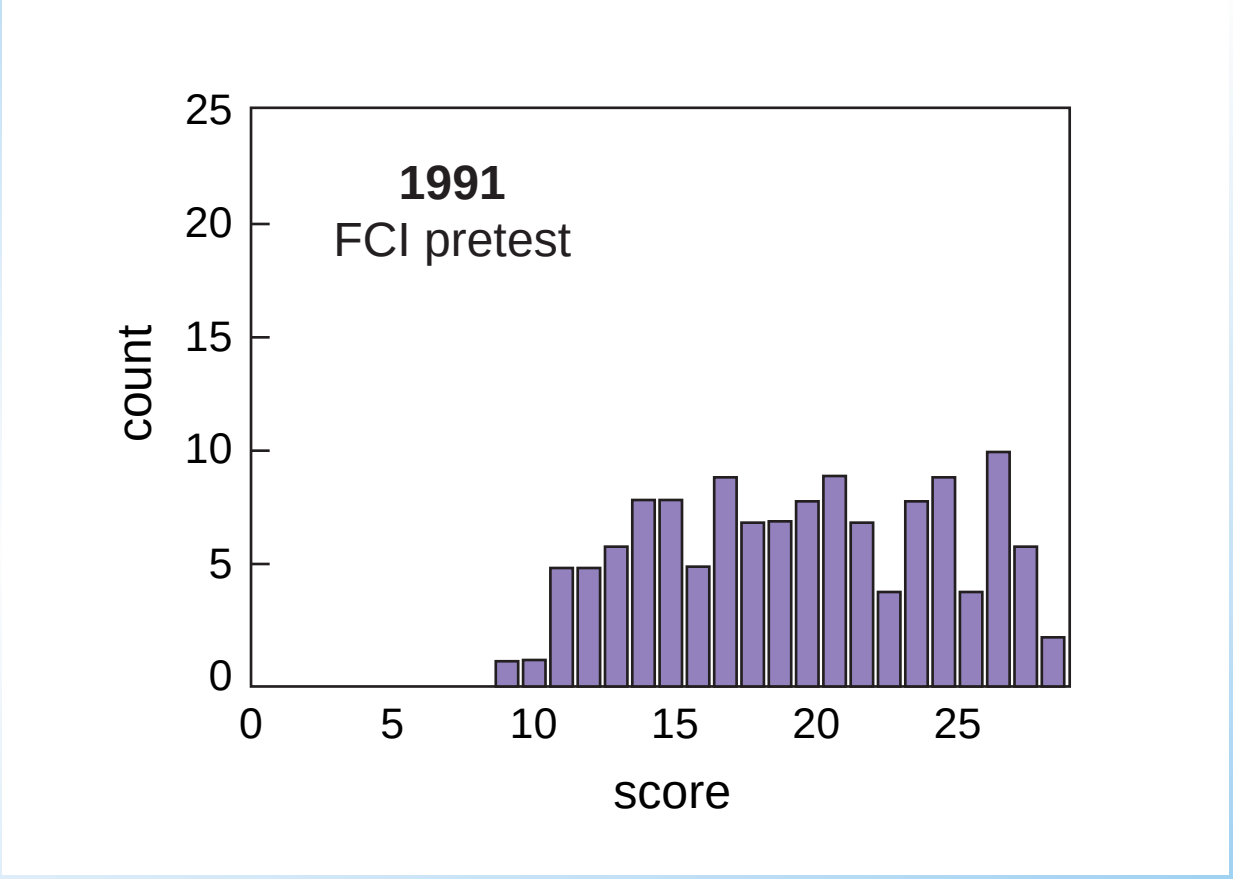
Is it any good?

- **Results**

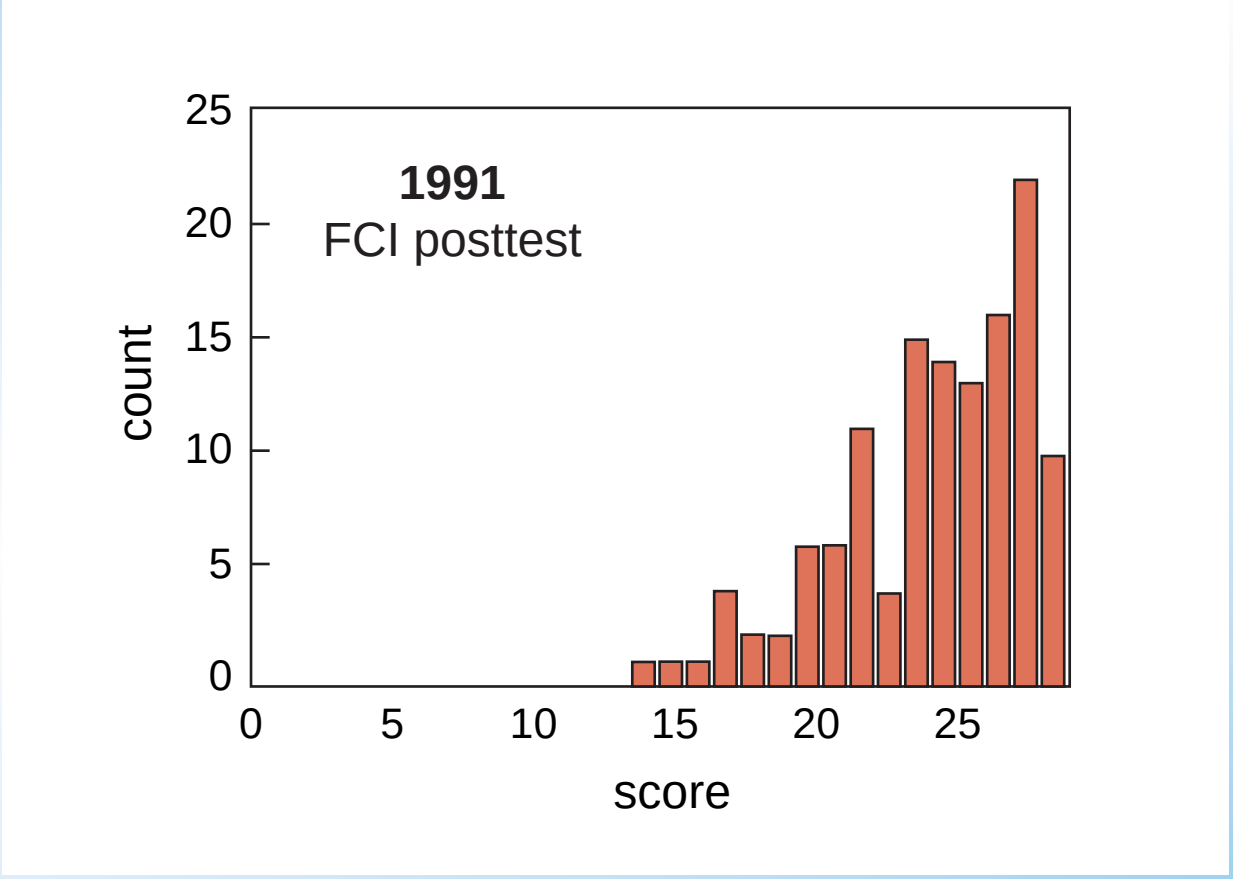
Is it any good?

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

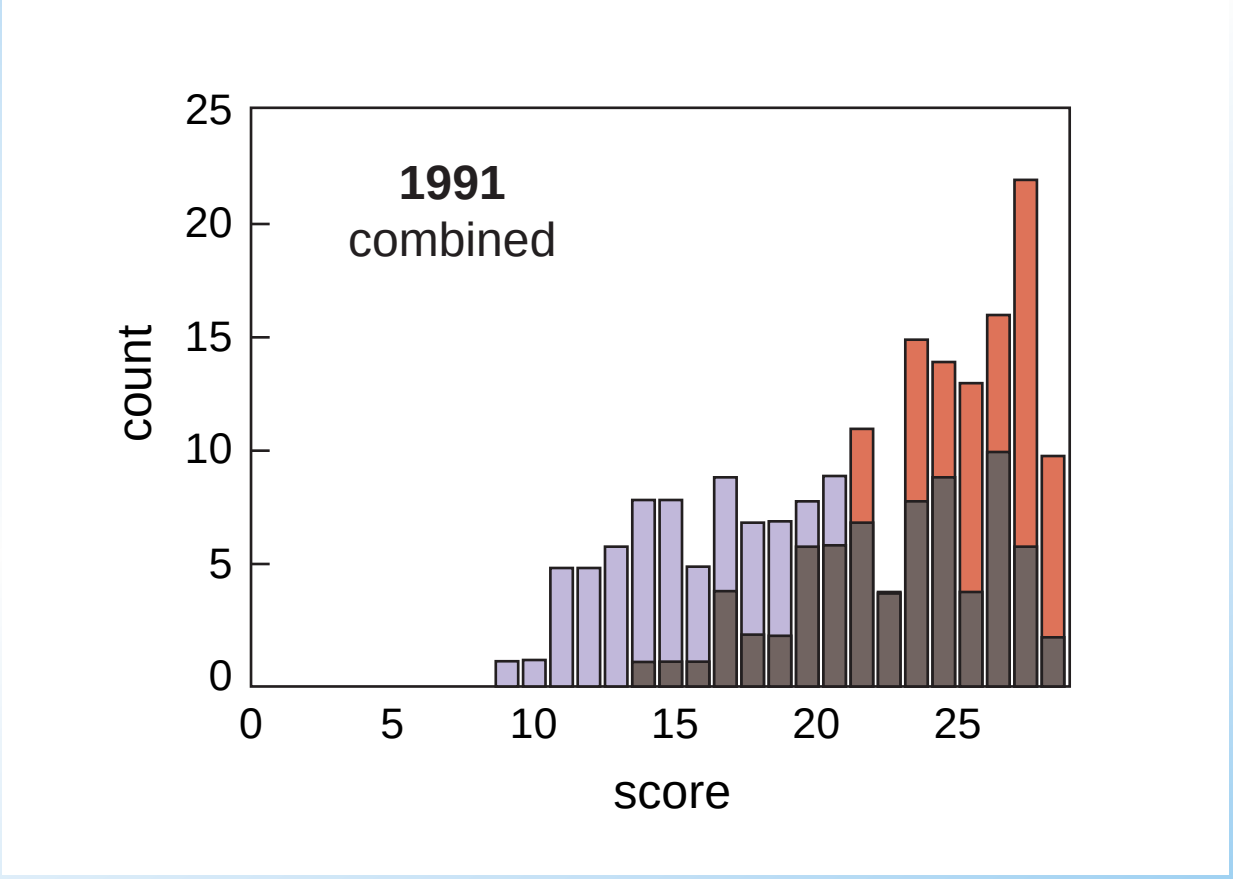
Results



Results



Results



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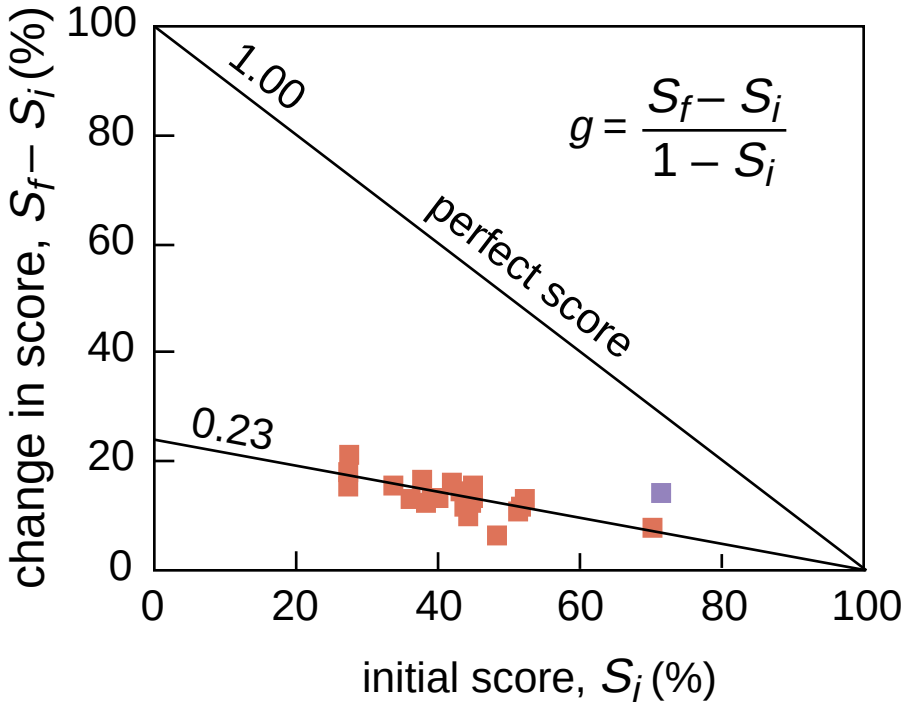
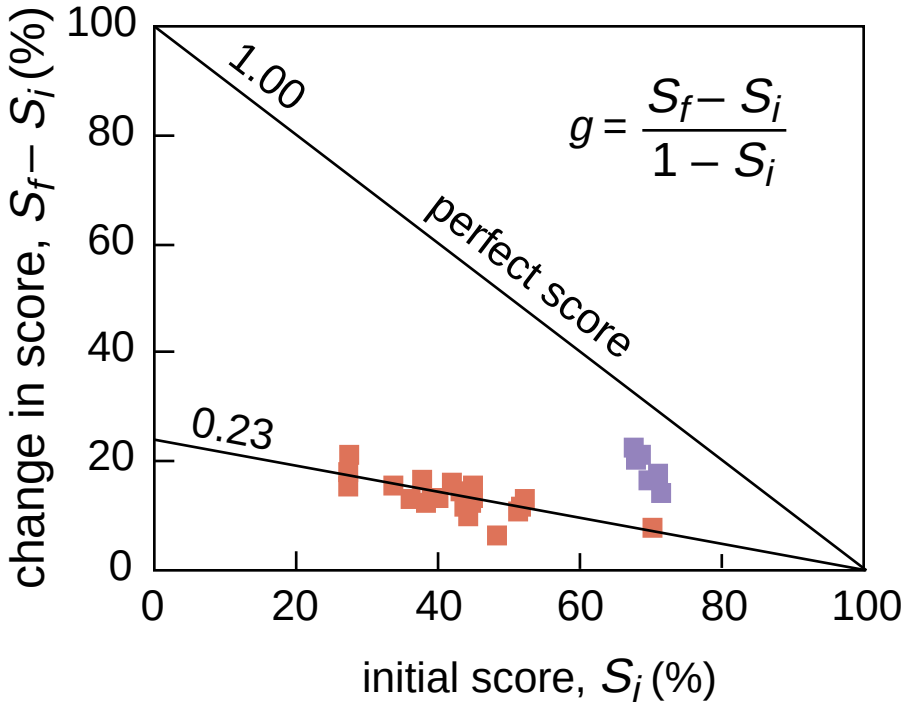

100
80
60
40
20
0
0
20
40
60
80
100
change in score, $S_f - S_i$ (%)
initial score, S_i (%)
1.00
perfect score
0.23
$g = \frac{S_f - S_i}{1 - S_i}$

Results


change in score, $S_f - S_i$ (%)
initial score, S_i (%)
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20
40
60
80
100
1.00
perfect score
0.23
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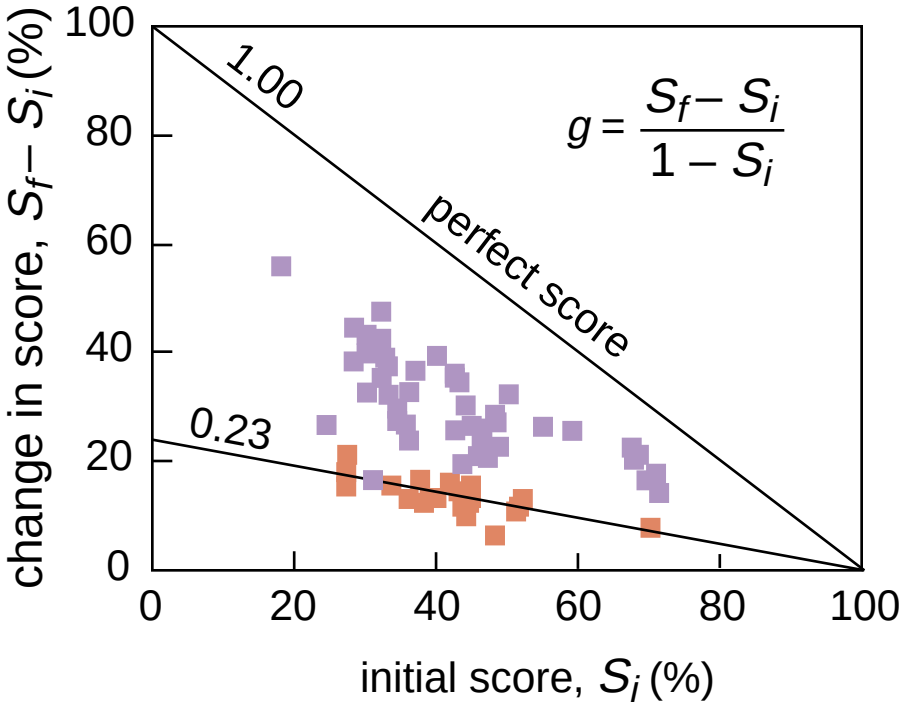
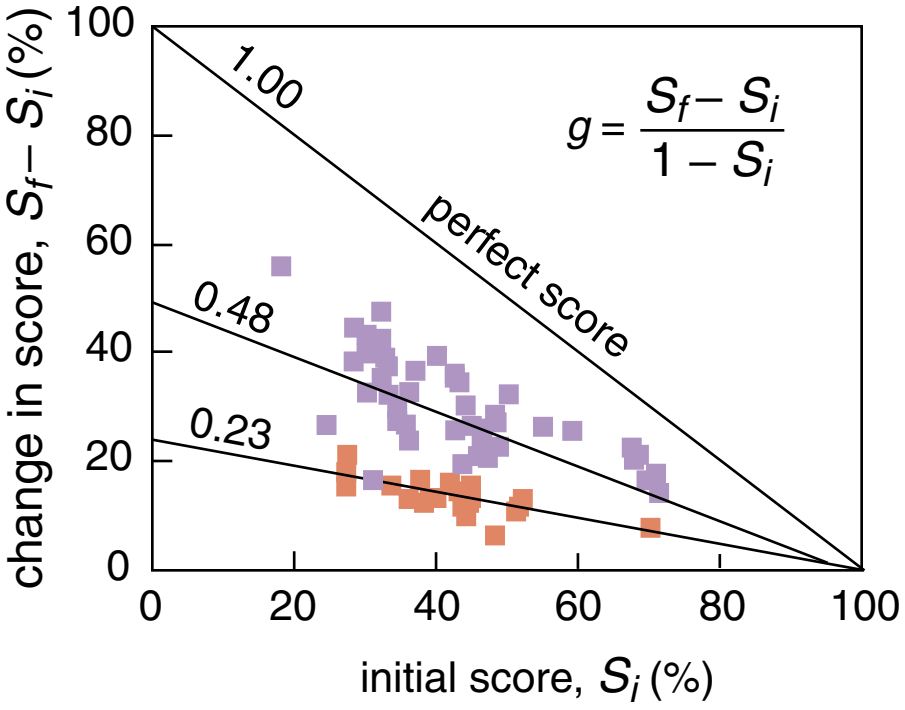
Results



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

Results



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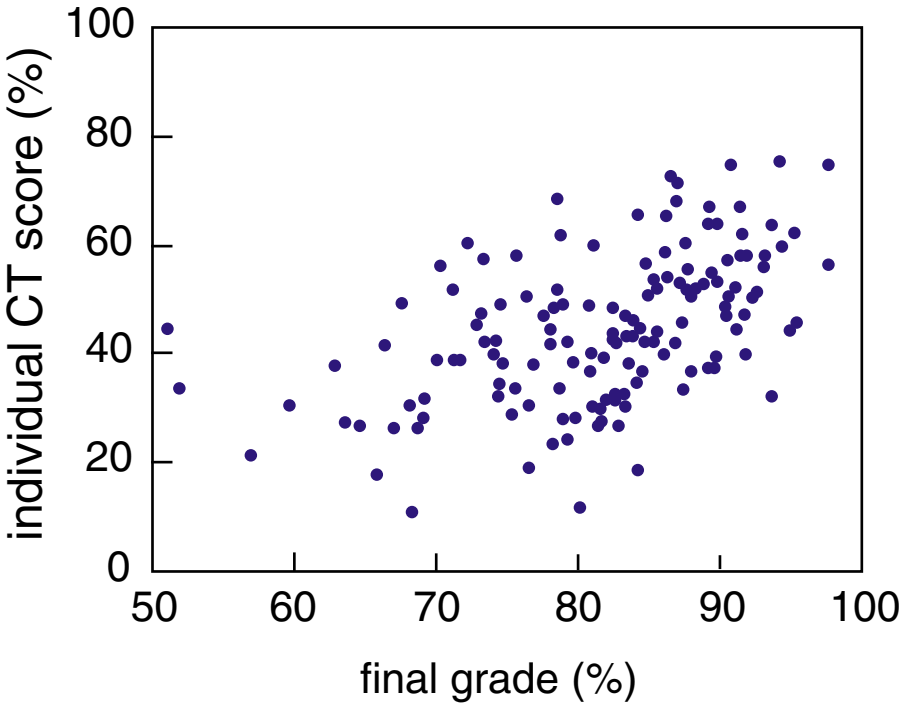
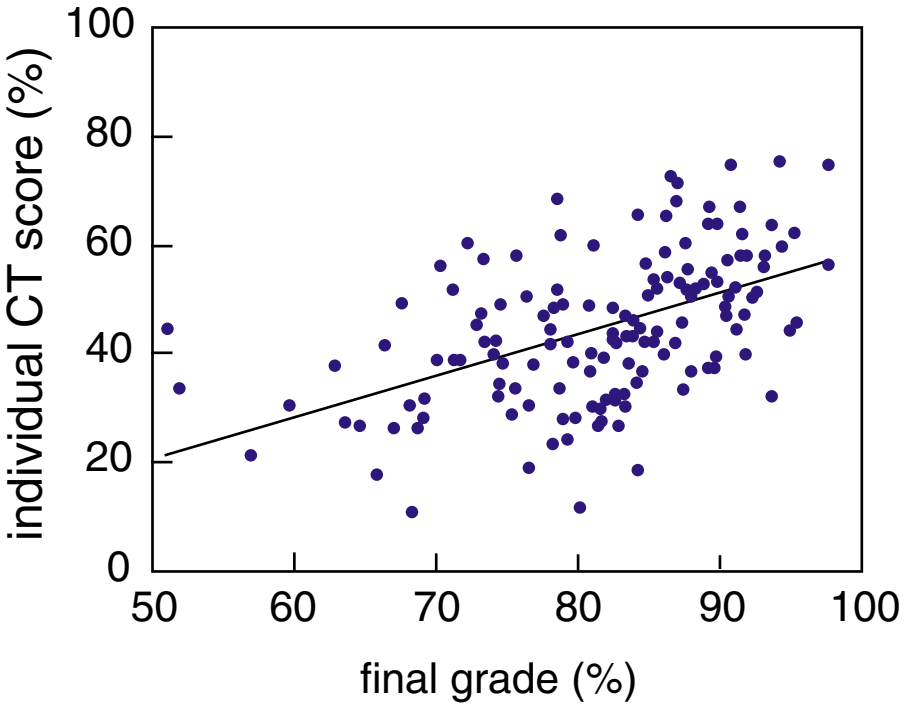
Who benefits?

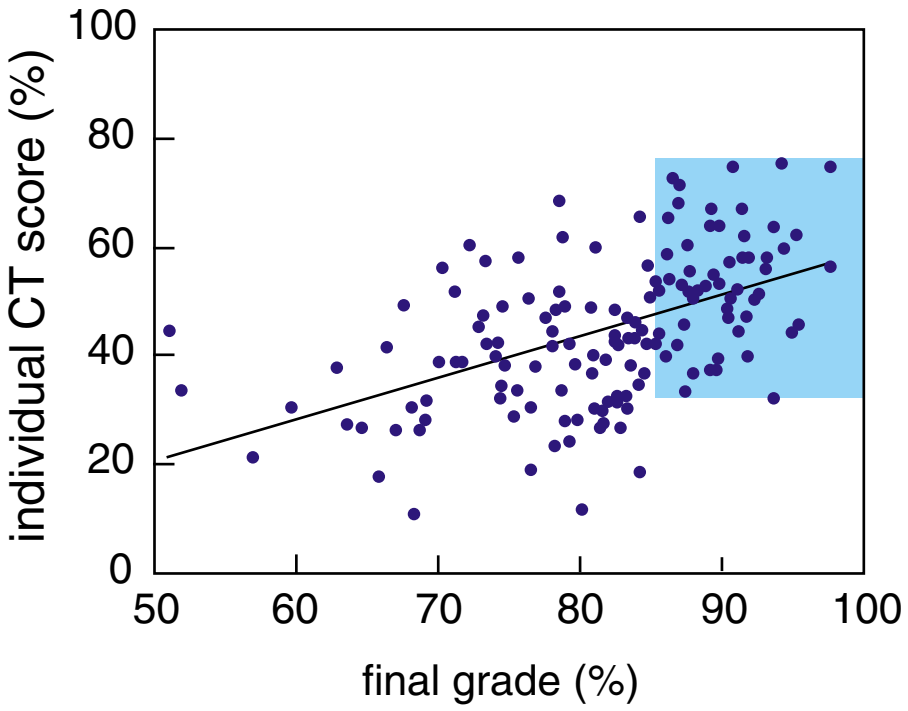


Who benefits?

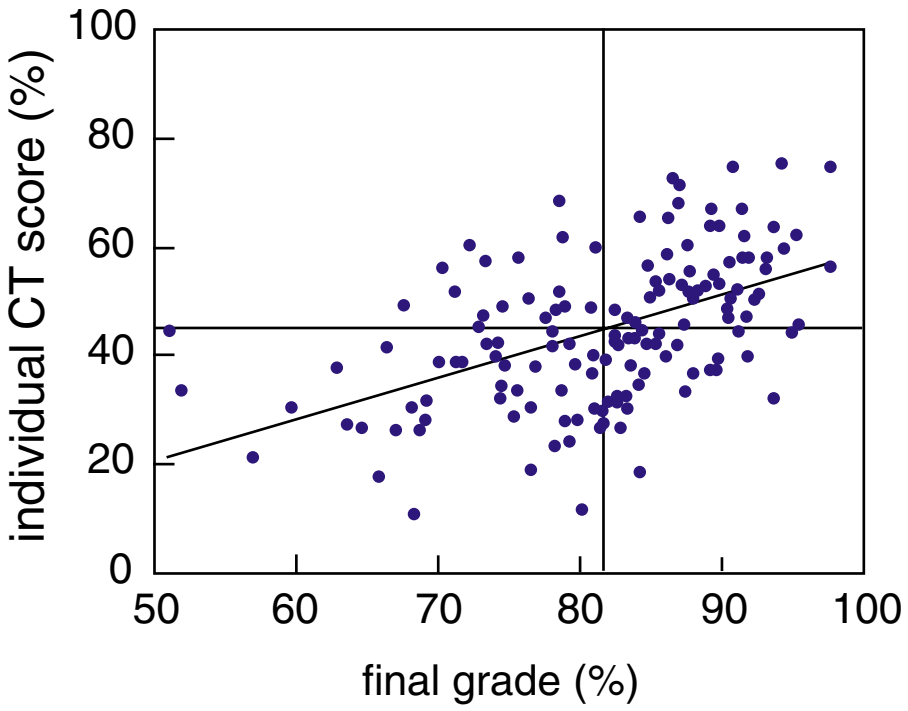


Who benefits?

even best students are challenged!



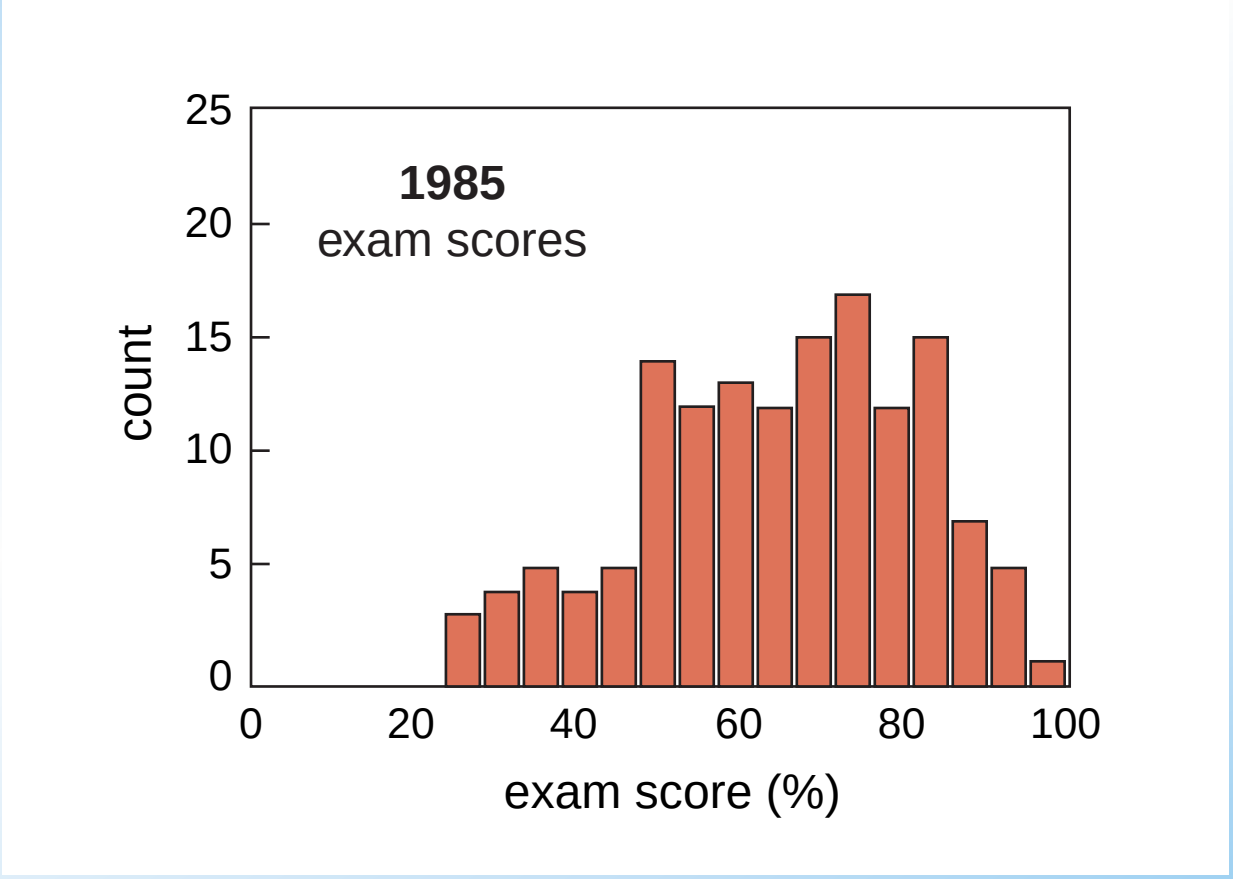
Who benefits?



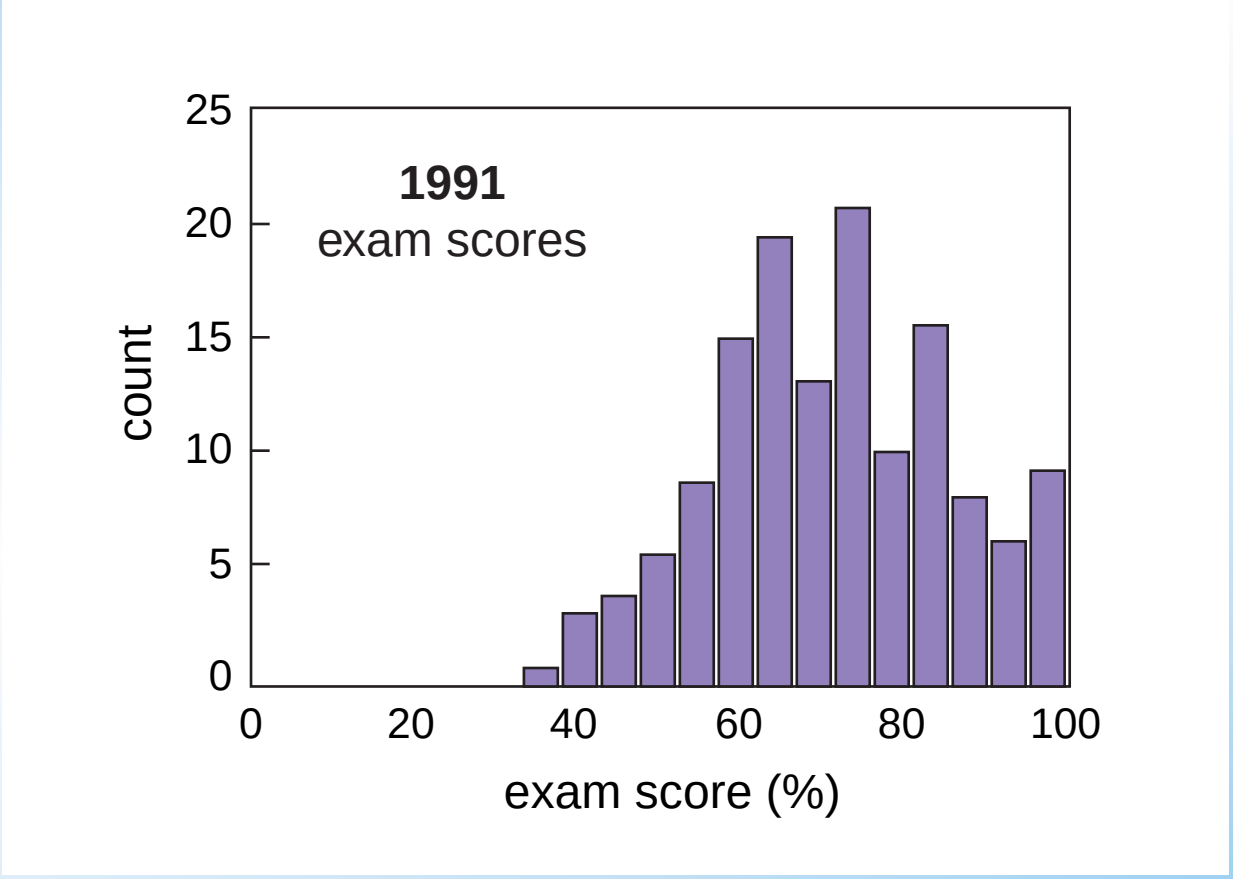
Results

What about problem solving…?

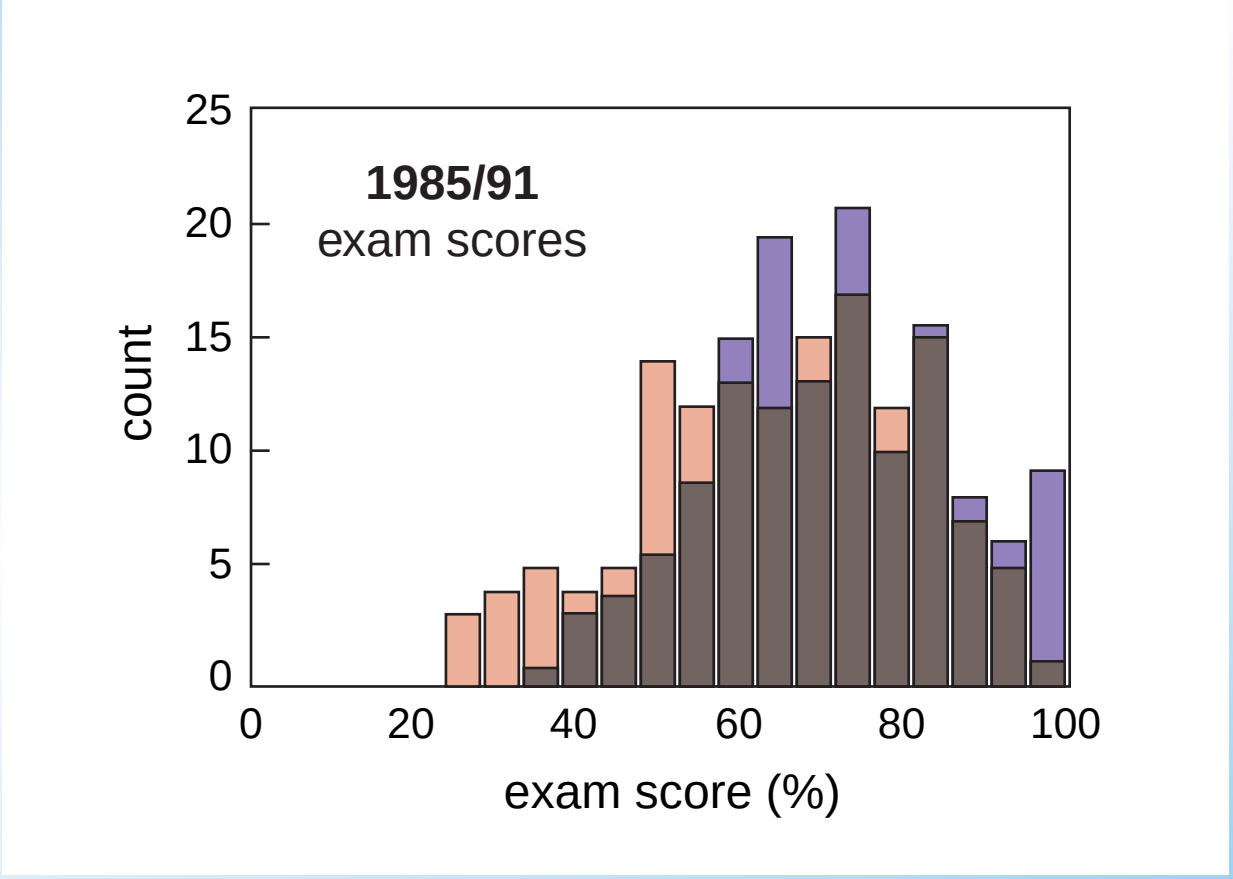
Results


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
0
20
40
60
80
100
exam score (%)

Results


1985/91
exam scores
count
25
20
15
10
5
0
0
20
40
60
80
100
exam score (%)

Coverage

traditional	
coverage	encyclopedic
retention	disappointing

Coverage

	traditional	interactive
coverage	encyclopedic	less?
retention	disappointing	more!

Why it works for students

- **focuses students on understanding**

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

Why it works for instructors

- **modification, not drastic change**

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

Challenges:

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

Conclusion

Rewards:

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

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