

PEER INSTRUCTION: TURNING A LECTURE INTO A SEMINAR

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Outline

- ▶ **Why change lectures?**

Outline

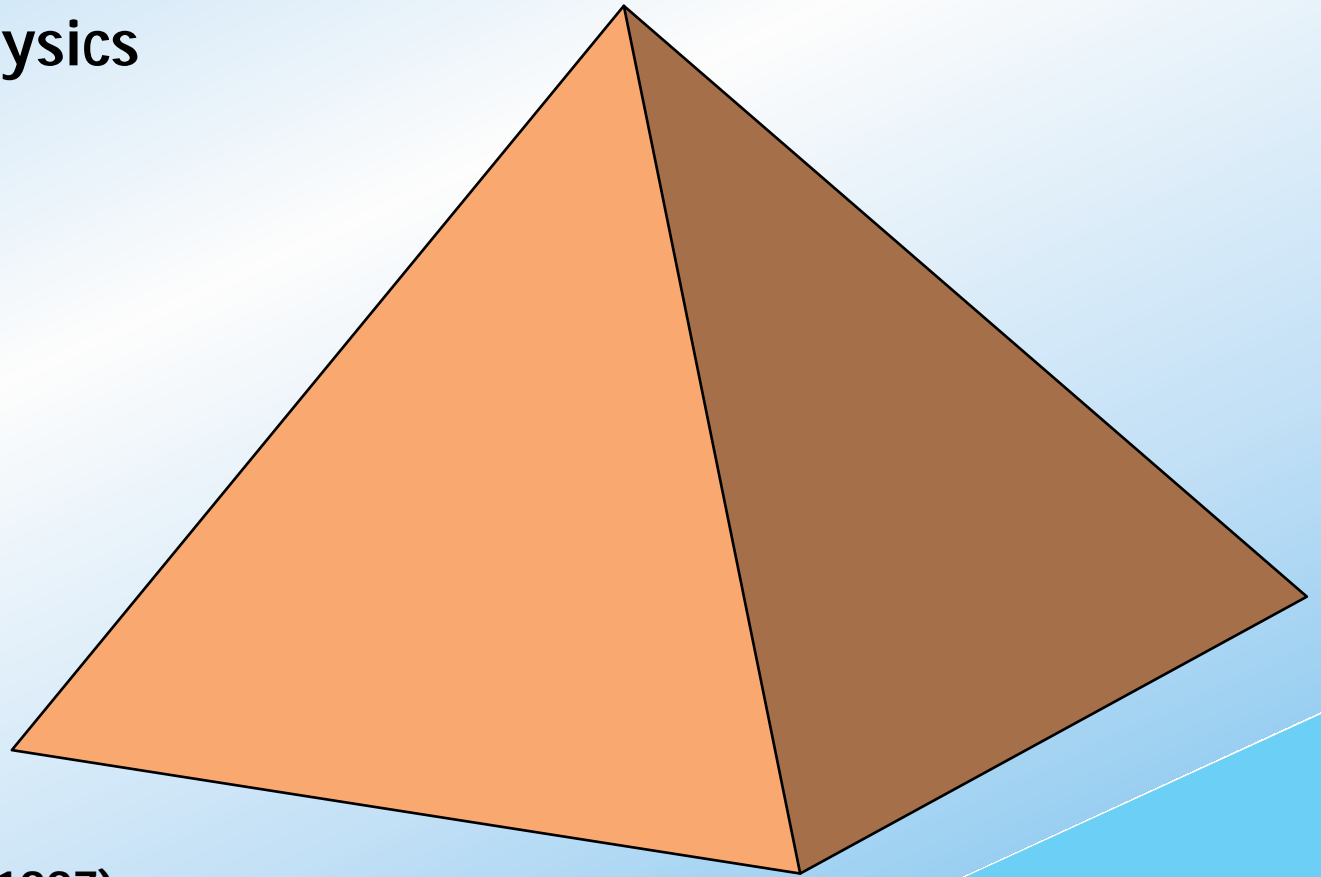
- ▶ **Why change lectures?**
- ▶ **How should we change?**

Outline

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

Some context

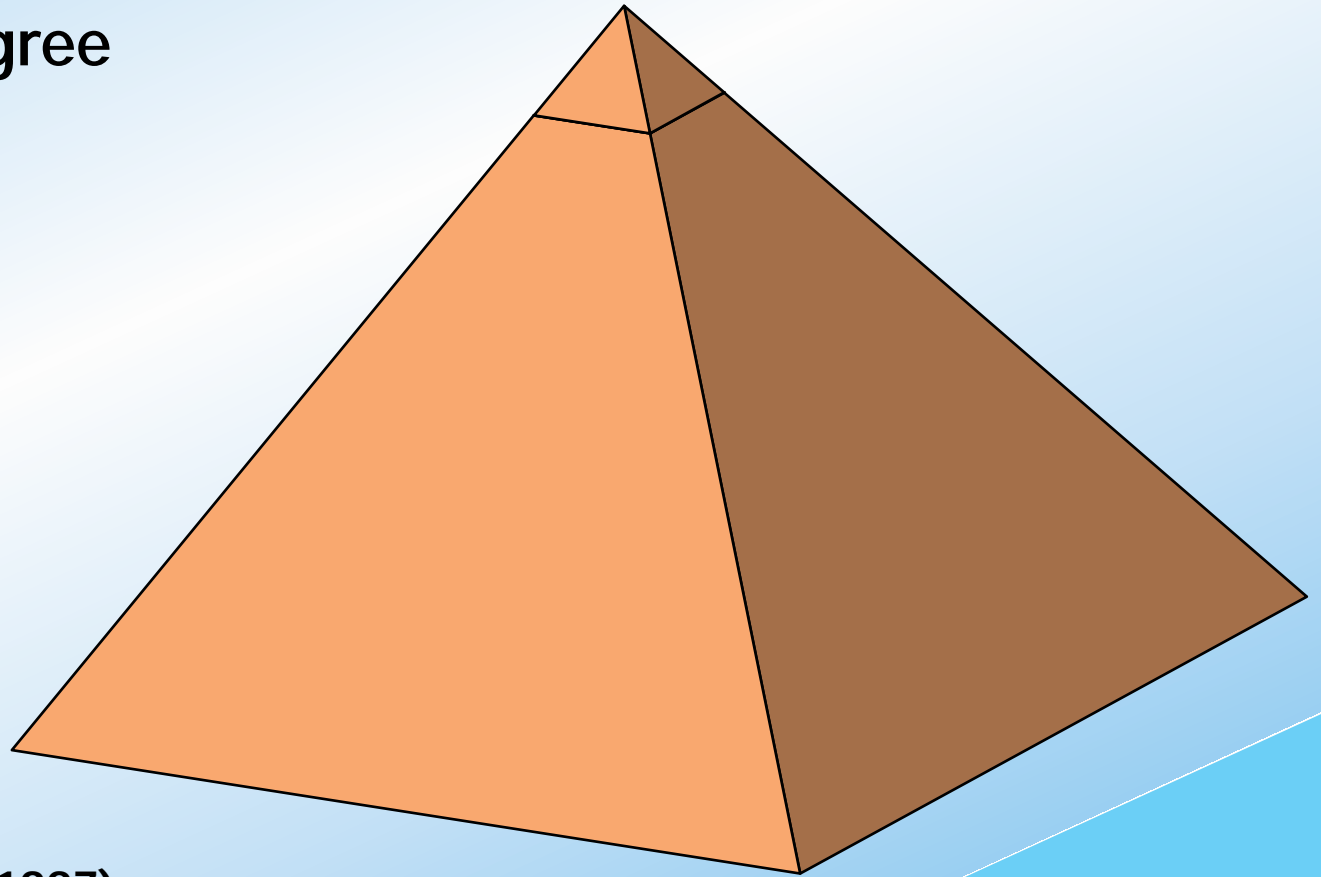
380,000 students take
introductory physics
each year...



AIP Report R-151.33 (1997)

Some context

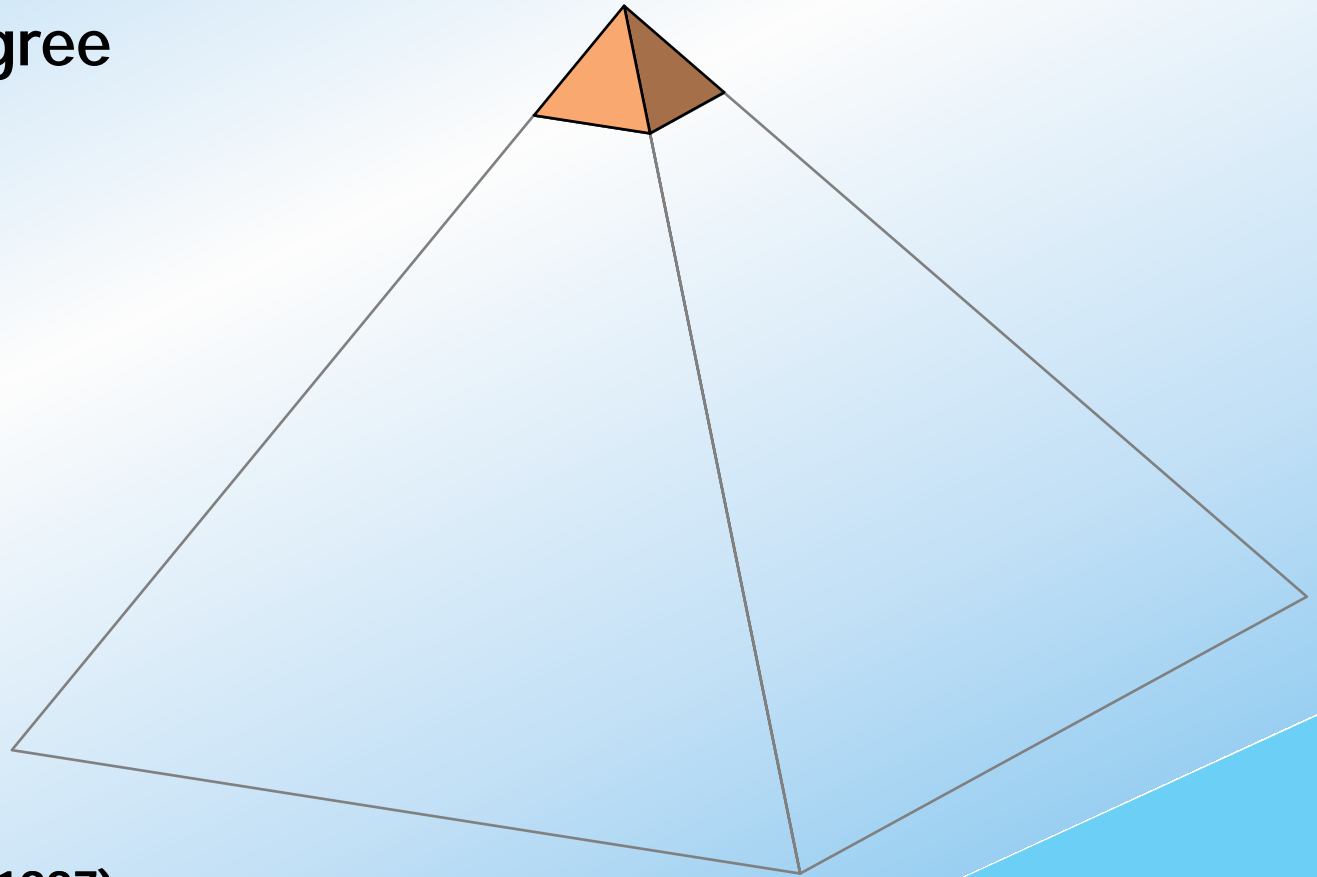
about 1% of these get
a bachelor's degree
in physics



AIP Report R-151.33 (1997)

Some context

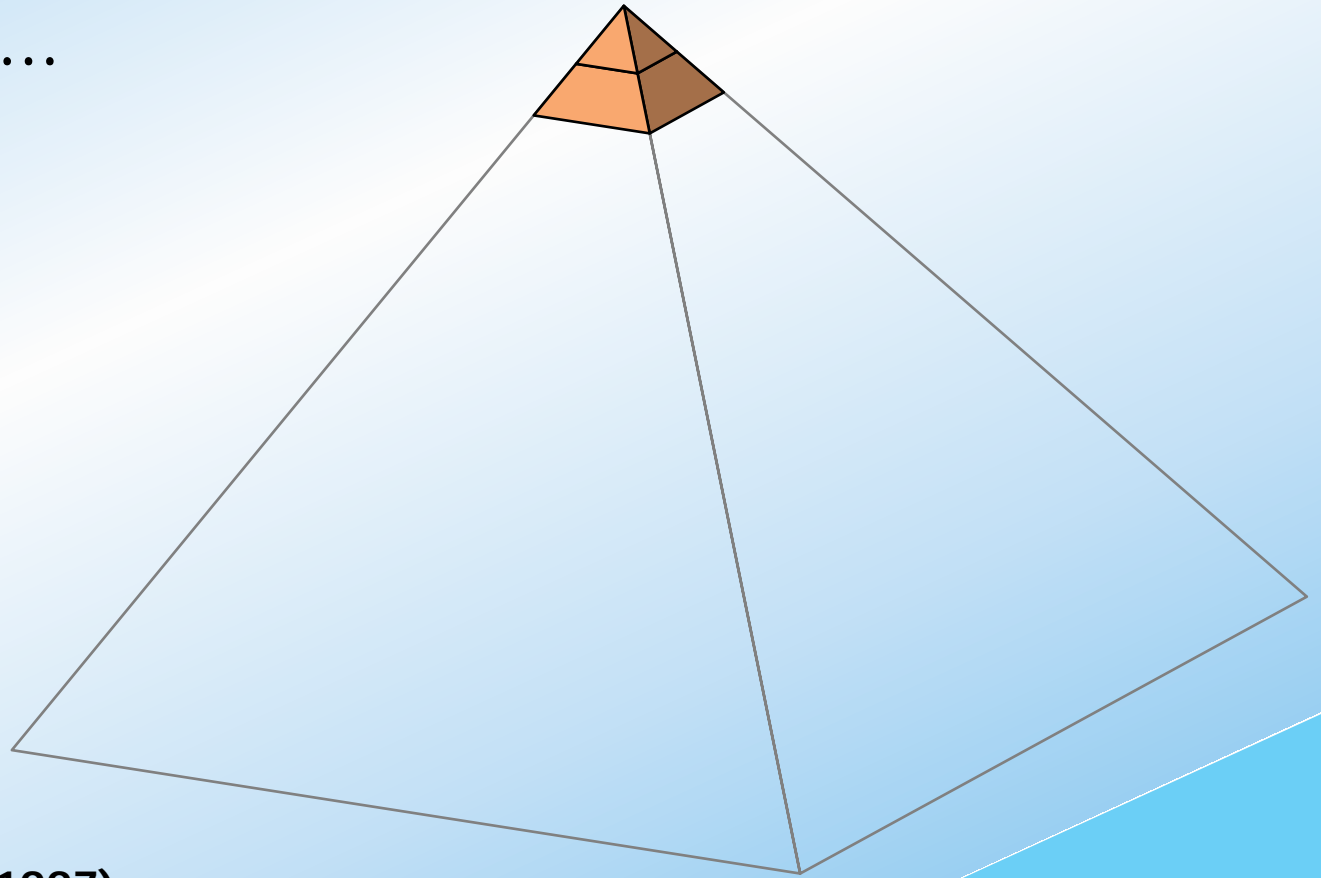
Of the 4,300 students with
a bachelor's degree
in physics...



AIP Report R-151.33 (1997)

Some context

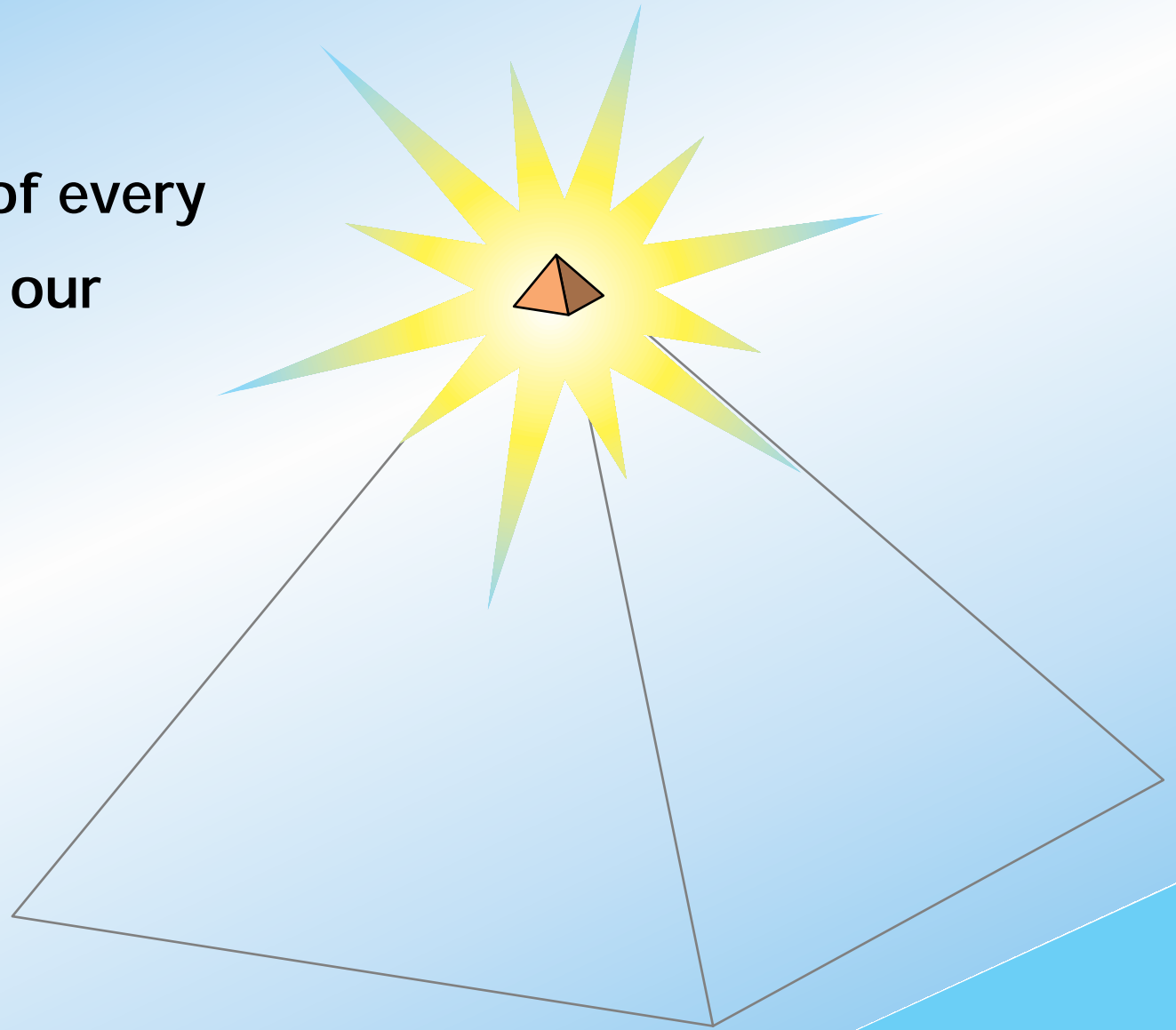
about 35% go on to get a
Ph.D. in physics...



AIP Report R-151.33 (1997)

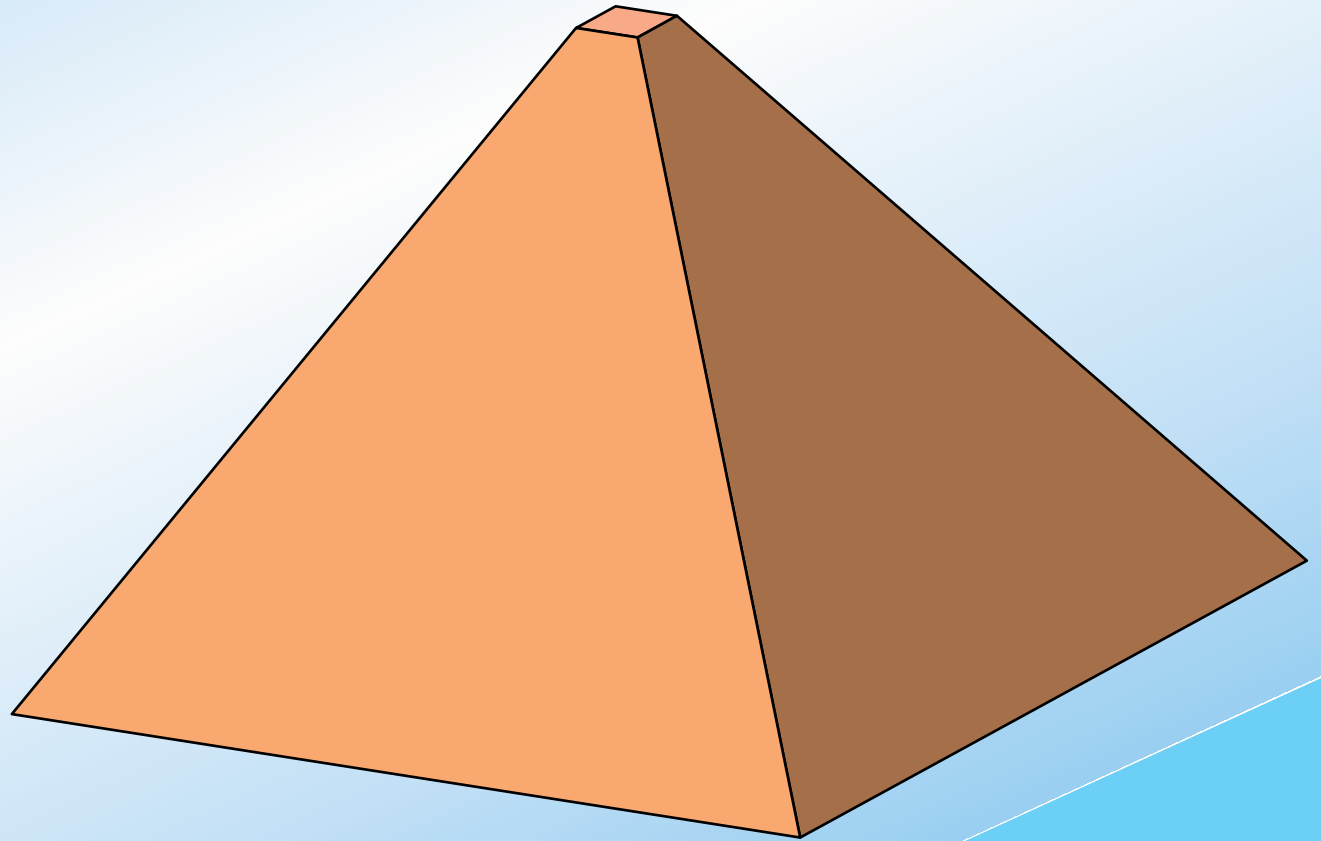
Some context

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



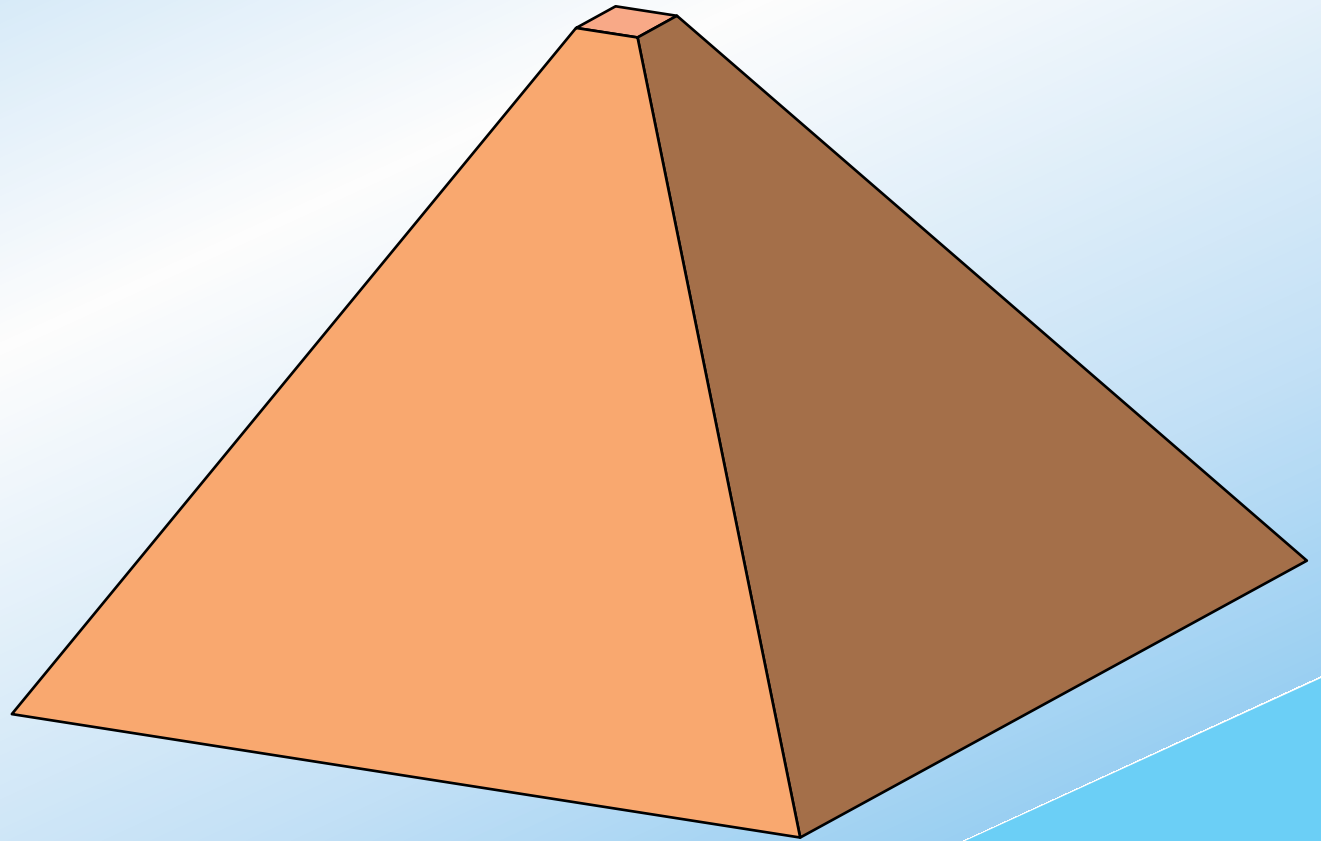
Some context

What about the
other 259...?



Some context

What do we know
about these
students?



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, slightly blurred 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 center in a bold, black, sans-serif font.

Why do we have this problem?

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...

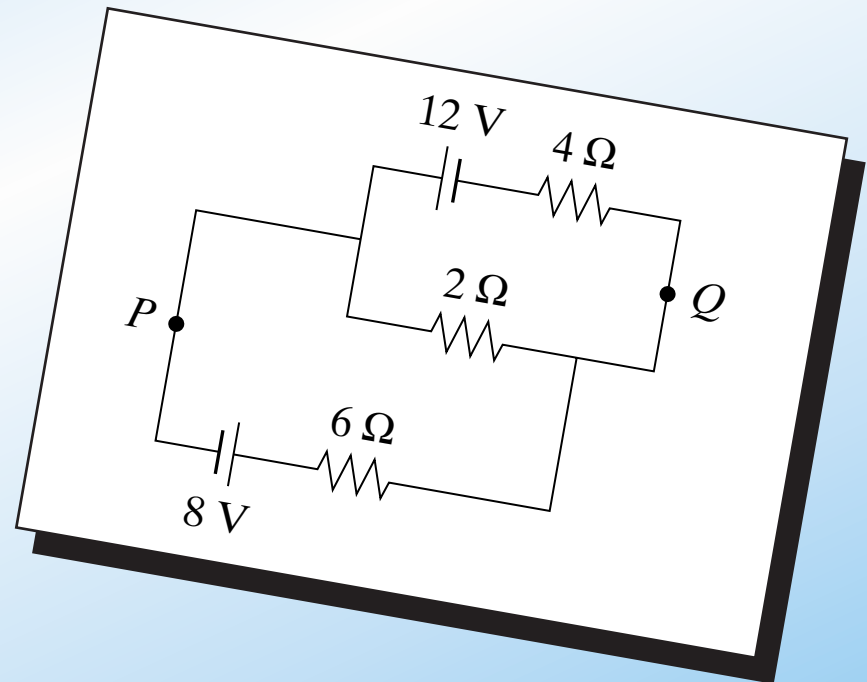
...but physics is more than just information!

Why change?

Conventional problems reinforce bad study habits

Why change?

Conventional problems reinforce bad study habits

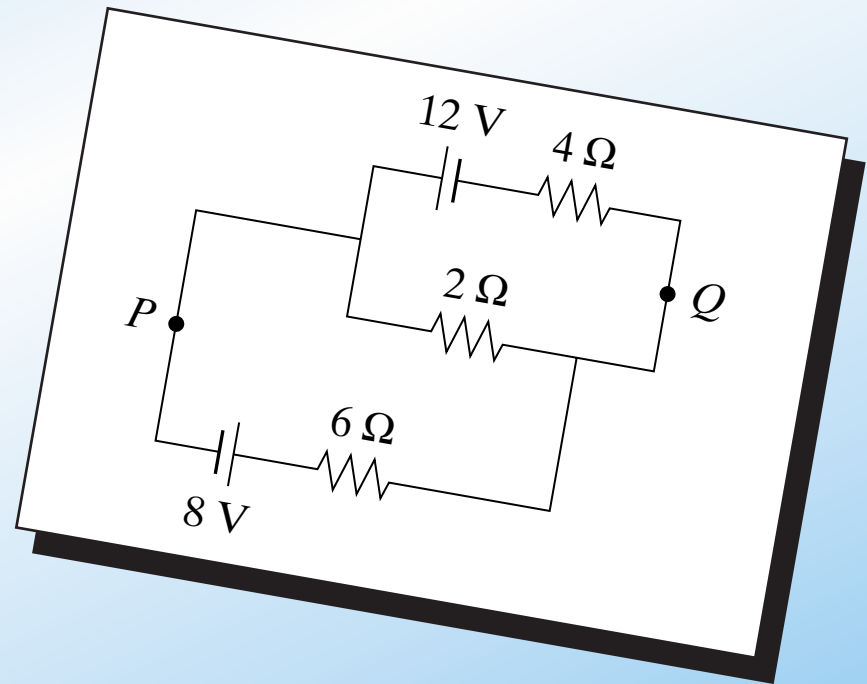


Why change?

Conventional problems reinforce bad study habits

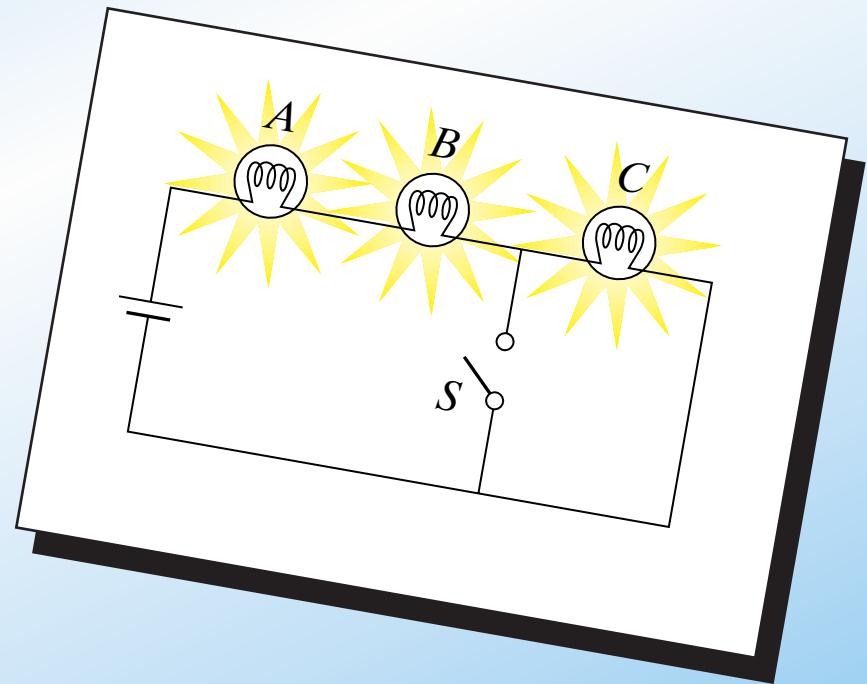
Calculate:

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



Why change?

Are basic principles understood?

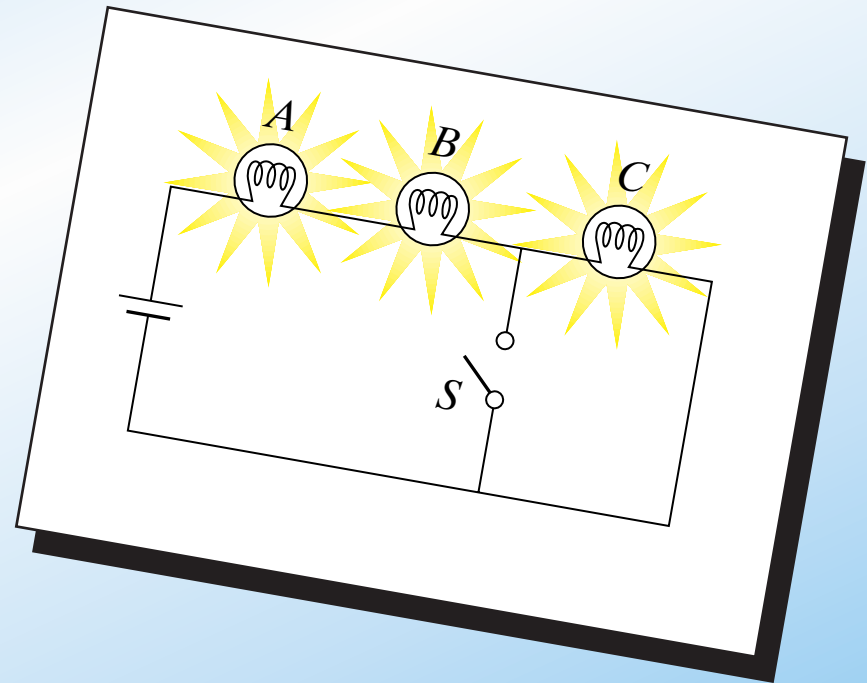


Why change?

Are basic principles understood?

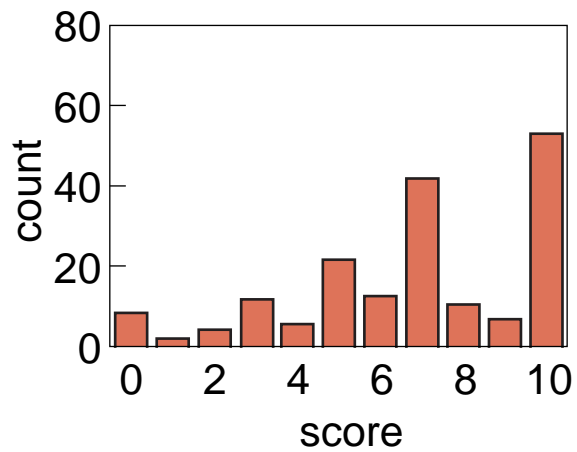
When S is closed, what happens to the:

- (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?

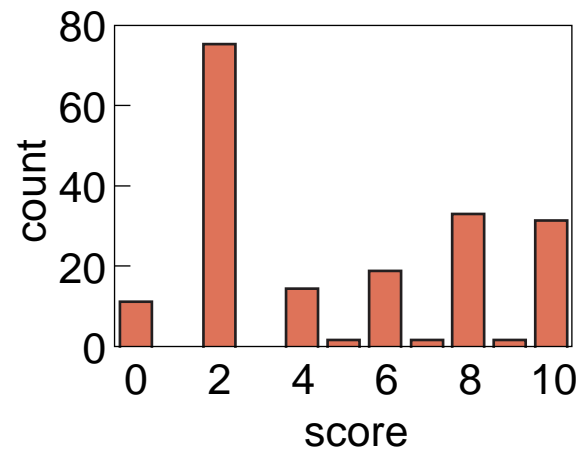


Why change?

conventional

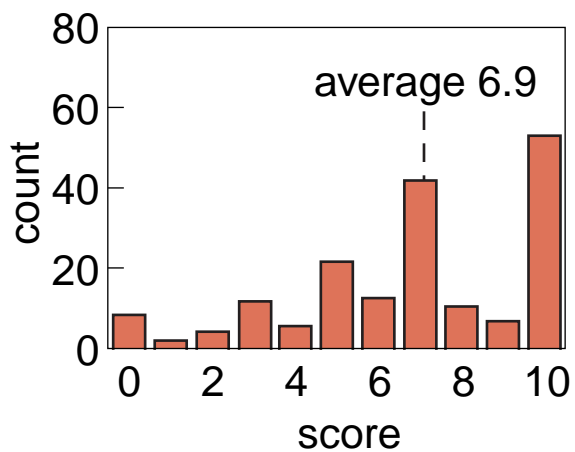


conceptual

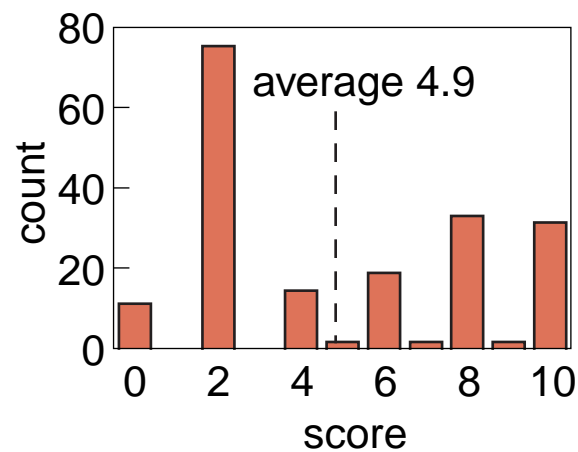


Why change?

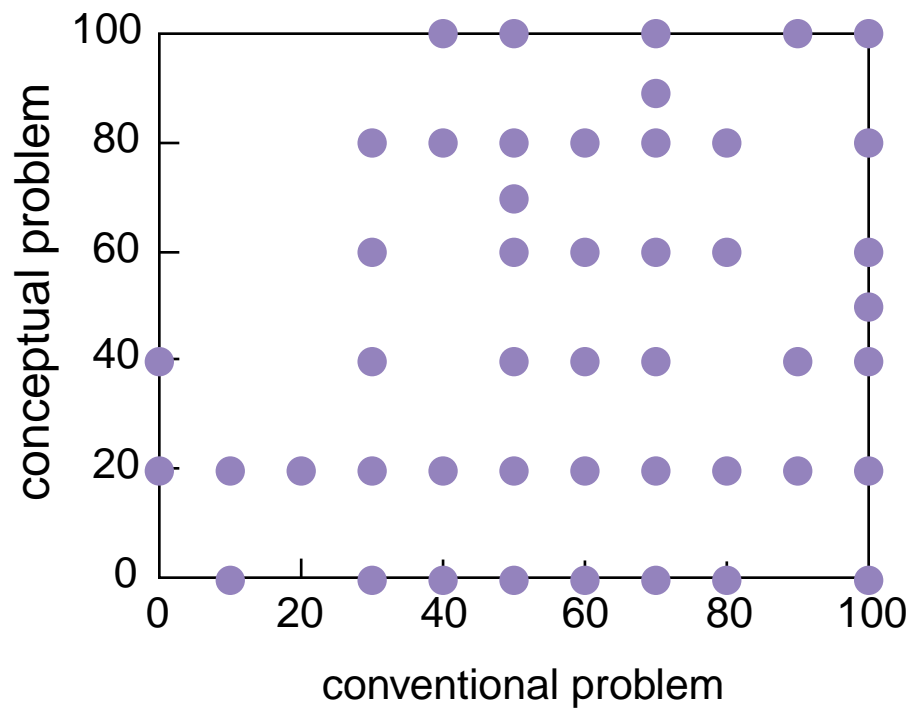
conventional



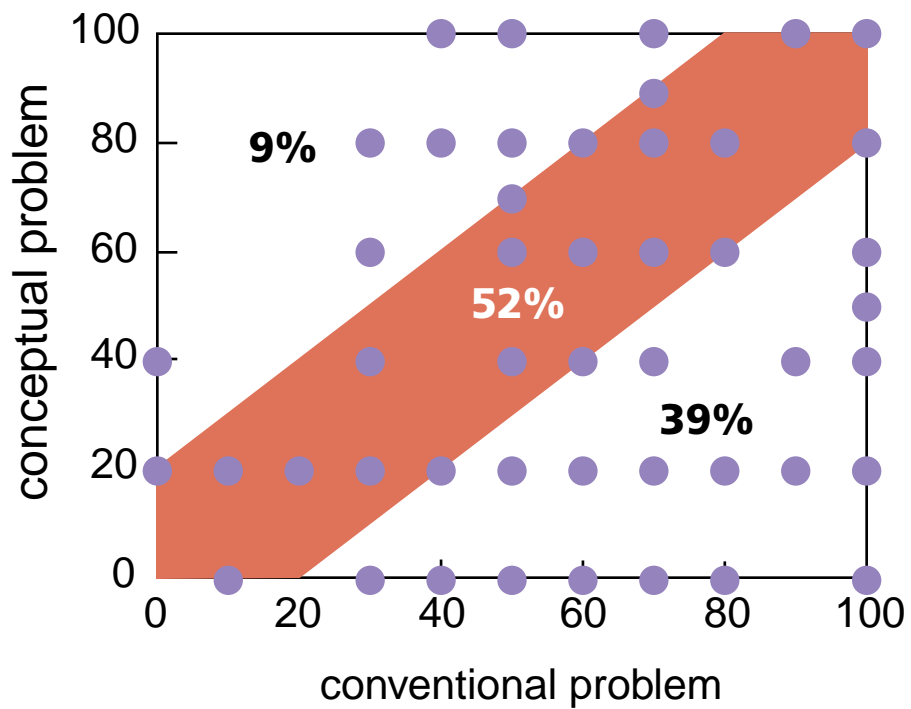
conceptual



Why change?



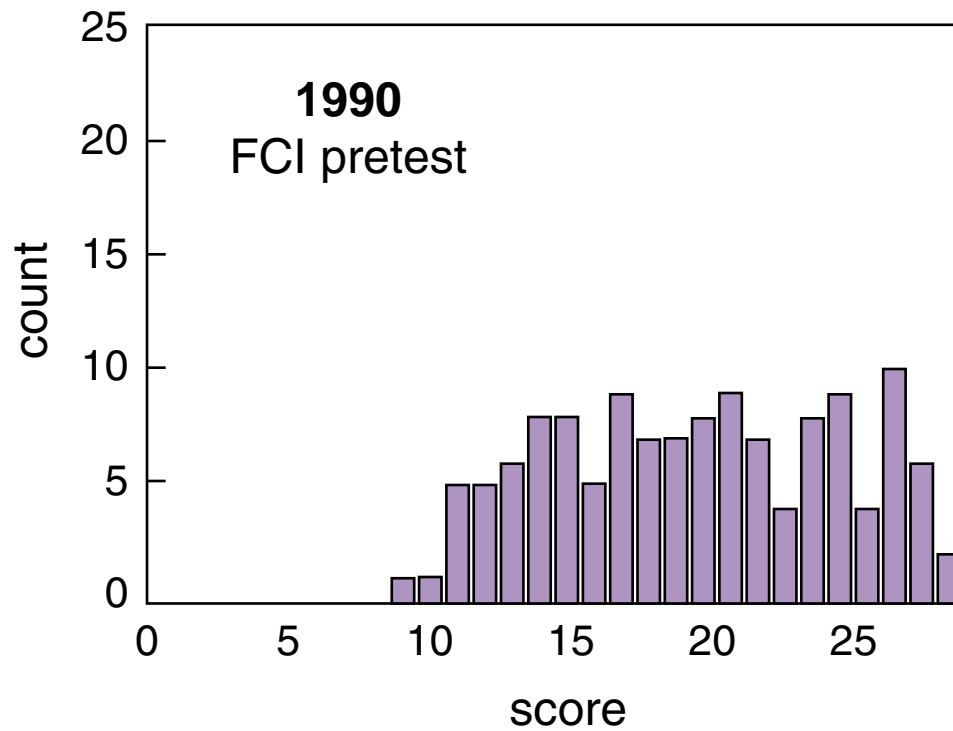
Why change?



Why change?

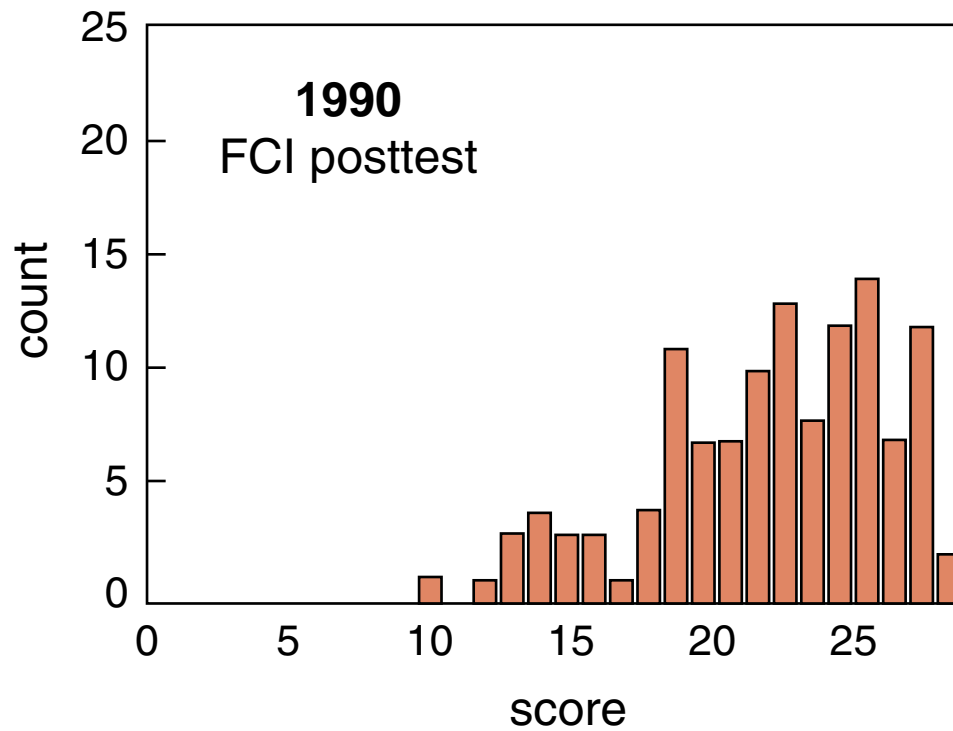
Memorization rarely produces understanding

Why change?

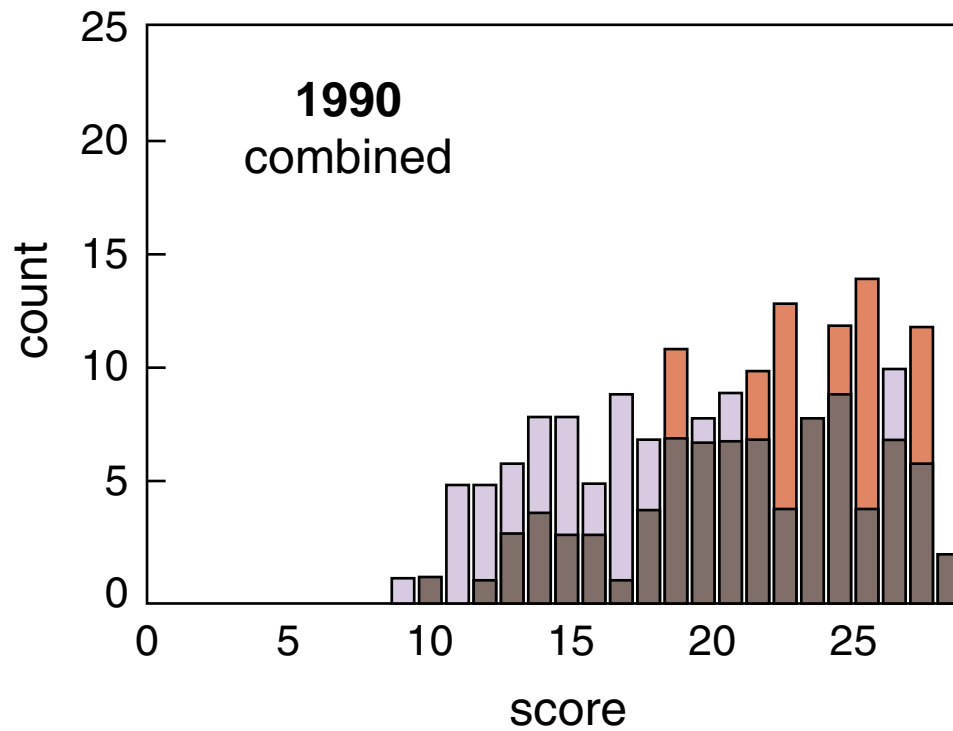


Hestenes, *et al.*, *TPT* 30, 141 (1992)

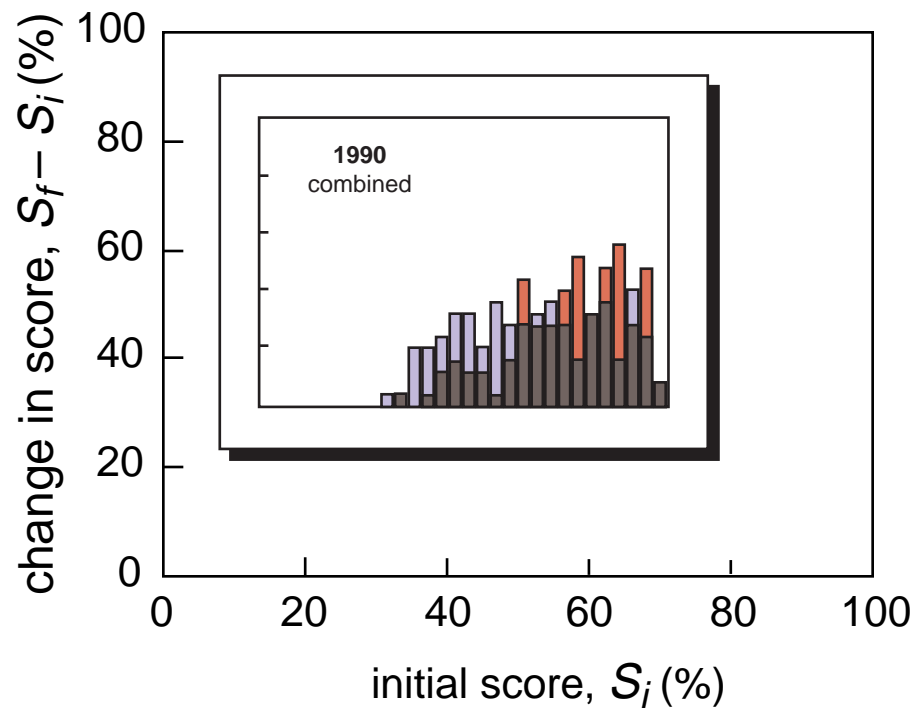
Why change?



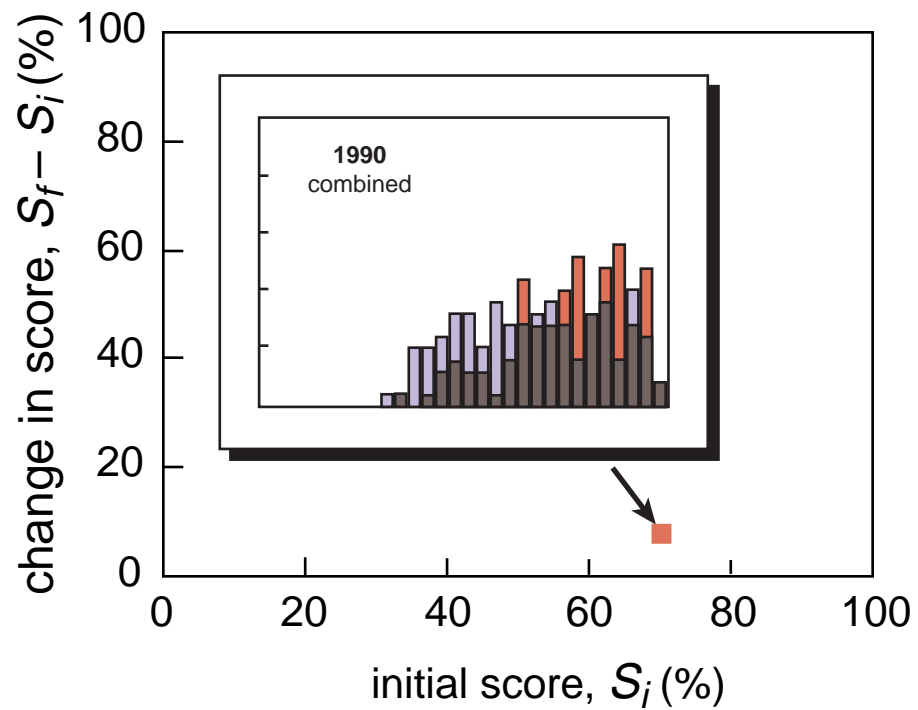
Why change?



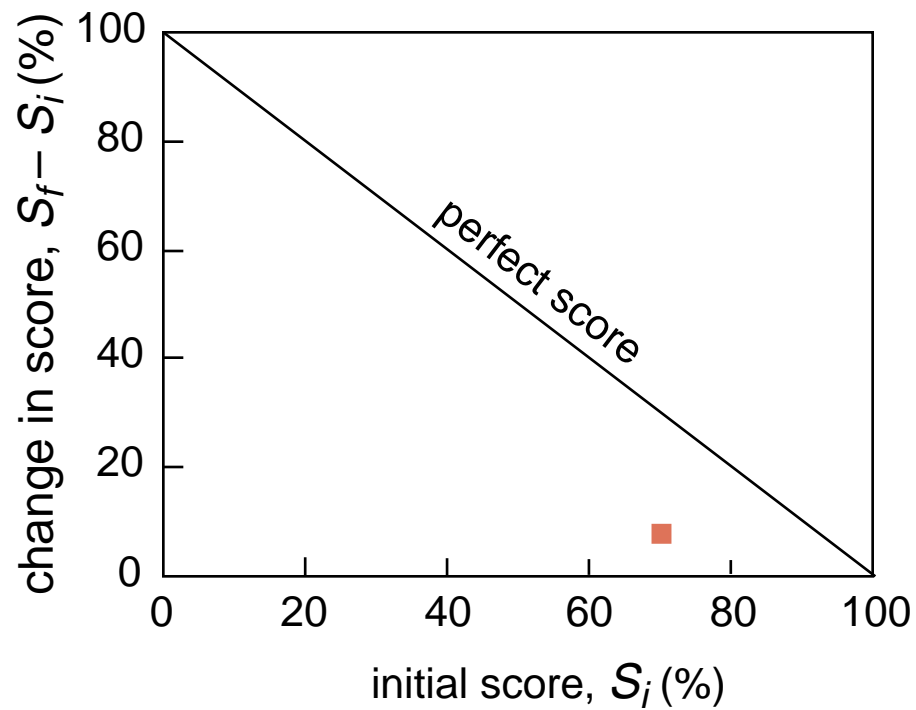
Why change?



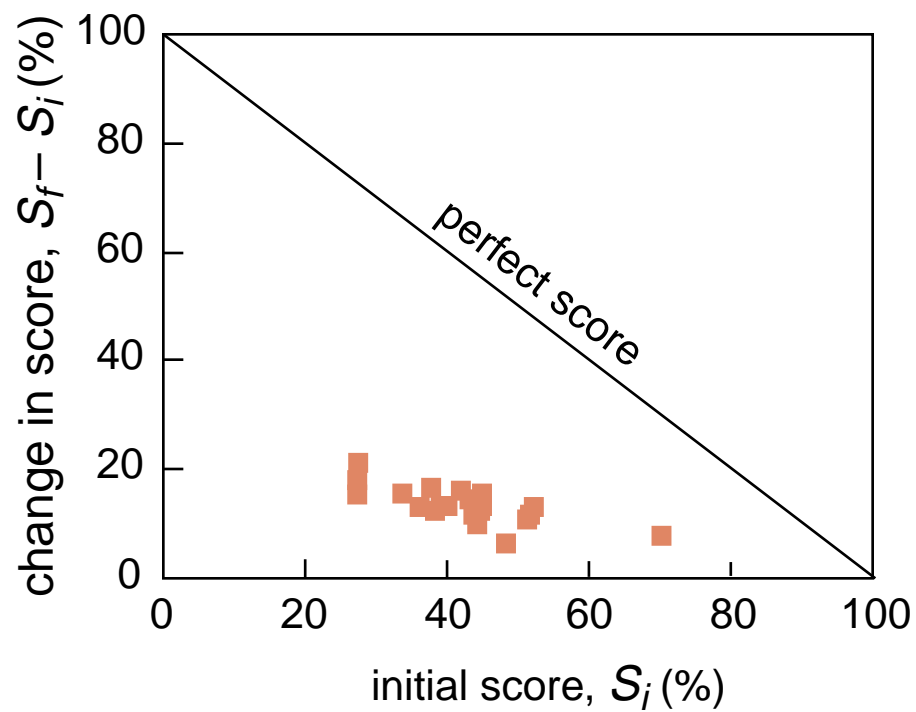
Why change?



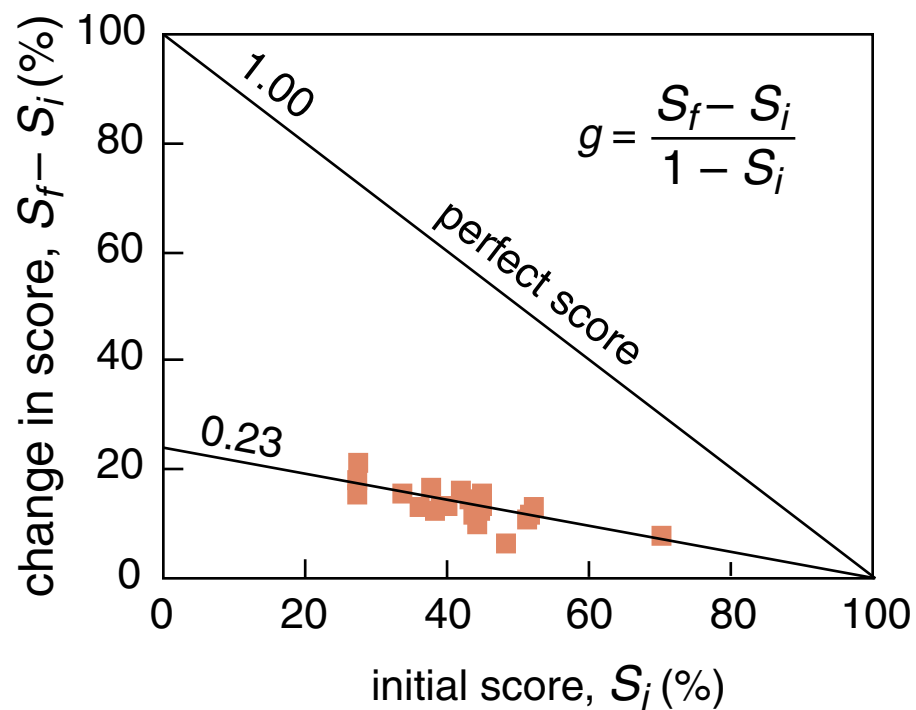
Why change?



Why change?



Why change?



A wide-angle photograph of a large lecture hall. In the foreground, the backs of many students' heads are visible as they sit at rows of desks. The students are looking towards the front of the room. At the front, a lecturer stands behind a podium, facing the audience. Behind the lecturer is a large, curved wall with several blackboards. A large projection screen is mounted on the wall, displaying text and a diagram. The room is dimly lit, with the primary light source being the projection screen and the stage lights. The text "So what should we do?" is overlaid in white on the blackboard area.

So what should we do?

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

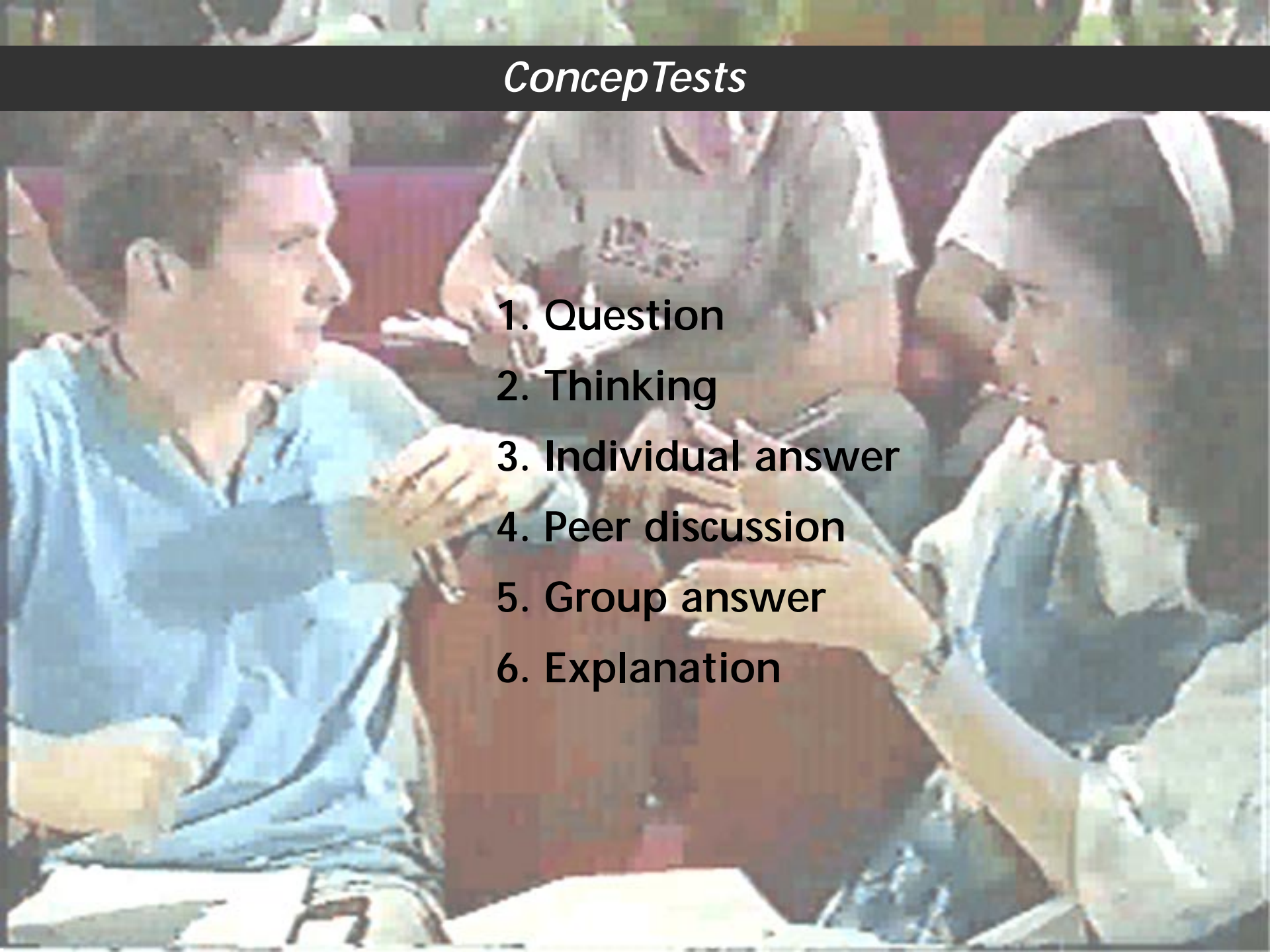
Peer Instruction

- ▶ 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

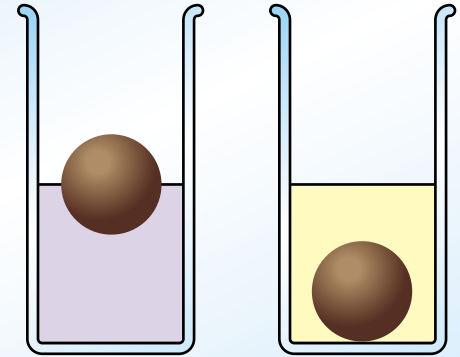
- ▶ Move first exposure to the material out of the classroom: **assign reading!**
- ▶ Use class to deepen and broaden understanding
- ▶ by identifying **key ideas**
- ▶ and giving students opportunities to **think**

ConcepTests

- 
- A photograph of three students in a classroom. On the left, a male student in a blue shirt is looking towards the center. In the middle, a female student in a grey shirt is looking down at a book or paper. On the right, a female student in a white shirt is looking towards the center. They appear to be engaged in a discussion or 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.

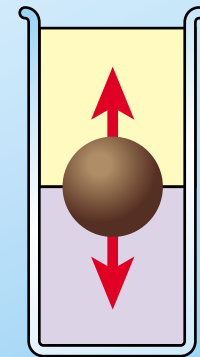
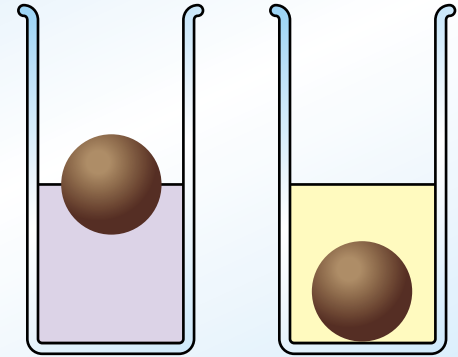


Sample ConceptTest

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.



Encouraging participation

- ▶ **Suitable ConcepTests**

Encouraging participation

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

Encouraging participation

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

Encouraging participation

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

Lecture segments

- ▶ Assume students have read beforehand:
"double-dip" principle
- ▶ No detailed derivations
- ▶ Worked examples: part of ConcepTests

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

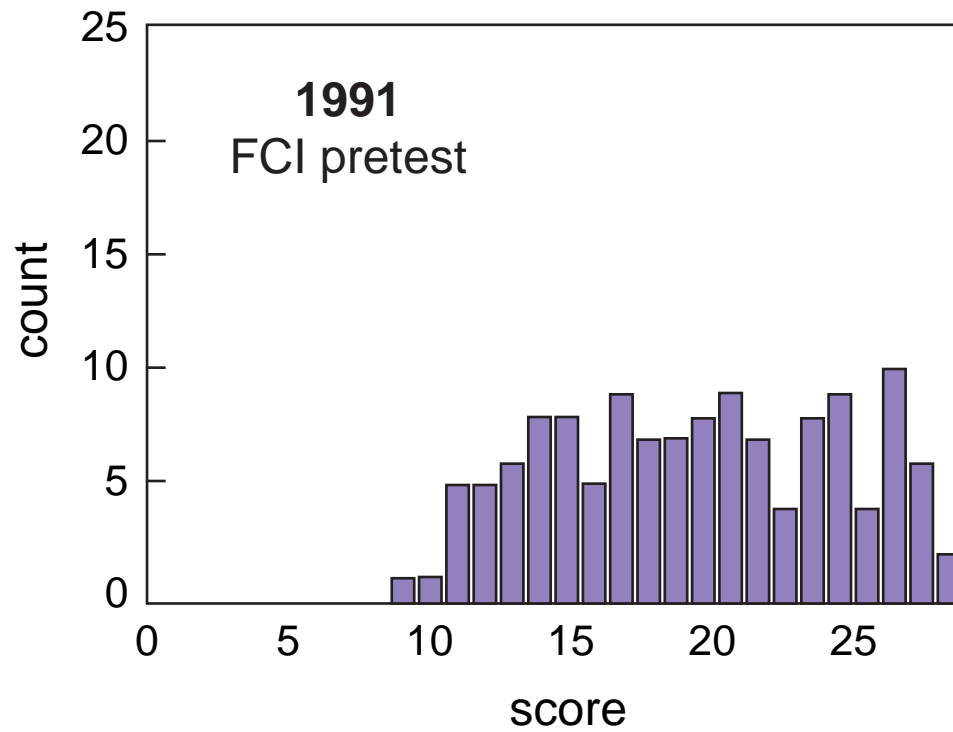
Essential elements

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

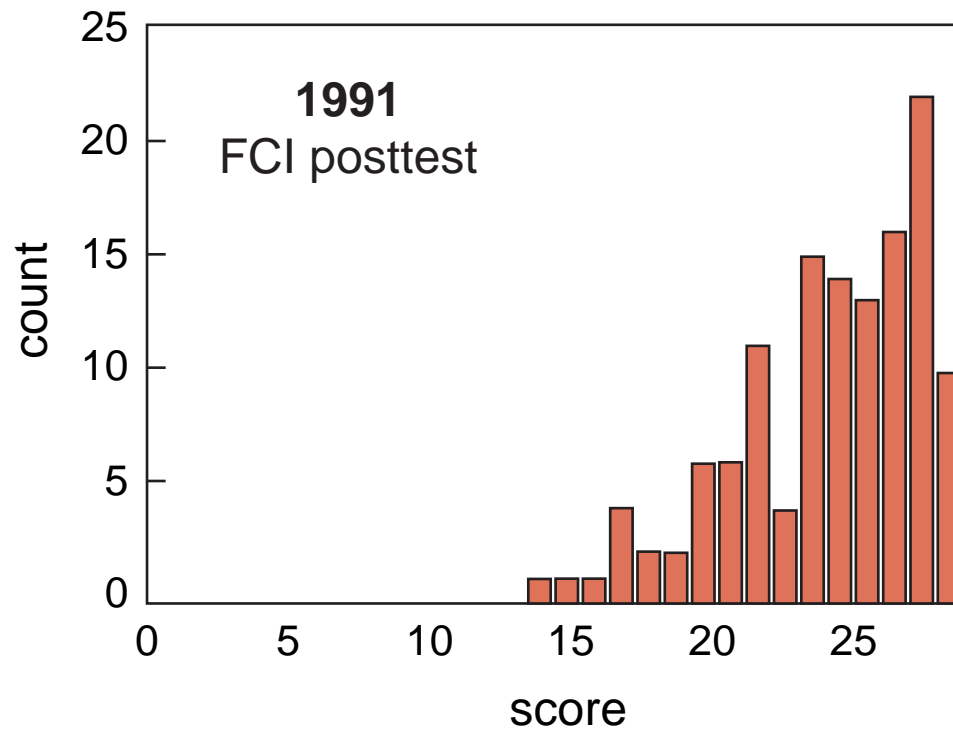
Is it any good?

- ▶ **Results at Harvard**
- ▶ **Other instructors**

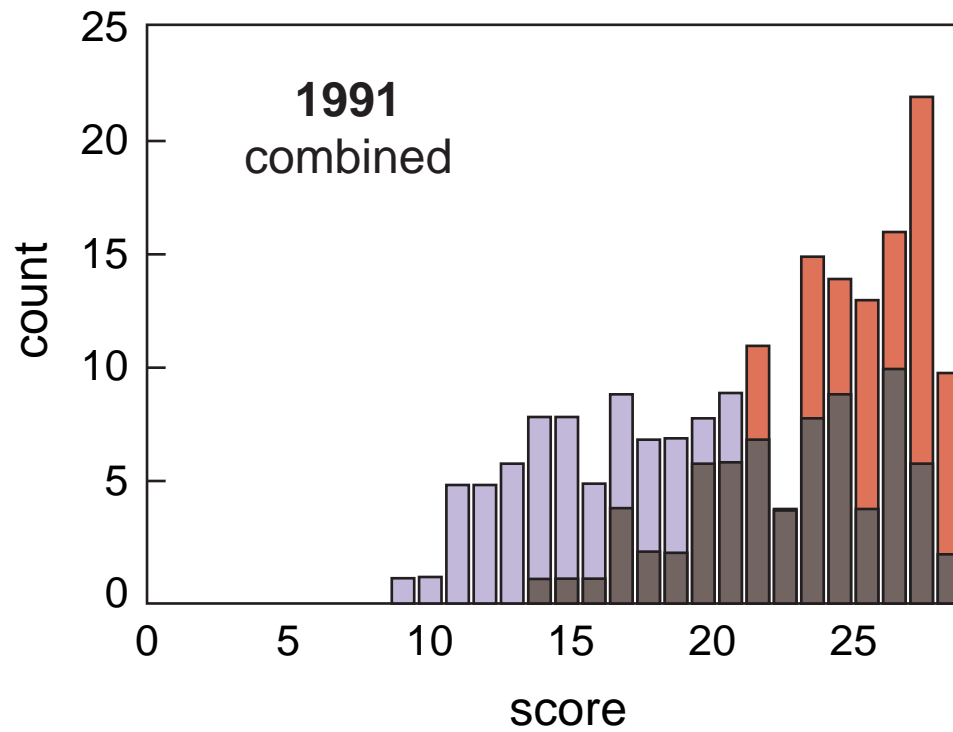
Results



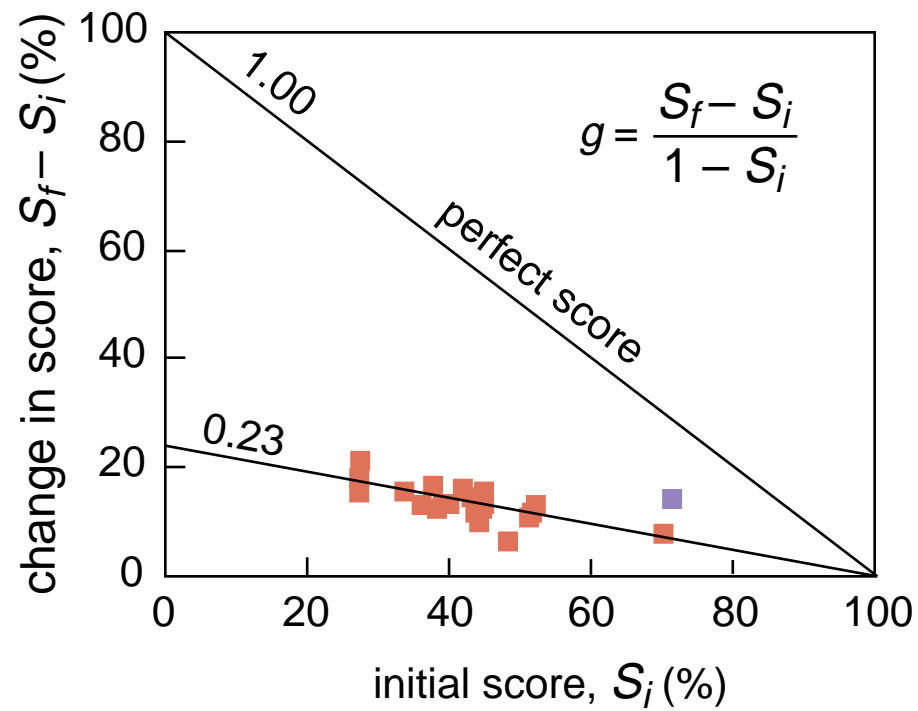
Results



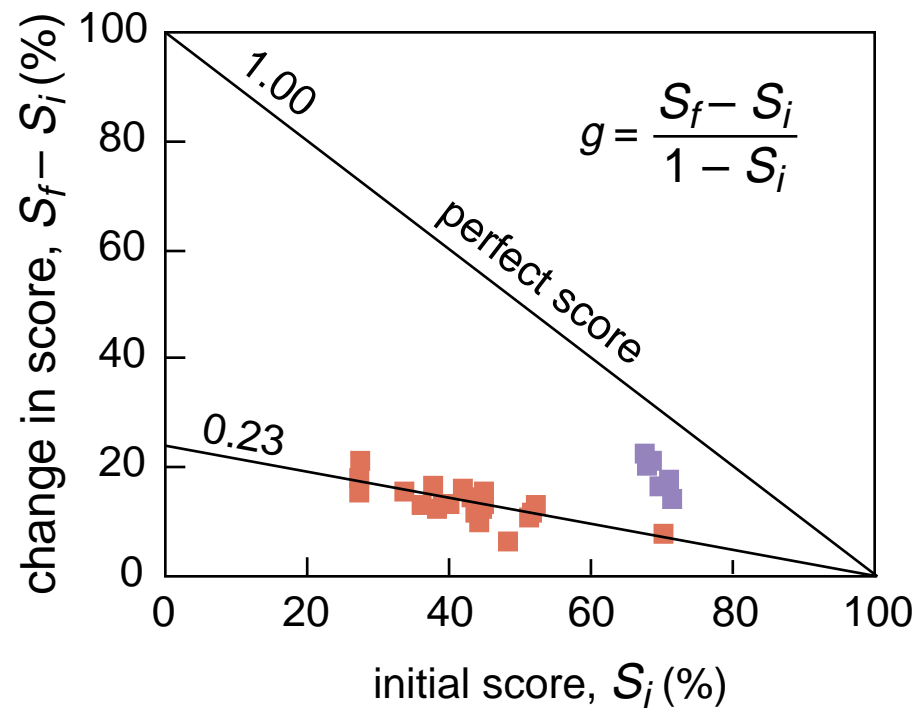
Results



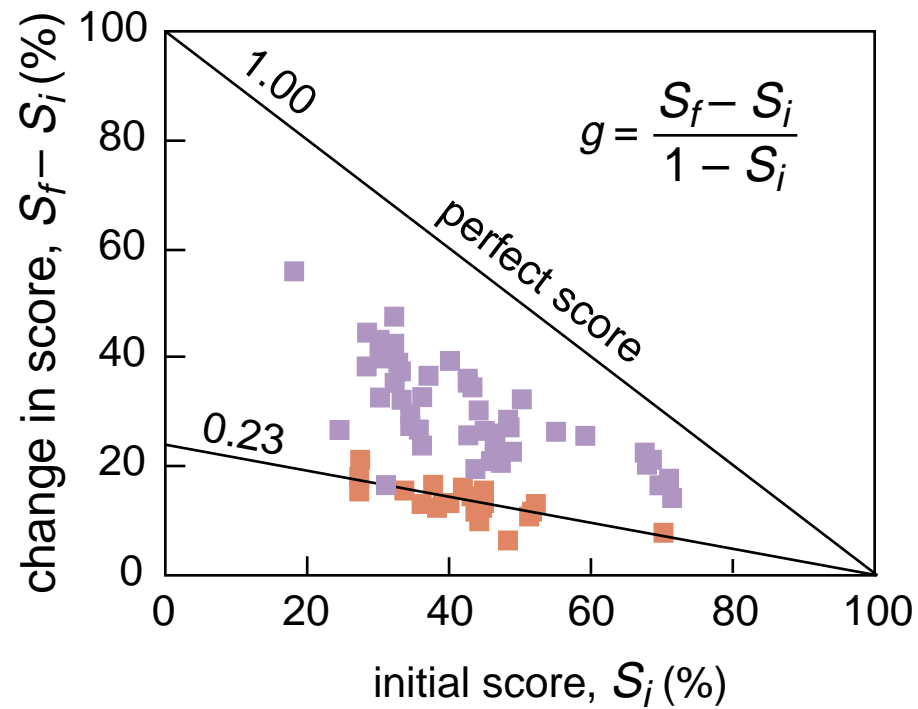
Results



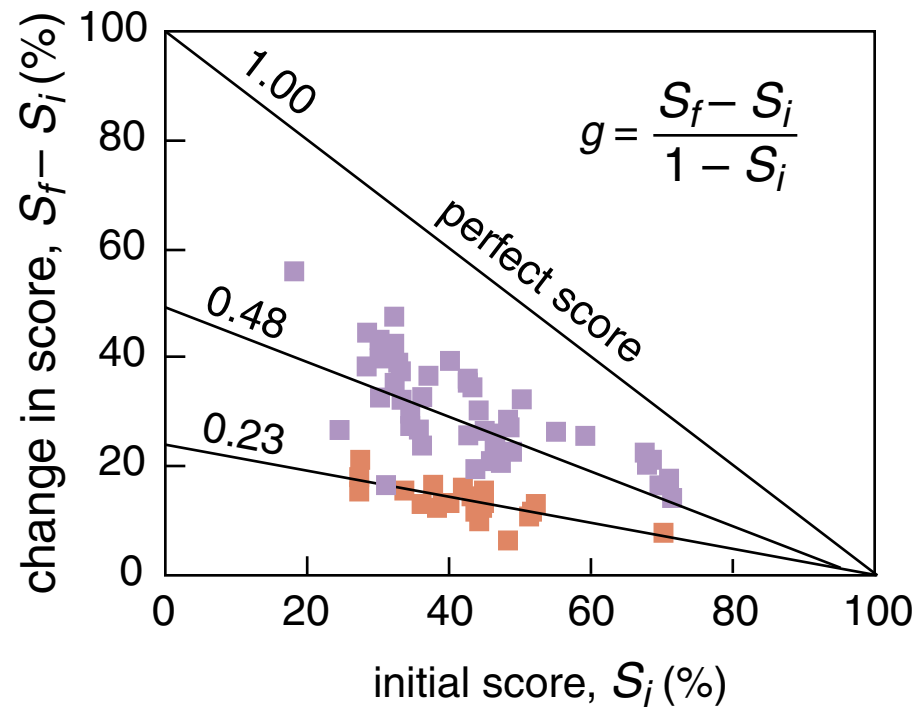
Results



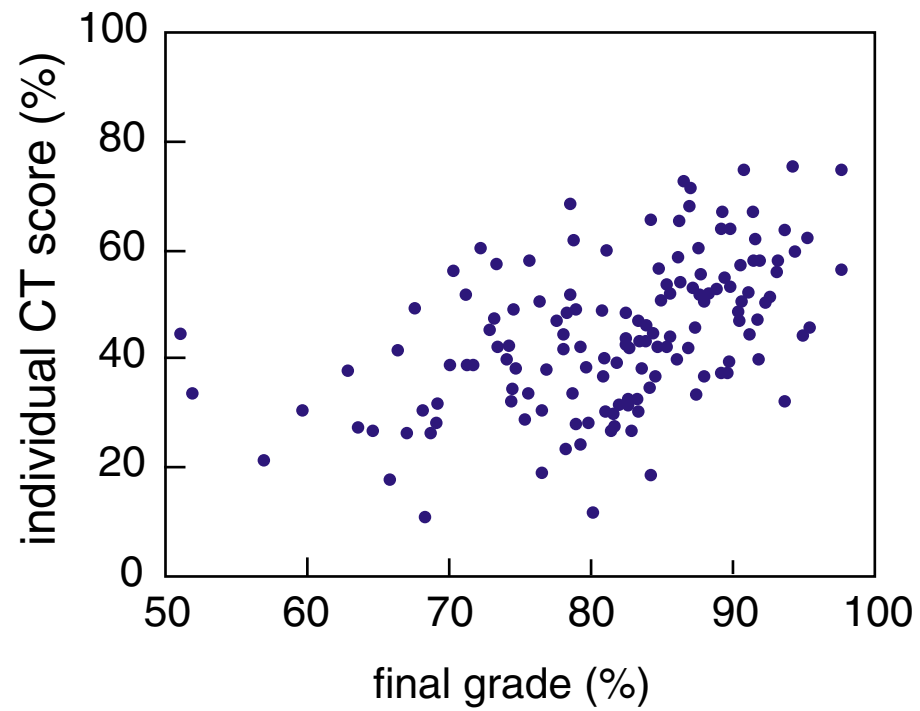
Results



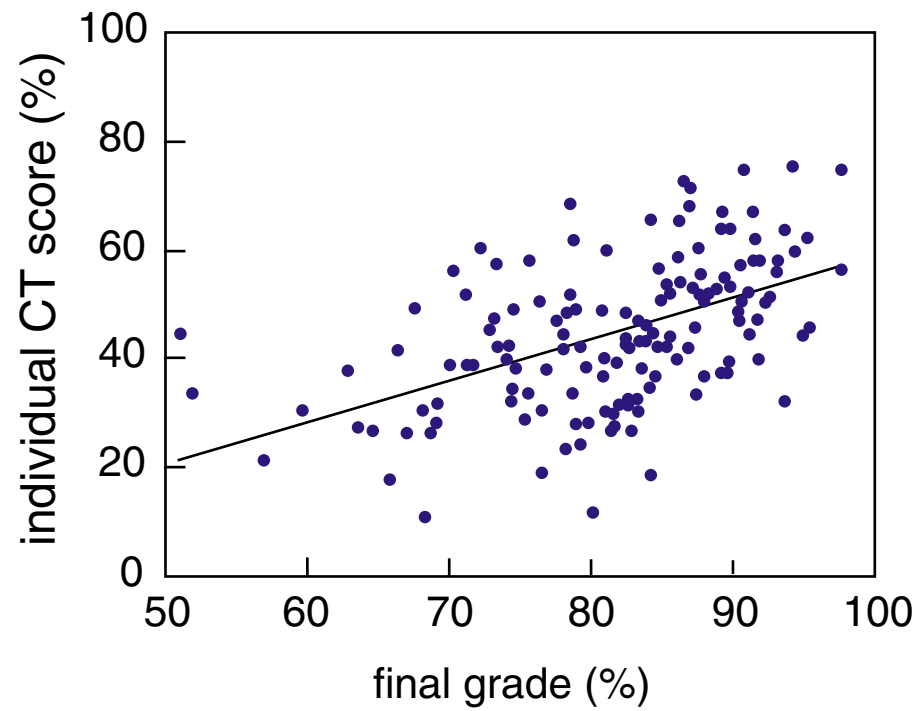
Results



Who benefits?

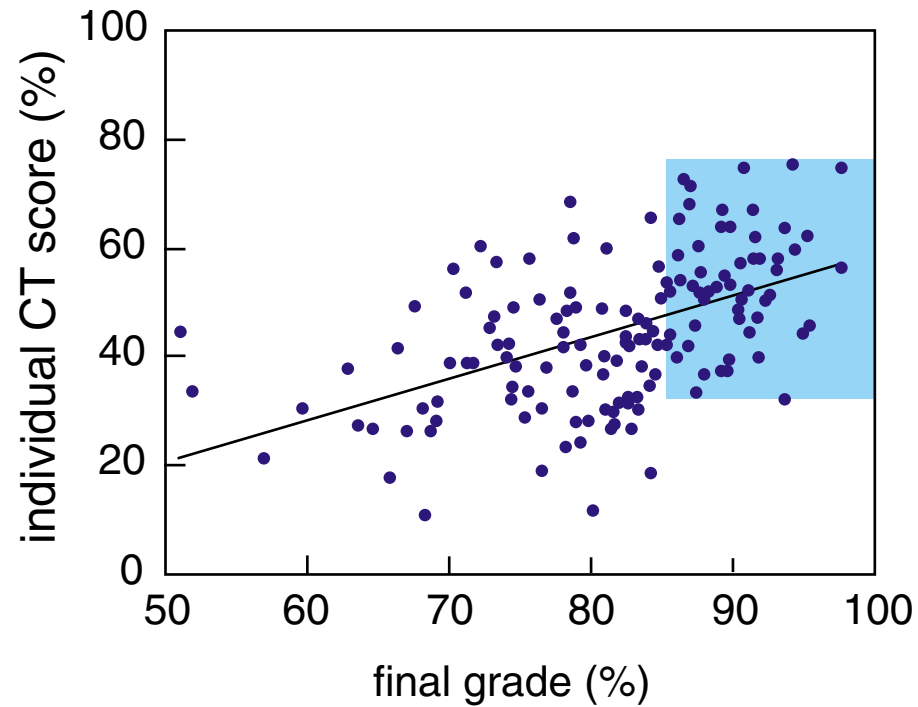


Who benefits?



Who benefits?

even best students are challenged!



Do students learn the concepts?

- ▶ **ConcepTests asked after mini-lecture on topic**
- ▶ **No further presentation on topic**
- ▶ **Free-response exam questions based on 7 ConcepTests**
- ▶ **Compare exam and ConcepTest results**

Results

All ConceptTests combined:

CORRECT

pre discussion post discussion on exam

34%

63%

61%

Summary

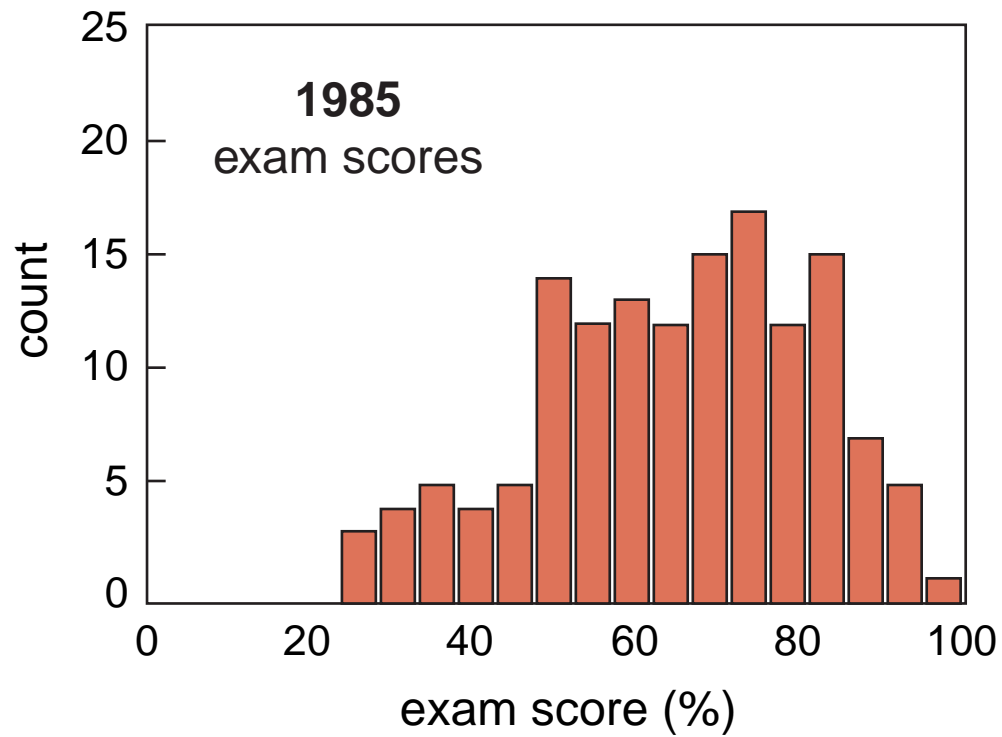
Students

- ▶ learn the concepts
- ▶ can apply them to different physical situations
- ▶ retain them to the end of the semester

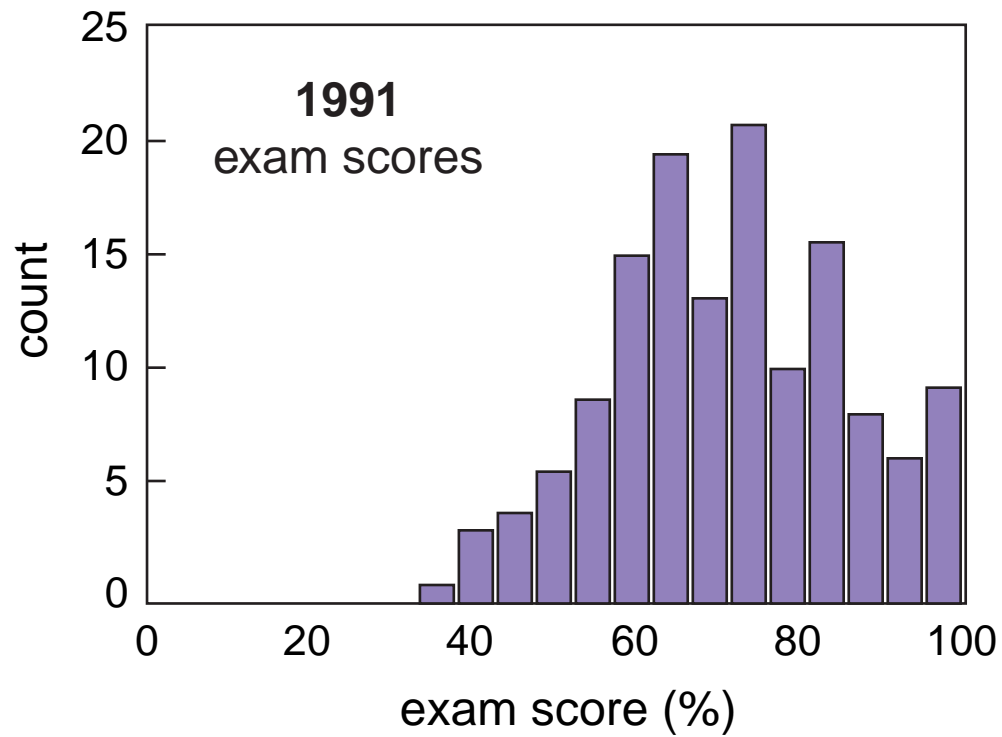
Results

What about problem solving...?

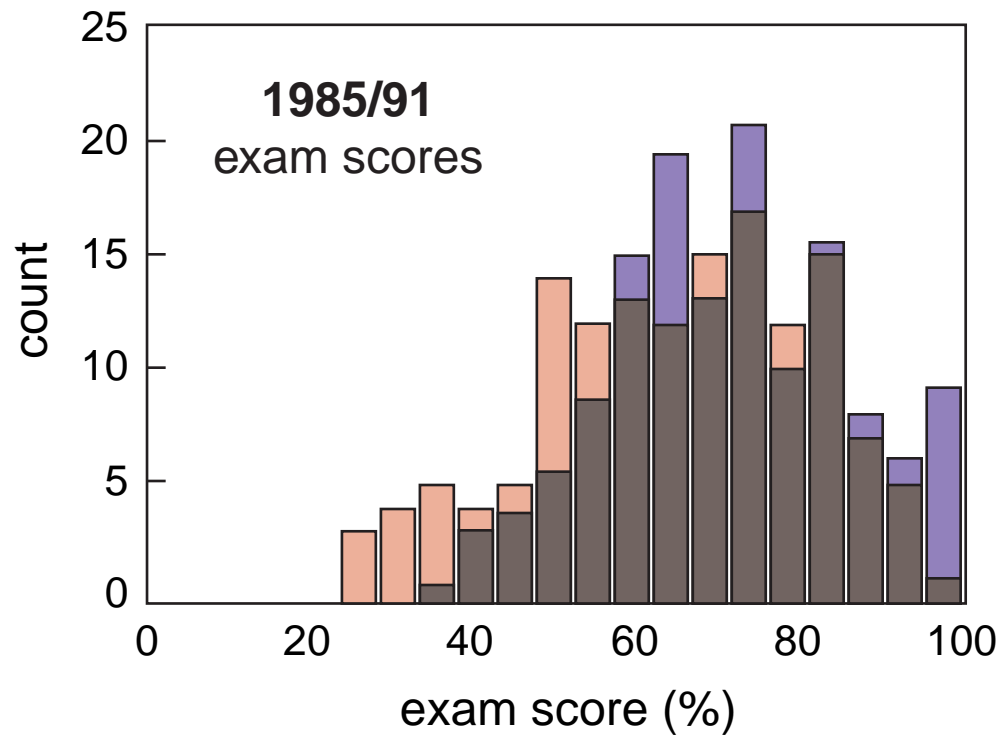
Results



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

/

/

/

/

PI implementation survey

Web-based, over 700 responses (377 "standard" PI)

- personal information
- course information
- background on PI
- implementation
- grading/assignments
- results
- evaluation
- community

The screenshot shows a web browser window with the title "Peer Instruction/Collaborative Learning Impleme...". The address bar shows "http://galileo.harvard.edu/PIsurvey.html". The page features the "project Galileo" logo with the tagline "your gateway to innovative science teaching techniques". Below the logo, the title "Peer Instruction/Collaborative Learning Implementation Survey" is displayed. The page includes a thank you message, a description of the survey, and a section for personal information.

Peer Instruction/Collaborative Learning Implementation Survey

Thank you for your willingness to share your experiences with collaborative learning. This survey should take about thirty minutes to complete.

Although the survey below may use some language specific to [Peer Instruction](#), please feel free to adapt the questions to other, similar strategies for engaging students, in which lectures are interspersed with questions aimed at uncovering student difficulties. If you have not used such an approach, please tell us by sending an e-mail to PIsurvey@staffsci.harvard.edu.

The results of this survey will be used to develop a *Peer Instruction Transplantation Guide* that will provide suggestions for implementation of active learning strategies in a variety of disciplines and settings. The guide will be freely available to survey participants. Participants will also receive unlimited free access to an exciting new *ConceptTest* delivery Web site that we are currently implementing. In addition to providing an expanded database of *ConceptTests* in several disciplines, this site will be able to deliver class-ready and Web-ready teaching materials, such as customized overhead transparencies in PDF format, Web pages and interactive study guides for students, and provide access to secure on-line testing of students.

A. Personal Information

A1. First Name (Required)

A2. Last Name (Required)

A3. Position (Required)

A4. Department

A5. Institution (Required)

A6. Country

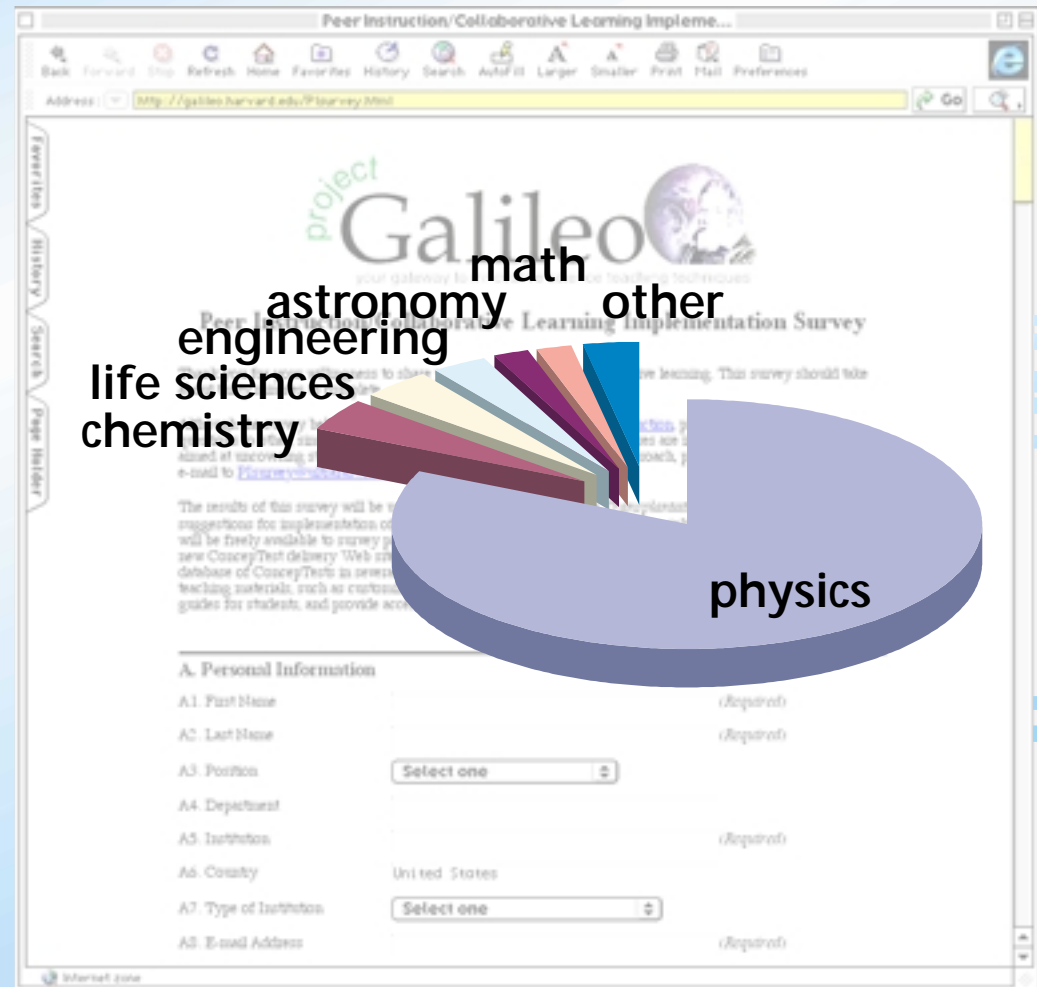
A7. Type of Institution (Required)

A8. E-mail Address (Required)

Demographics

Discipline of surveyed PI users:

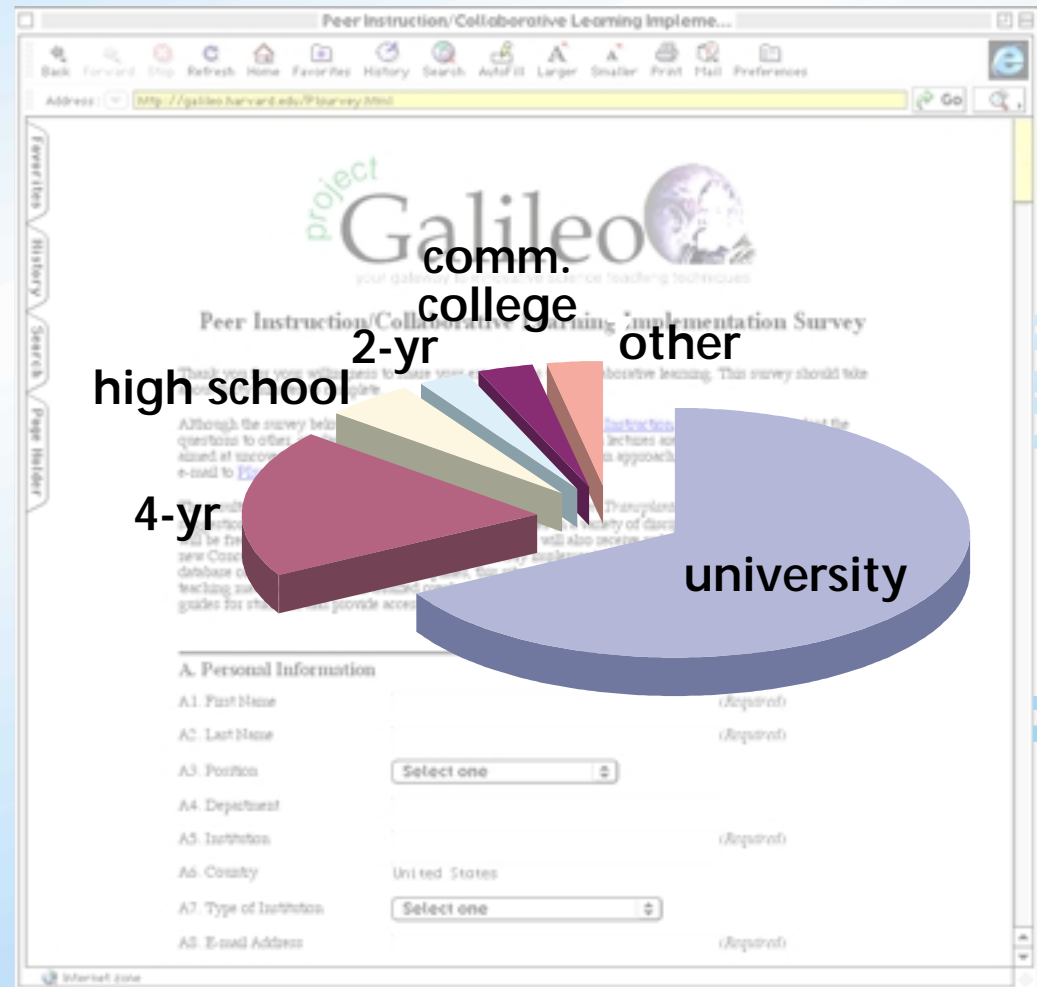
Physics	82%
Chemistry	4%
Life sciences	4%
Engineering	3%
Astronomy	2%
Mathematics	2%
Other/blank	3%



Demographics

Institution types of surveyed PI users:

University	67%
4-yr college	19%
High school	5%
2-yr college	3%
Comm. college	3%
Other/blank	3%

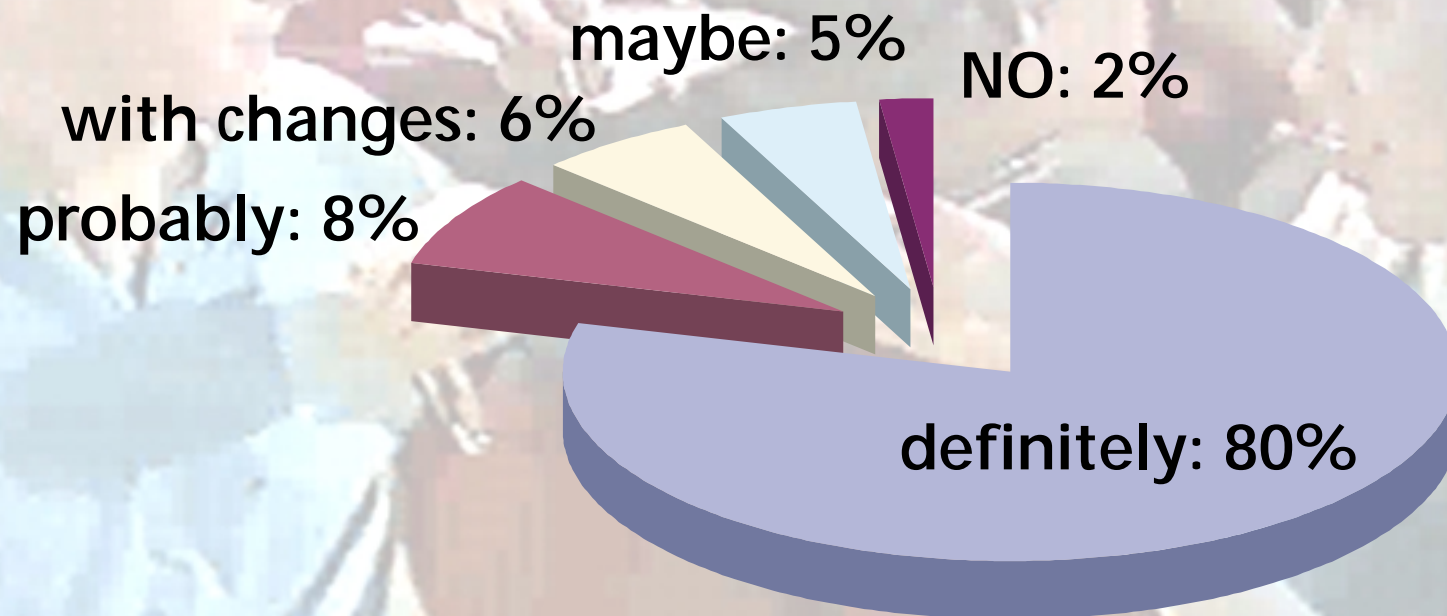


Does it work?



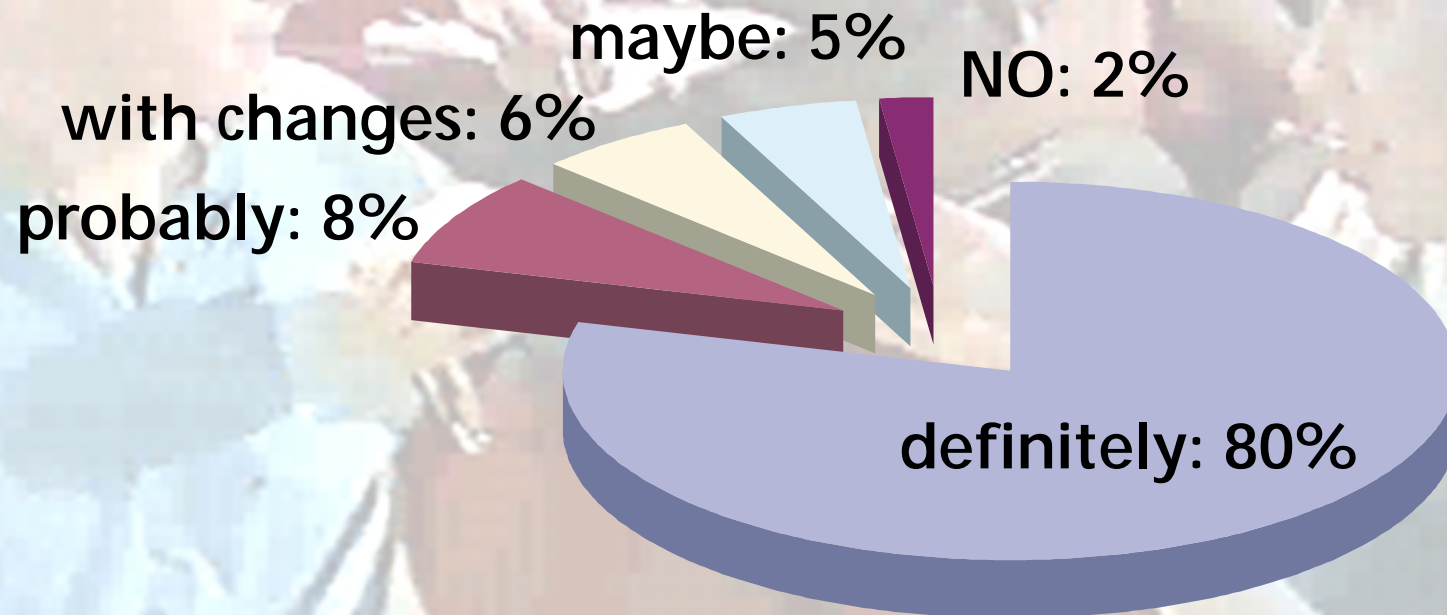
Does it work?

Plan to use PI again:



Does it work?

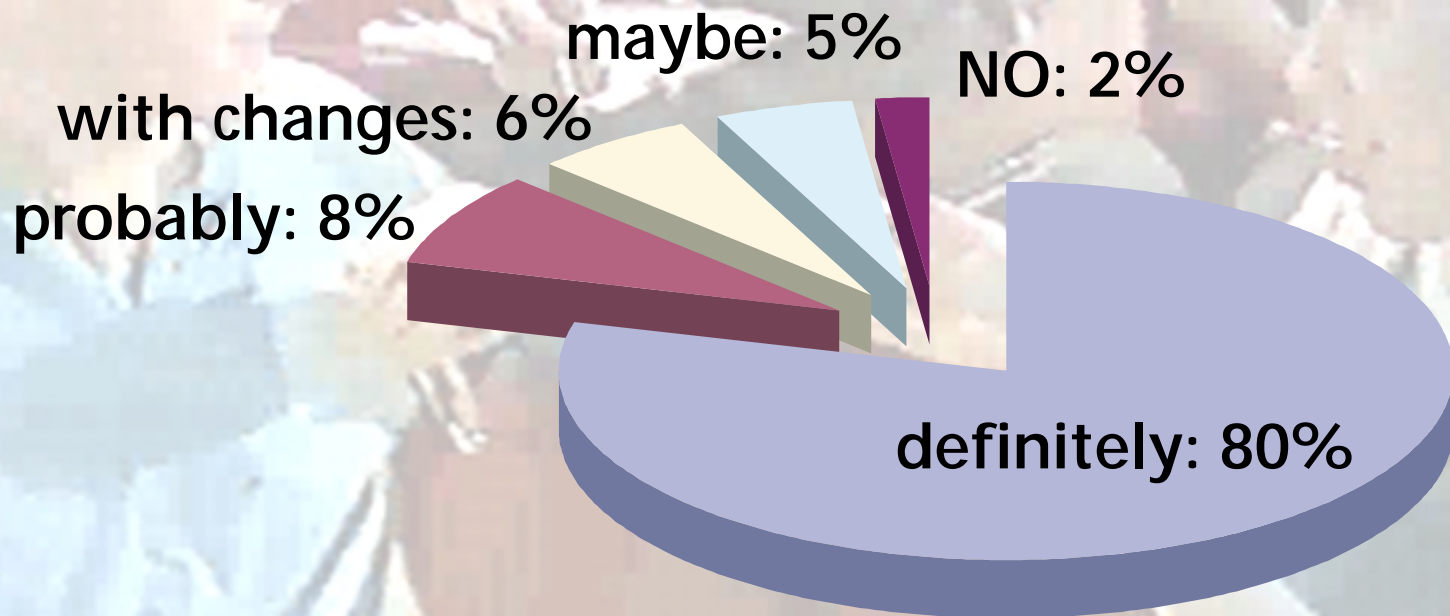
Plan to use PI again:



332 (88% of PI users) likely to use PI again

Does it work?

Plan to use PI again:



332 (88% of PI users) likely to use PI again

27% of these use a standard assessment instrument

What makes it work?

consistency and student response important!

Survey findings

- ▶ **Peer Instruction works**
- ▶ **Successful in a wide variety of settings**
- ▶ **Existing resources help implementation**

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

Challenges:

- ▶ skepticism
- ▶ growing pains

Conclusion

Rewards:

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

Work done with Eric Mazur

Funding: National Science Foundation

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

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