

Educating innovators for the 21st century



Program on Innovative Teaching and Learning
MECESUP/LASPAU @Harvard University
Cambridge, MA, 9 November 2011



Innovation

Innovation

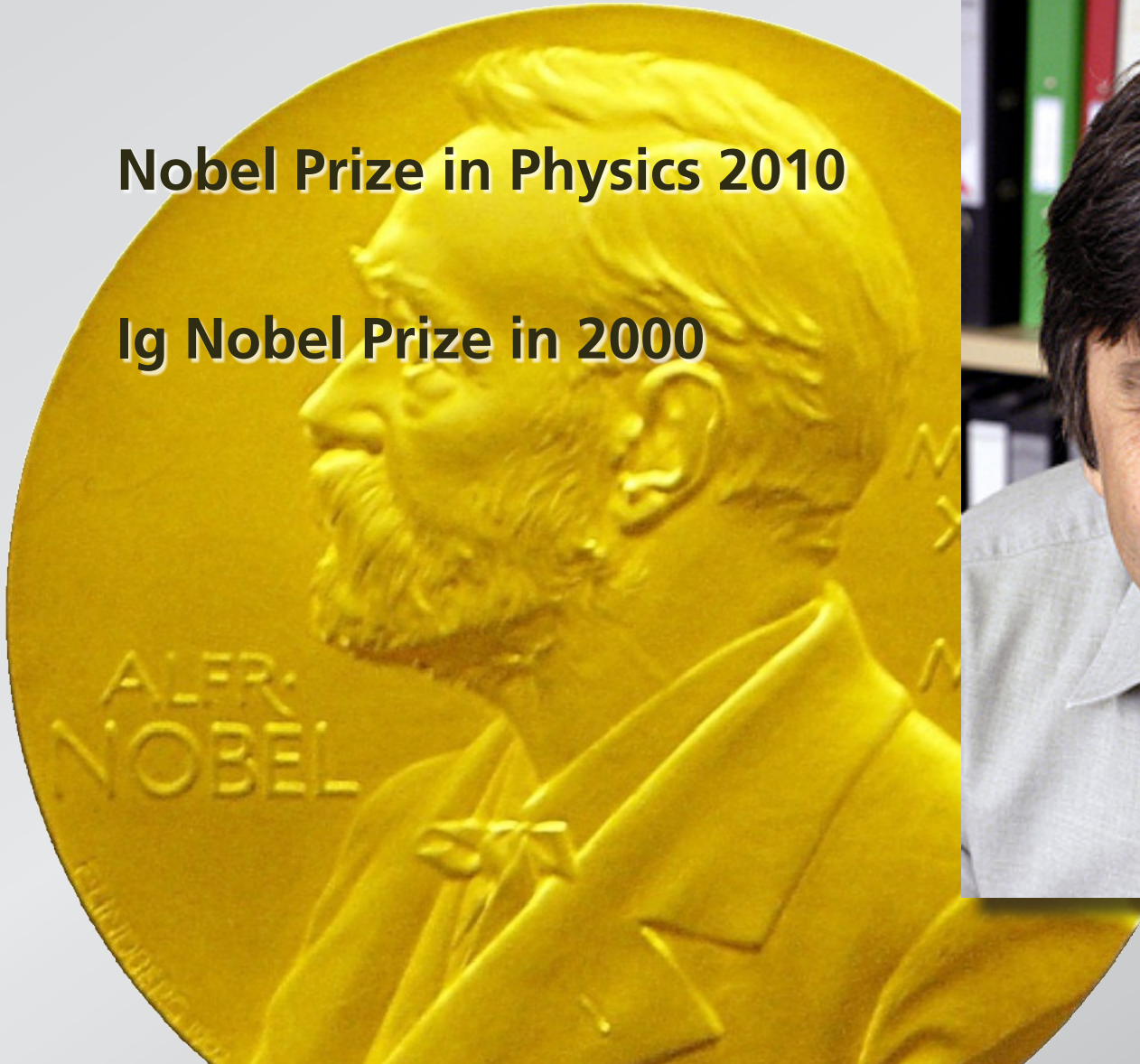
Nobel Prize in Physics 2010



Innovation

Nobel Prize in Physics 2010

Ig Nobel Prize in 2000



Innovation

**“For me it’s very boring to work
on the same thing year after year...”**

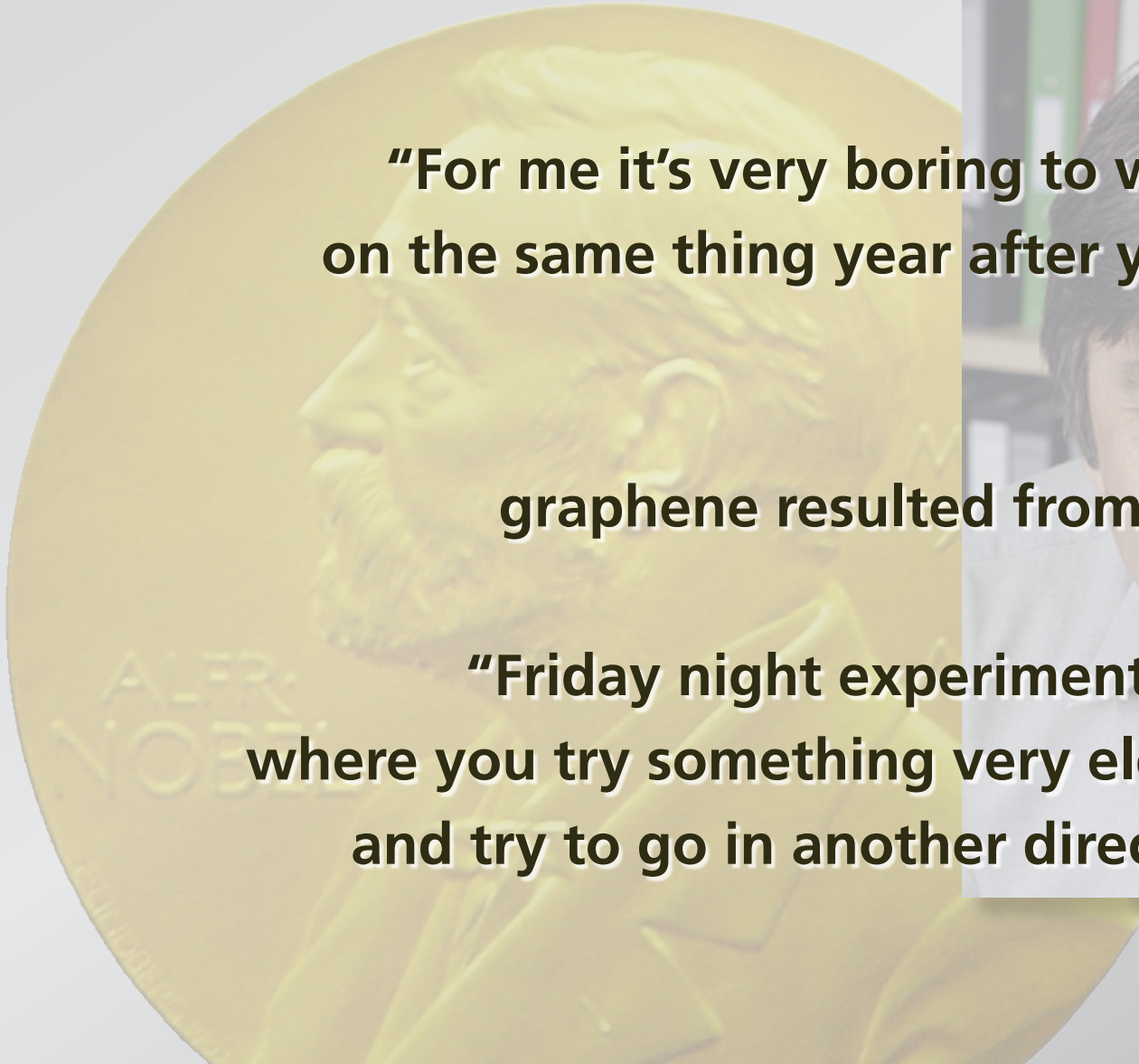
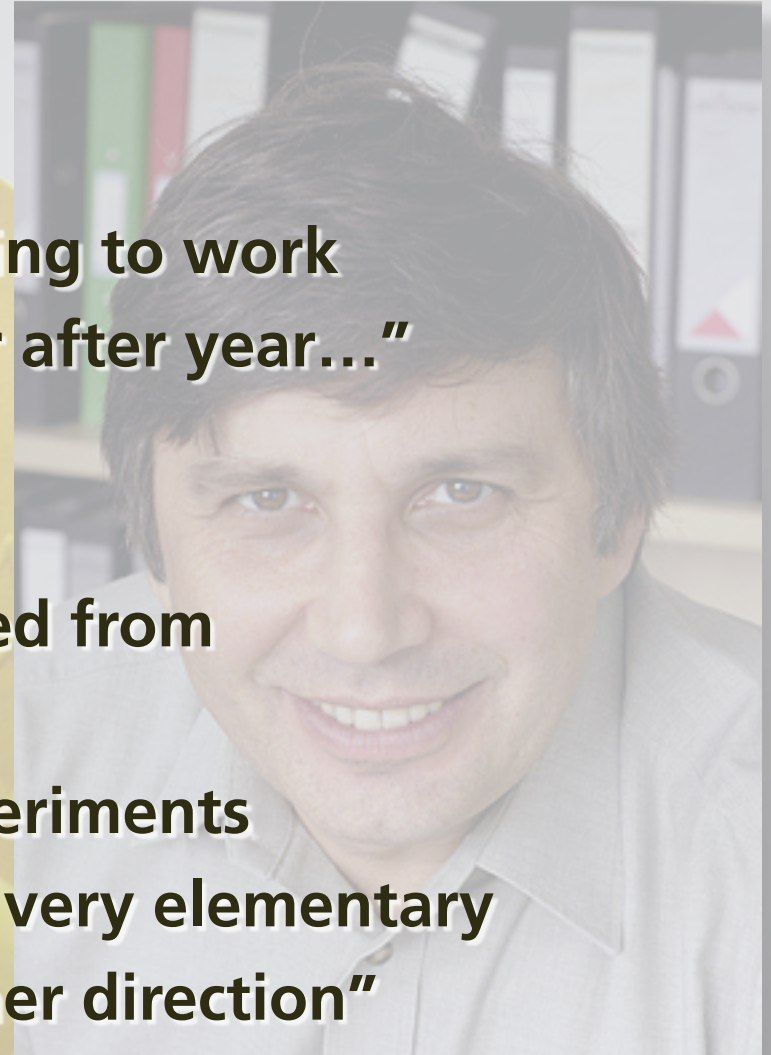


Innovation

**“For me it’s very boring to work
on the same thing year after year...”**

graphene resulted from

**“Friday night experiments
where you try something very elementary
and try to go in another direction”**



Innovation

innovation requires whole-brain thinking:

- **right-brain imagination and creativity**
- **left-brain logic and planning**

Innovation

how can we foster/teach innovation?

Innovation

Need to...

- **teach *problem* solving**
- **encourage risk taking**

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How do we learn?

Think of something you are good at — something that you know you do well.

How do we learn?

Think of something you are good at — something that you know you do well.

How did you become good at this?

How do we learn?

Became good at it by:

1. practicing
2. lectures
3. trial and error
4. apprenticeship
5. other

How we teach...



Learning spaces



Learning spaces



Learning spaces



Outline

- Education



Outline

- Education
- Peer Instruction



Outline

- Education
- Peer Instruction
- Results

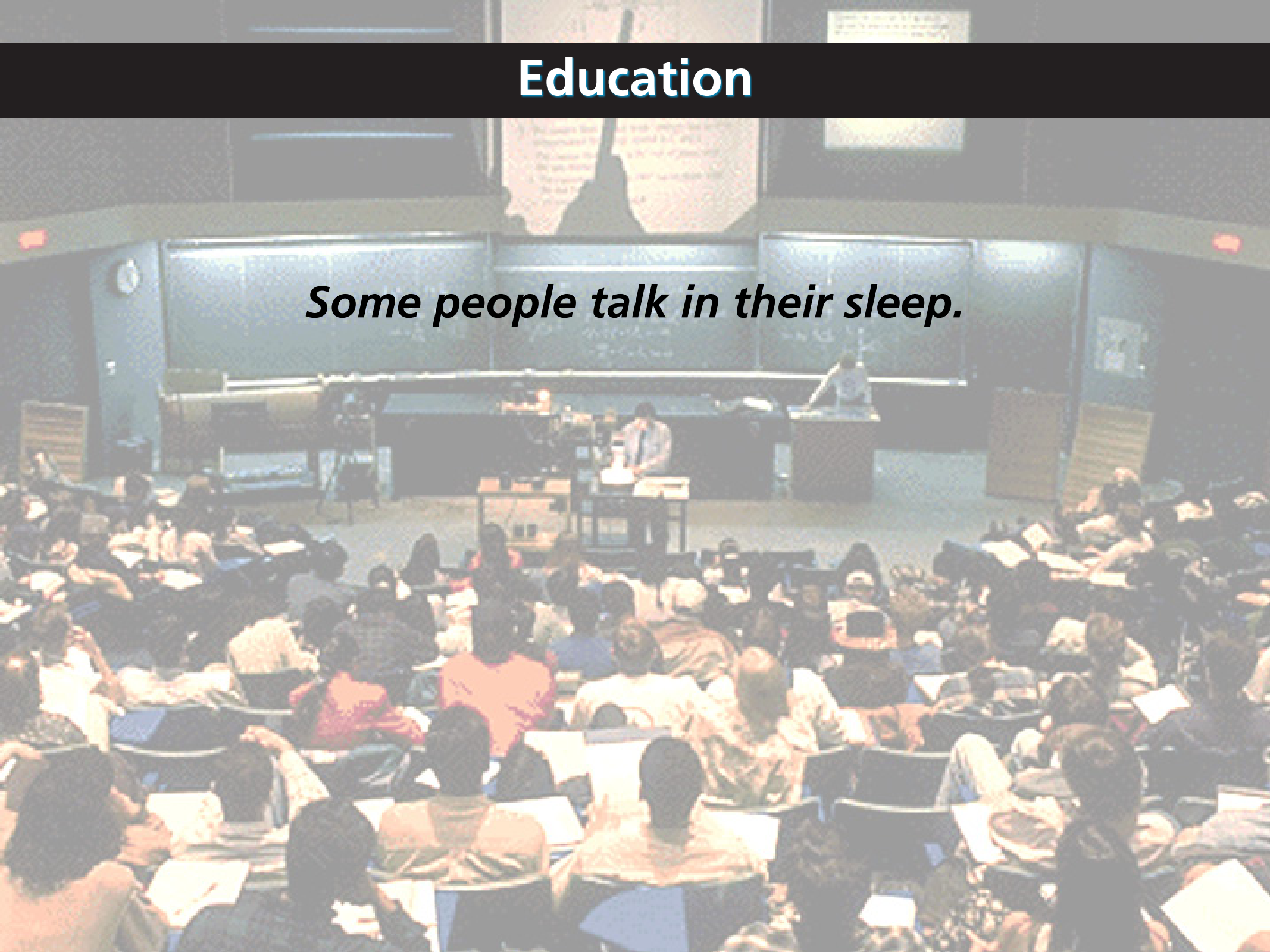


Education



Education

Some people talk in their sleep.

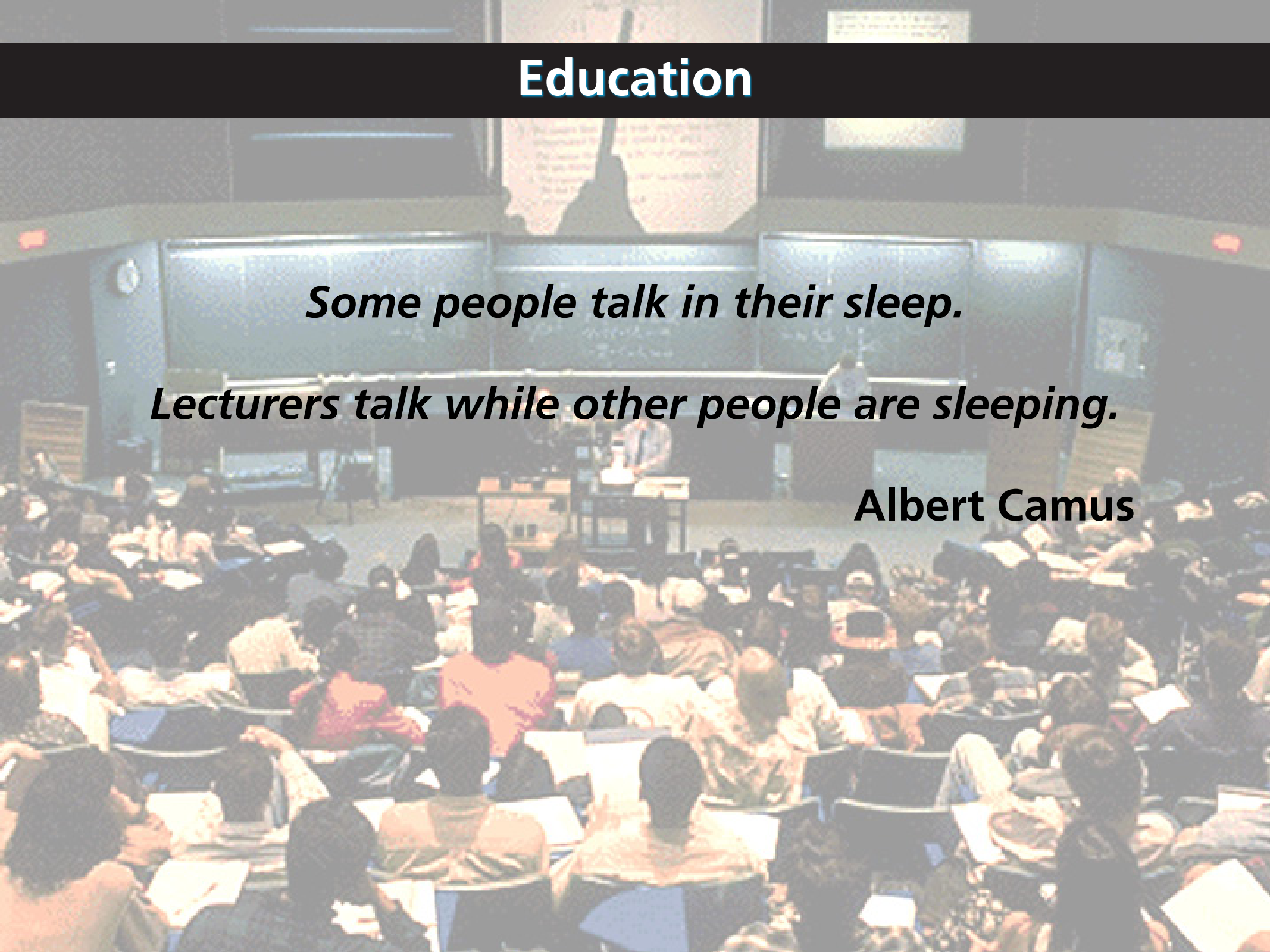


Education

Some people talk in their sleep.

Lecturers talk while other people are sleeping.

Albert Camus

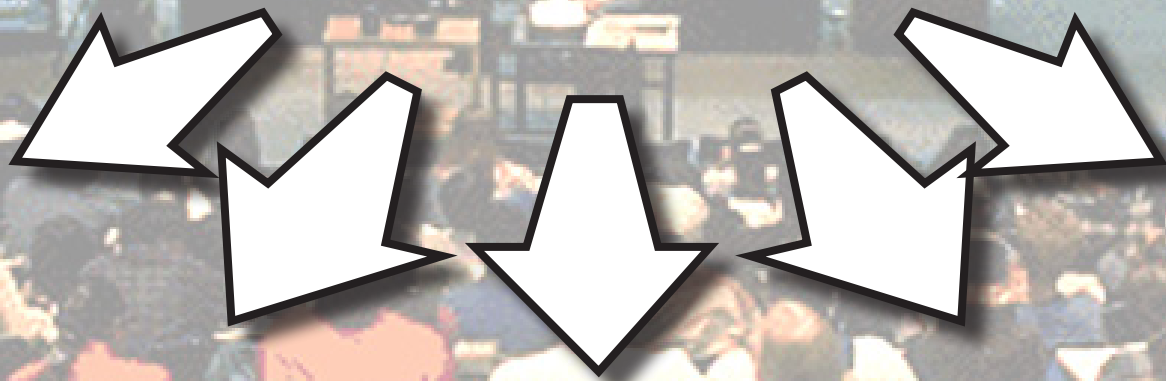


Education



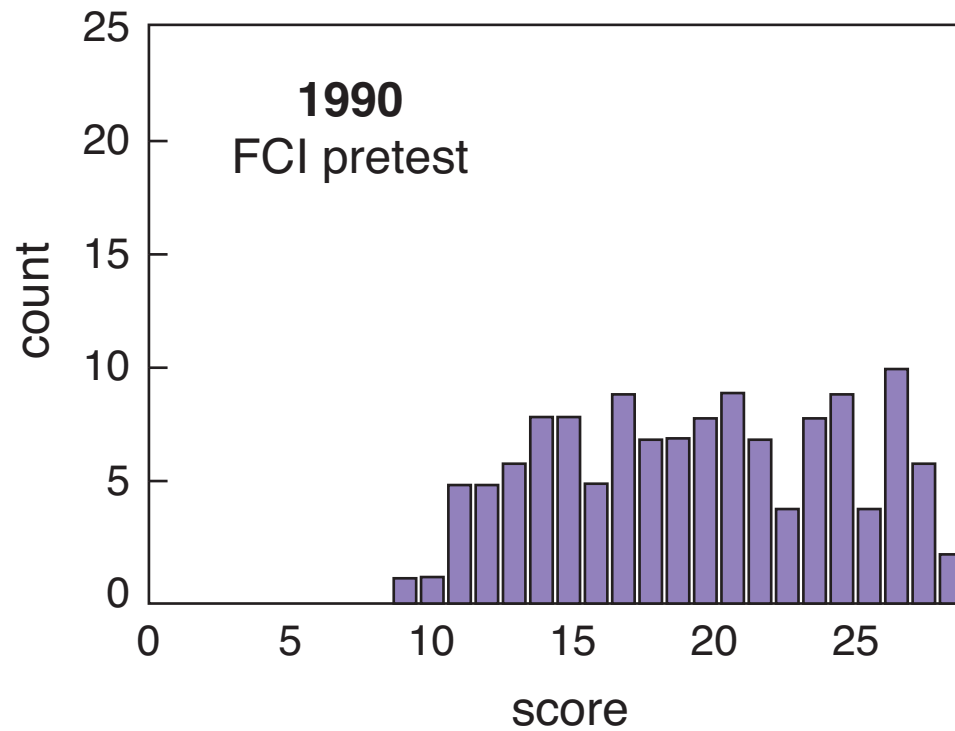
Education

lectures focus on information transfer...



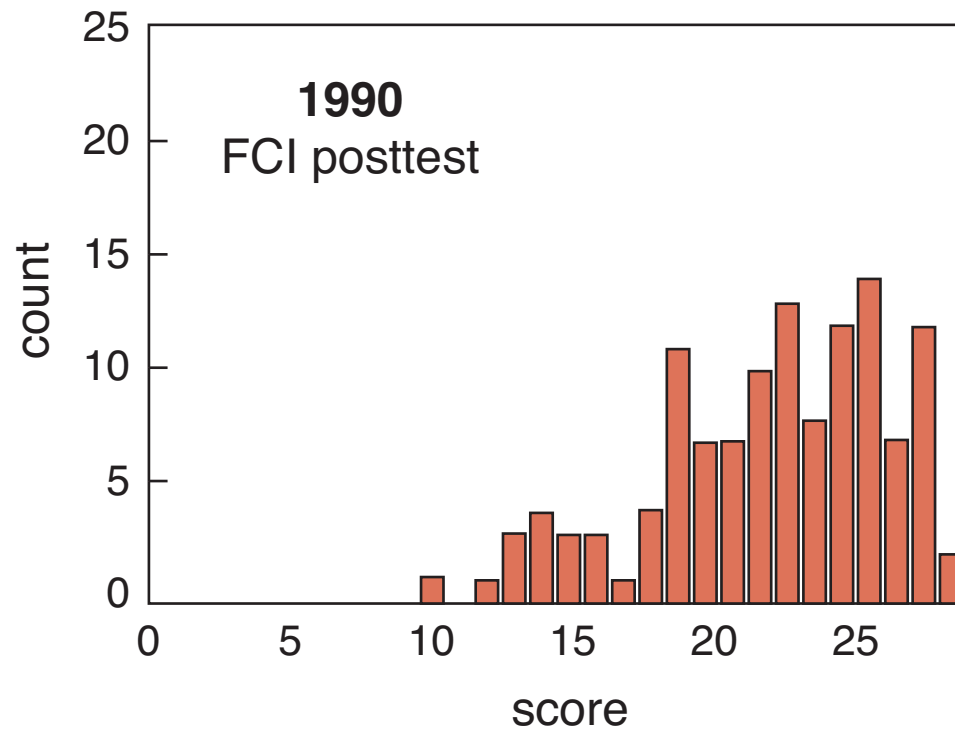
Education

education is not just information transfer



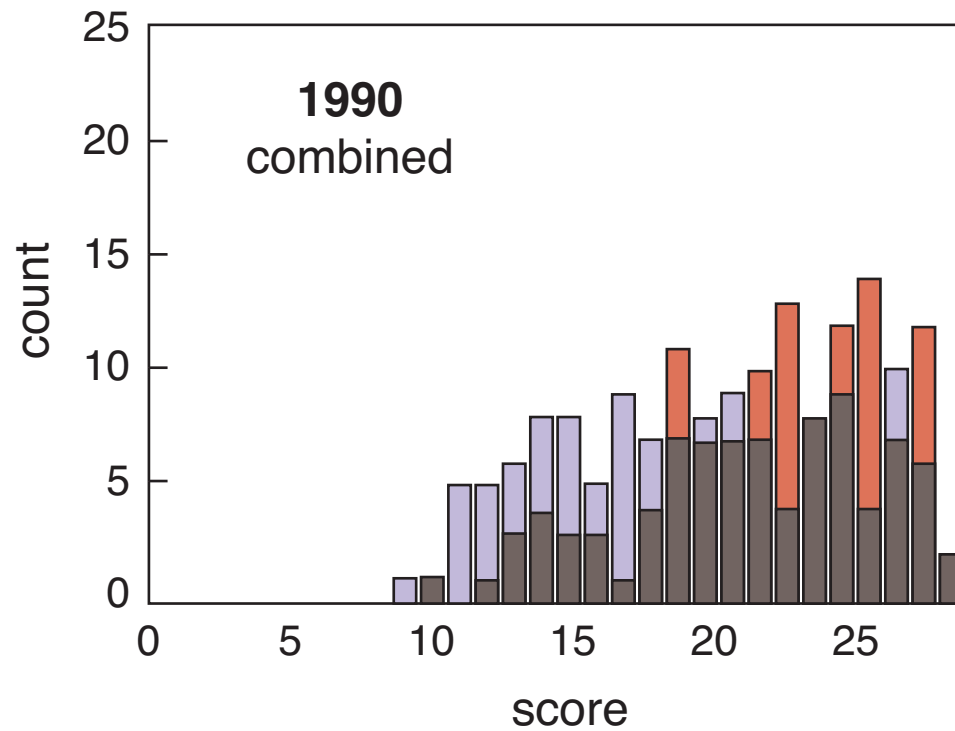
Education

education is not just information transfer



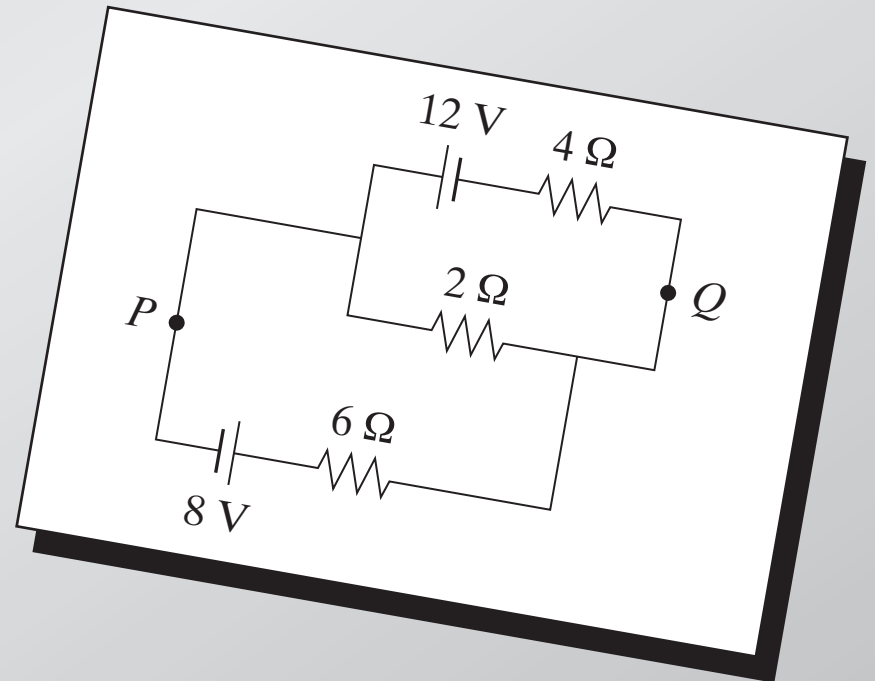
Education

education is not just information transfer



Education

conventional problems misleading



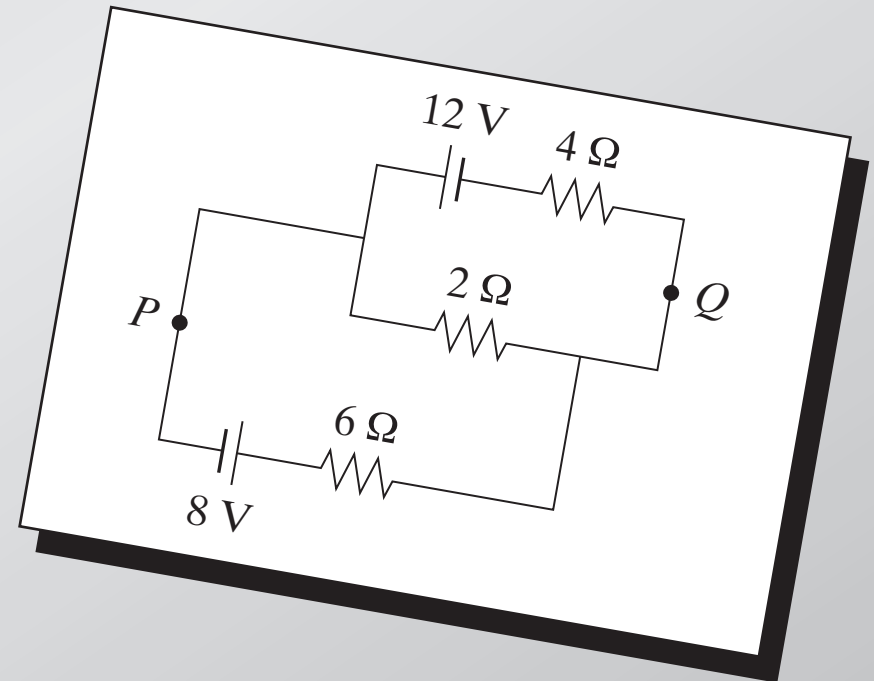
Education

conventional problems misleading

Calculate:

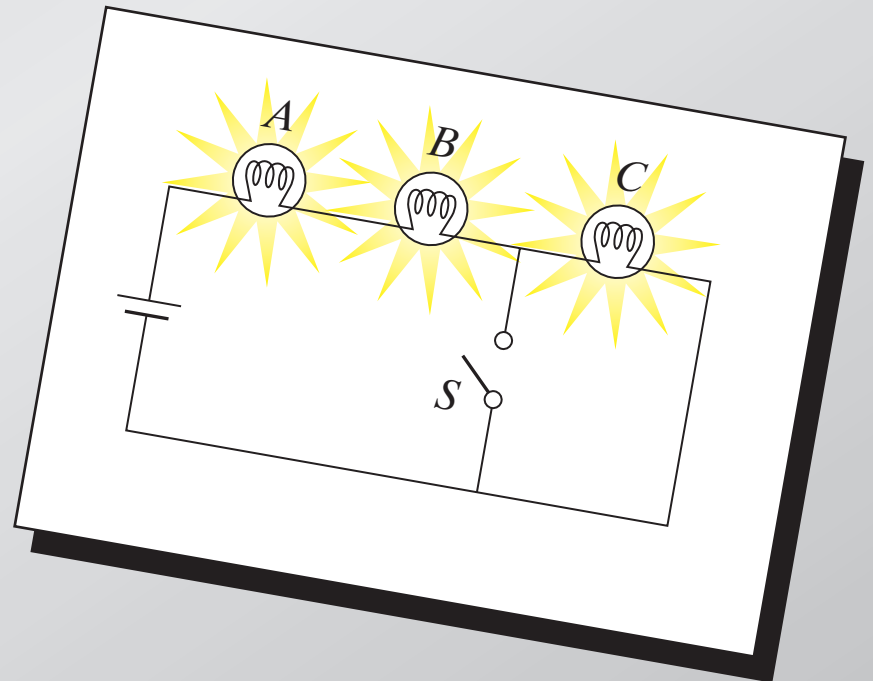
(a) current in $2\text{-}\Omega$ resistor

(b) potential difference
between P and Q



Education

are the basic principles understood?

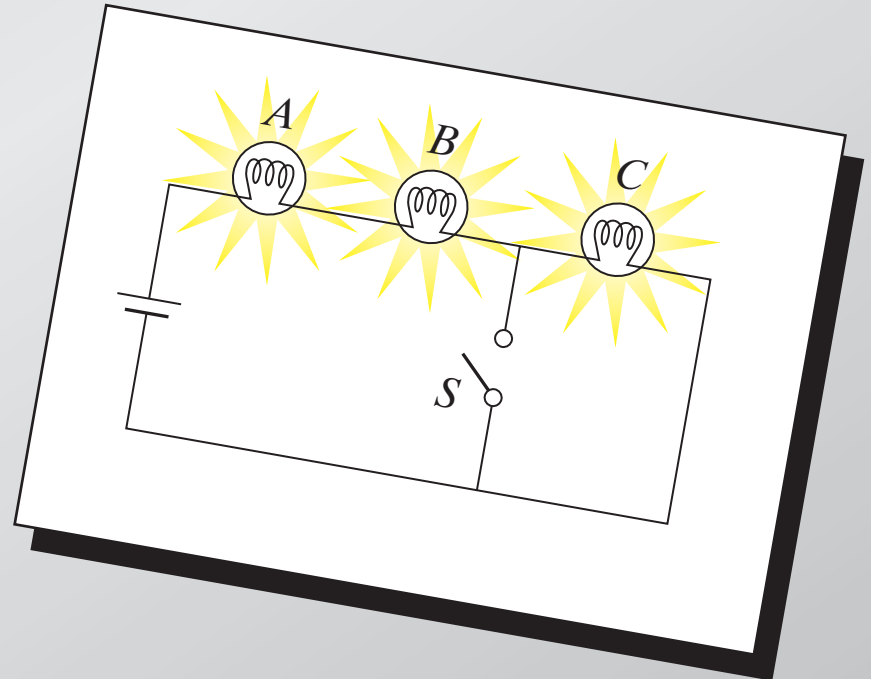


Education

are the basic principles understood?

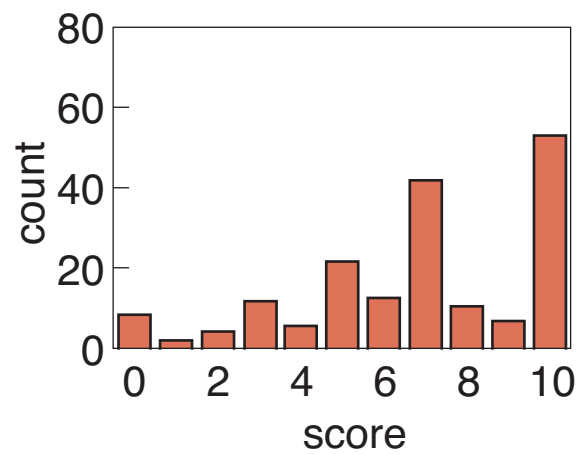
When S is closed, what happens to:

- (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?

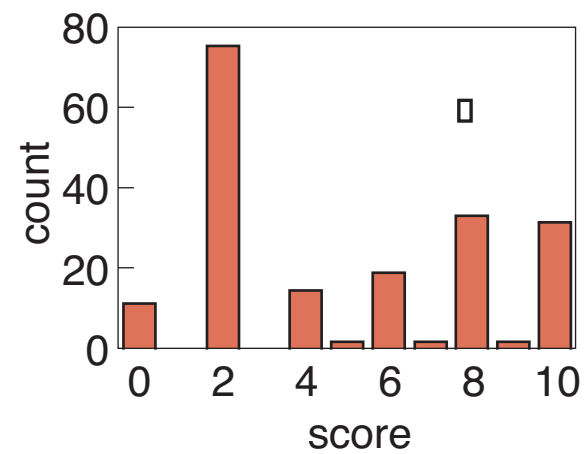


Education

conventional

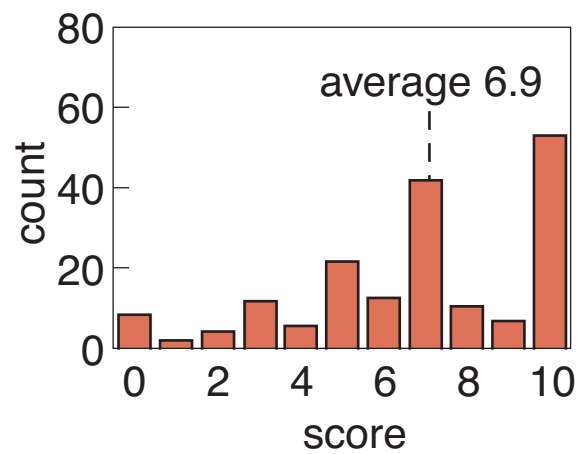


conceptual

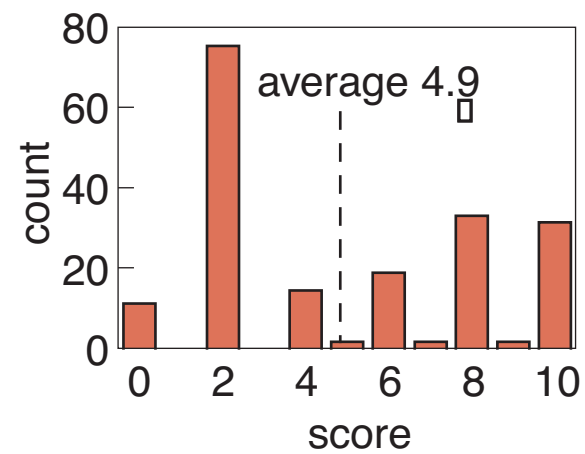


Education

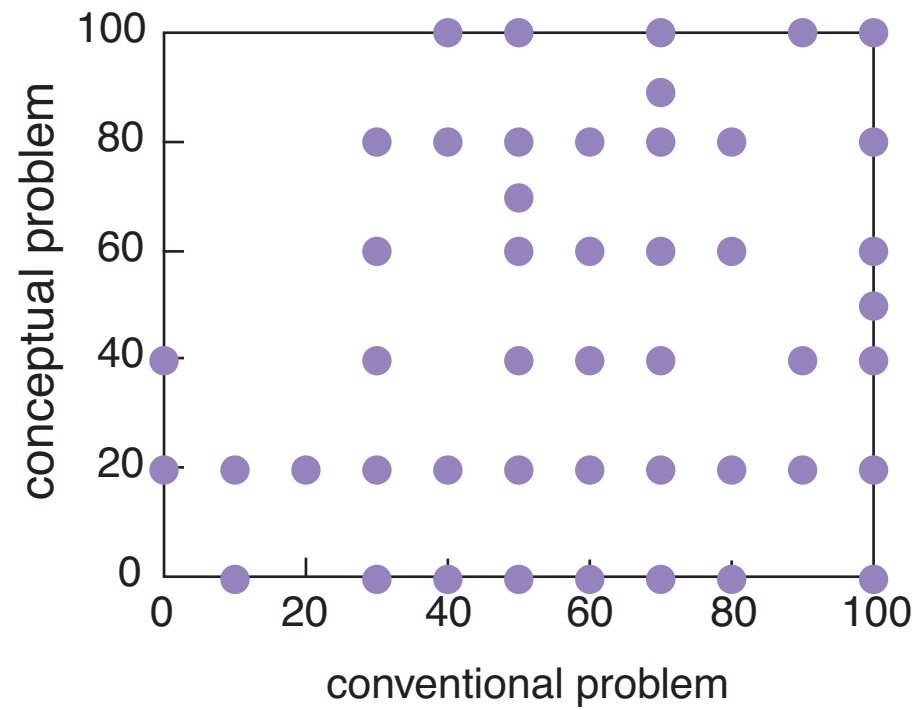
conventional



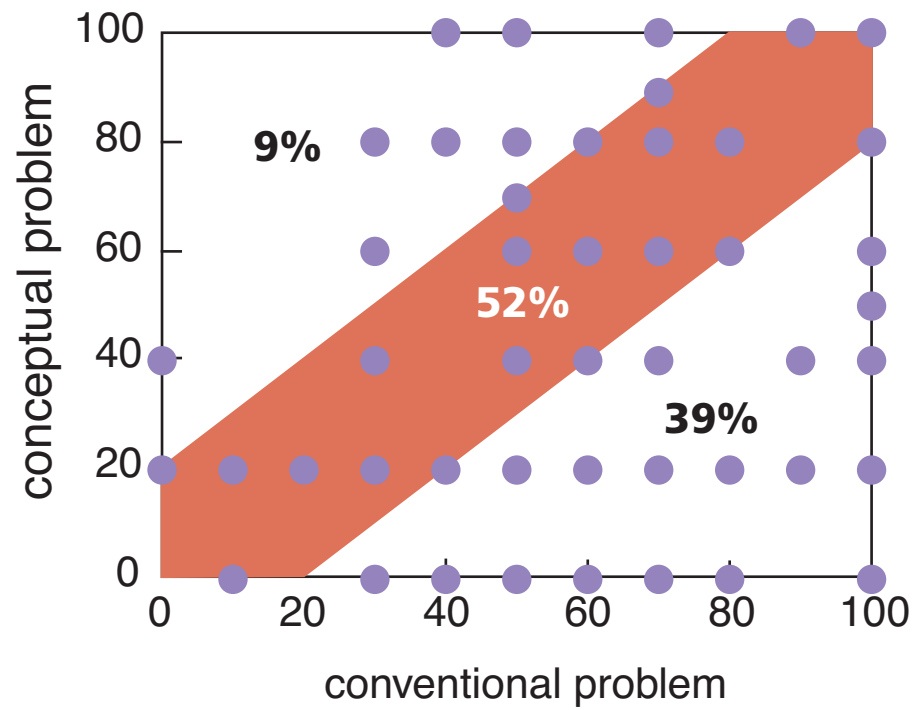
conceptual



Education



Education



So what should we do?



Peer Instruction

Give students more responsibility for gathering information...

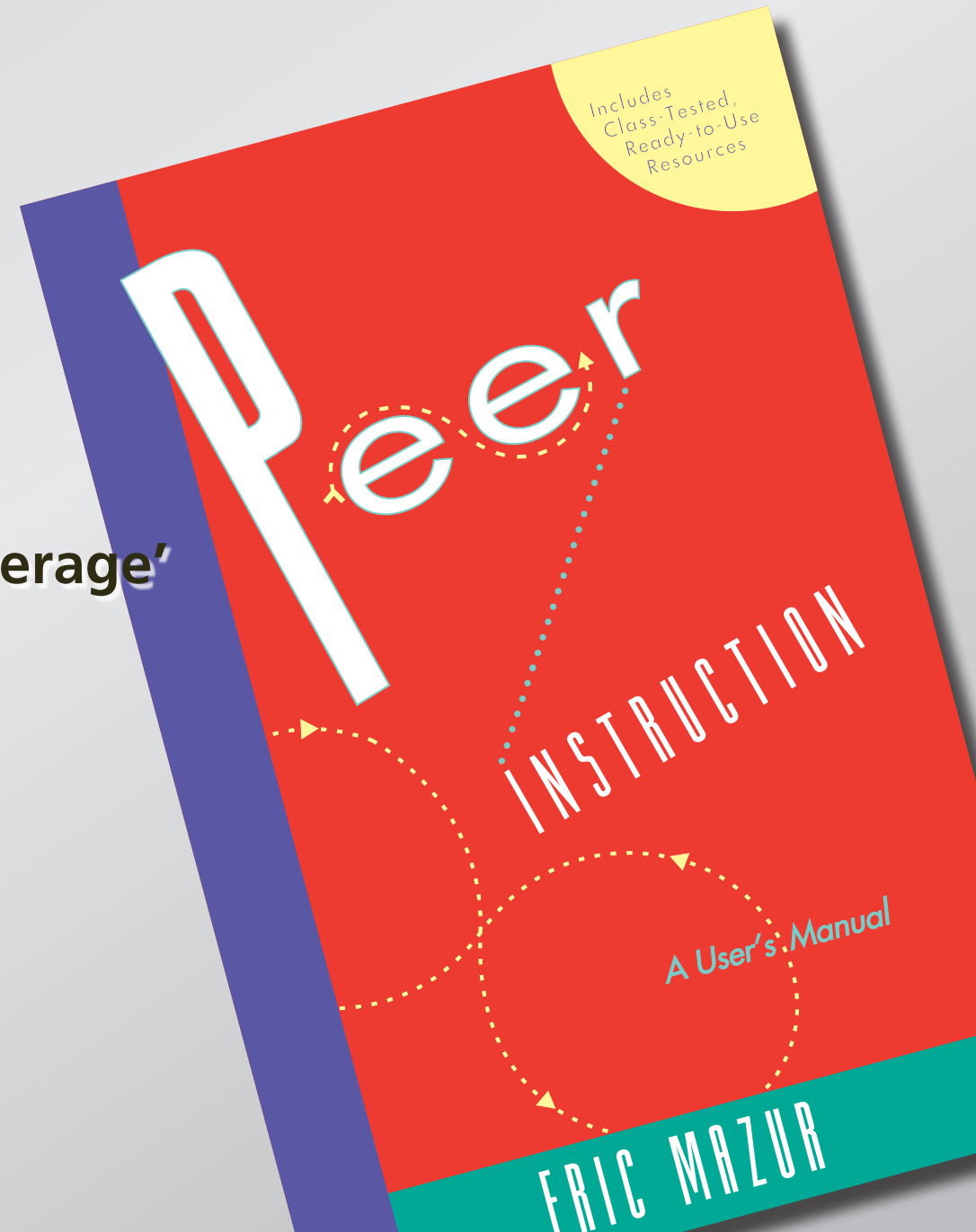
Peer Instruction

**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

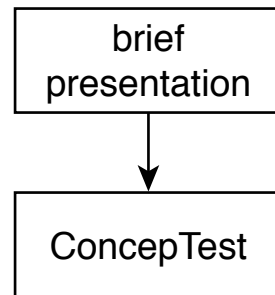
ConcepTest:

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

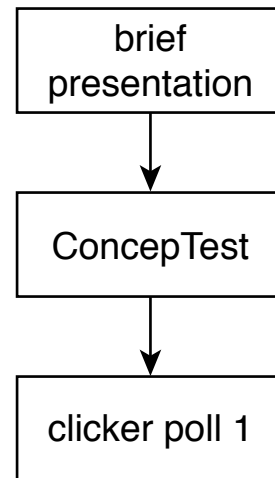
Peer Instruction

brief
presentation

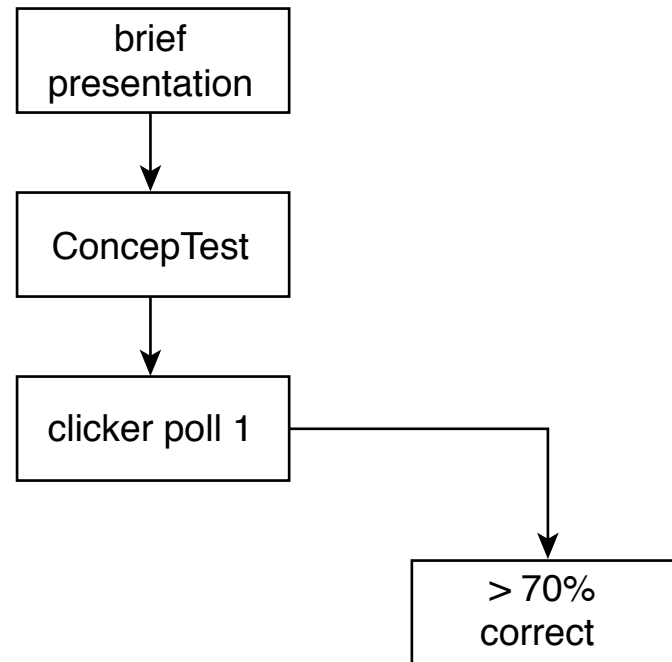
Peer Instruction



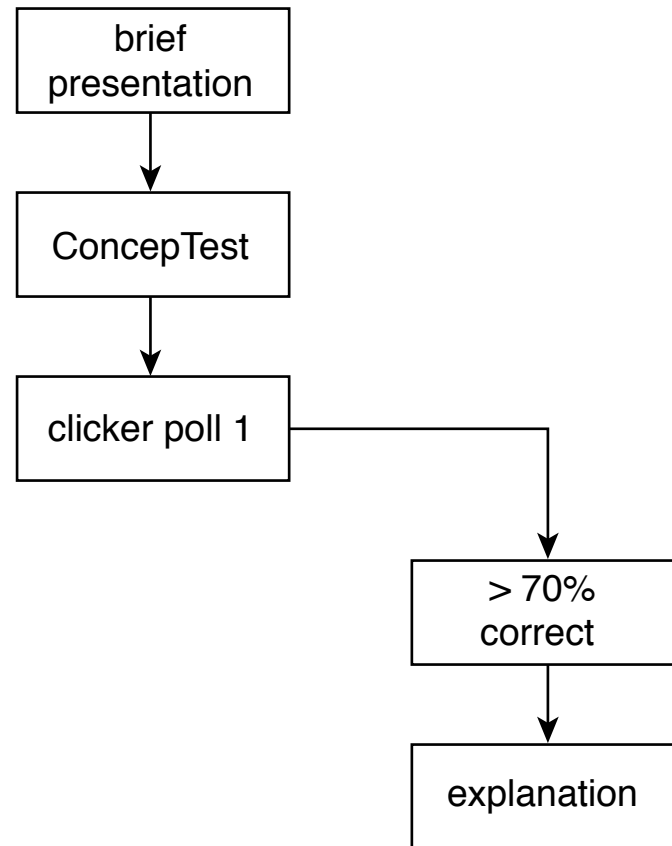
Peer Instruction



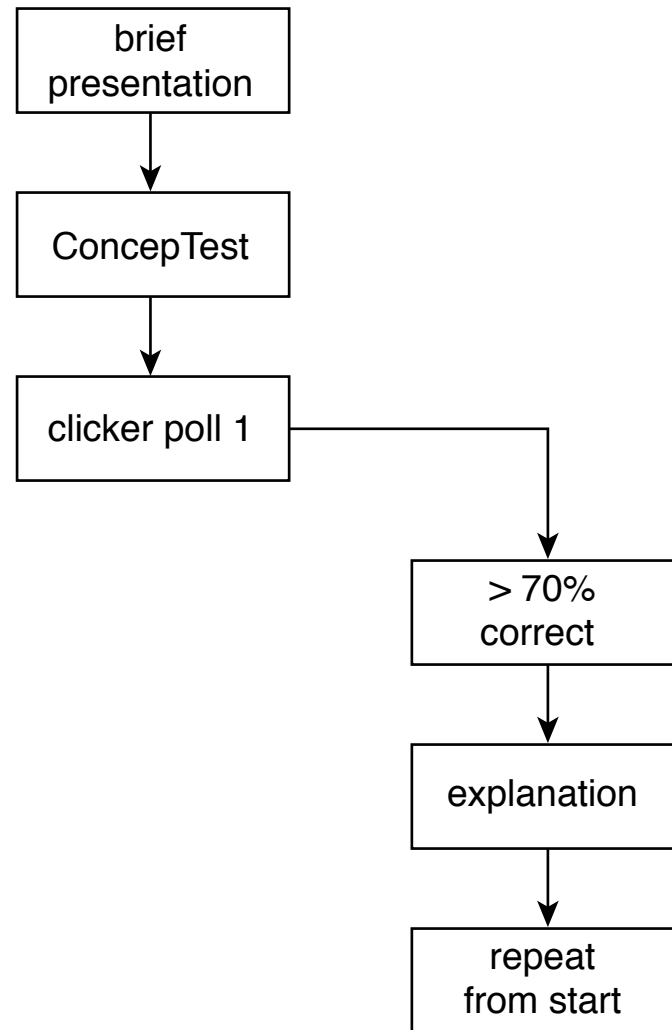
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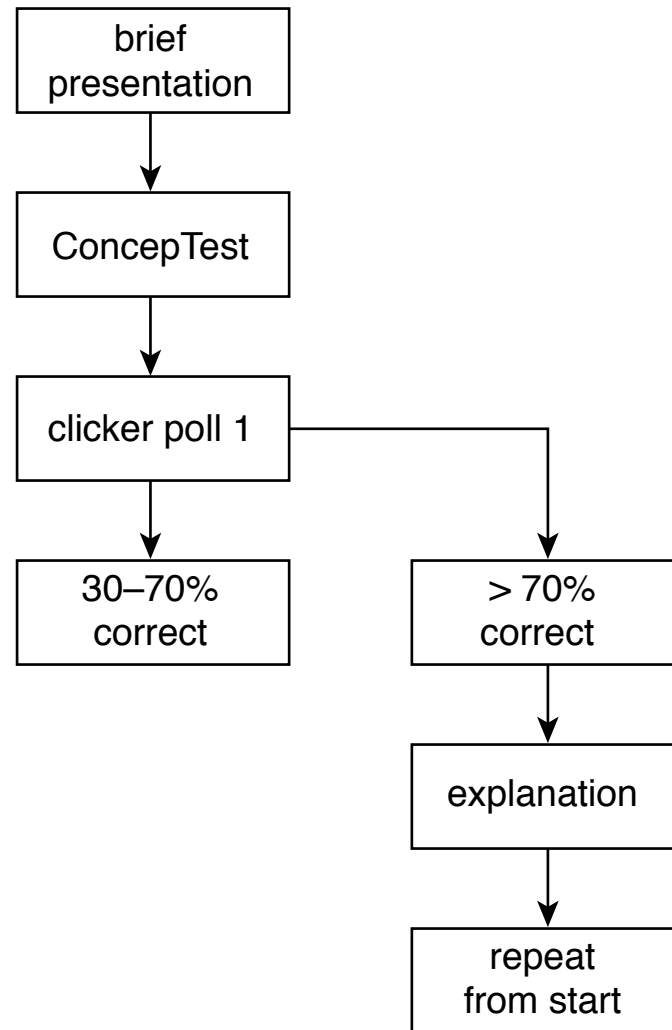
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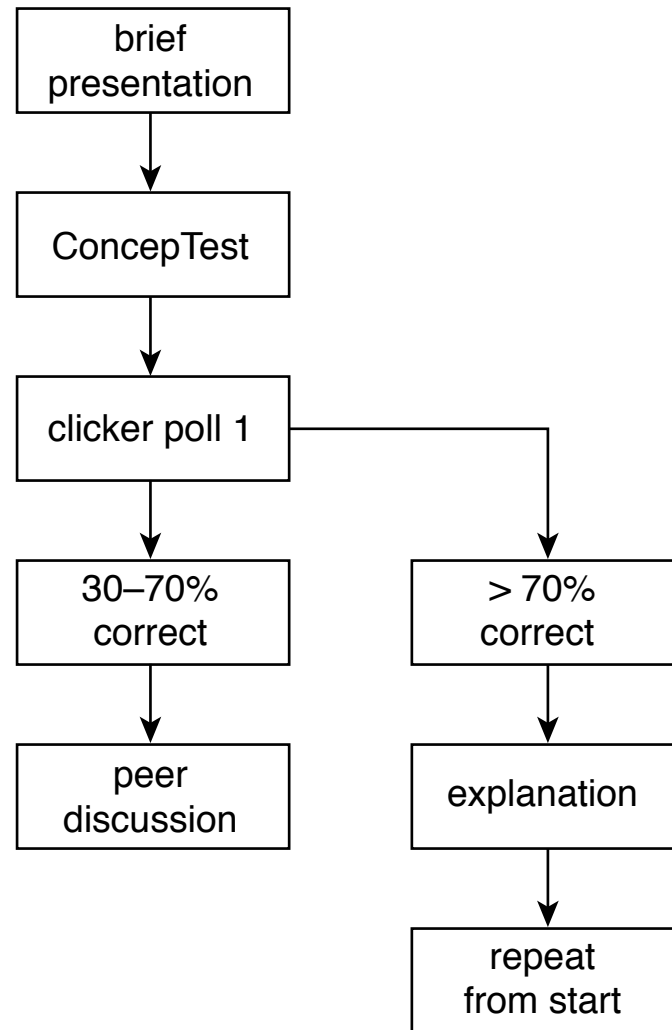
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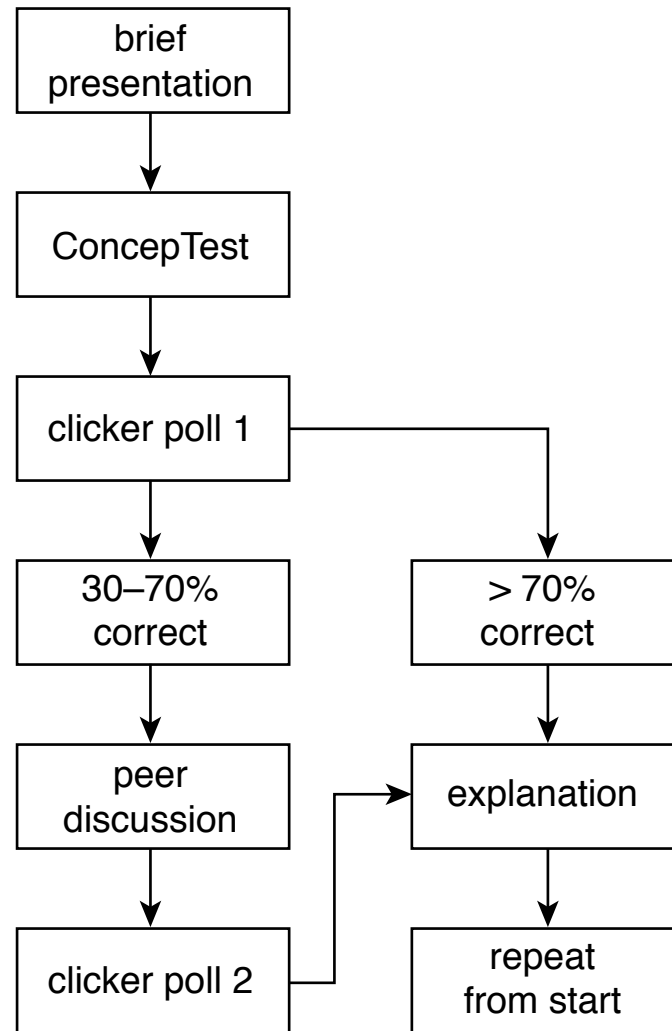
Peer Instruction



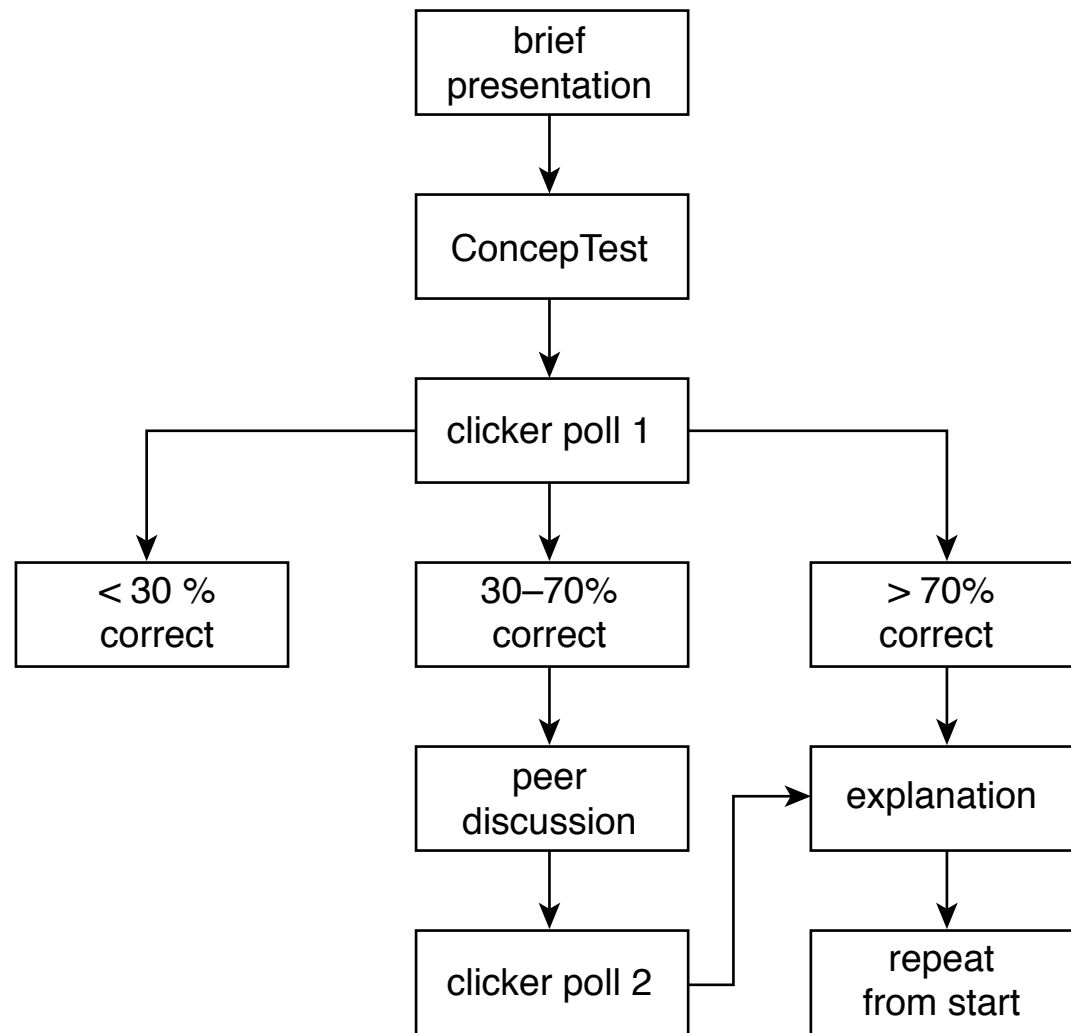
Peer Instruction



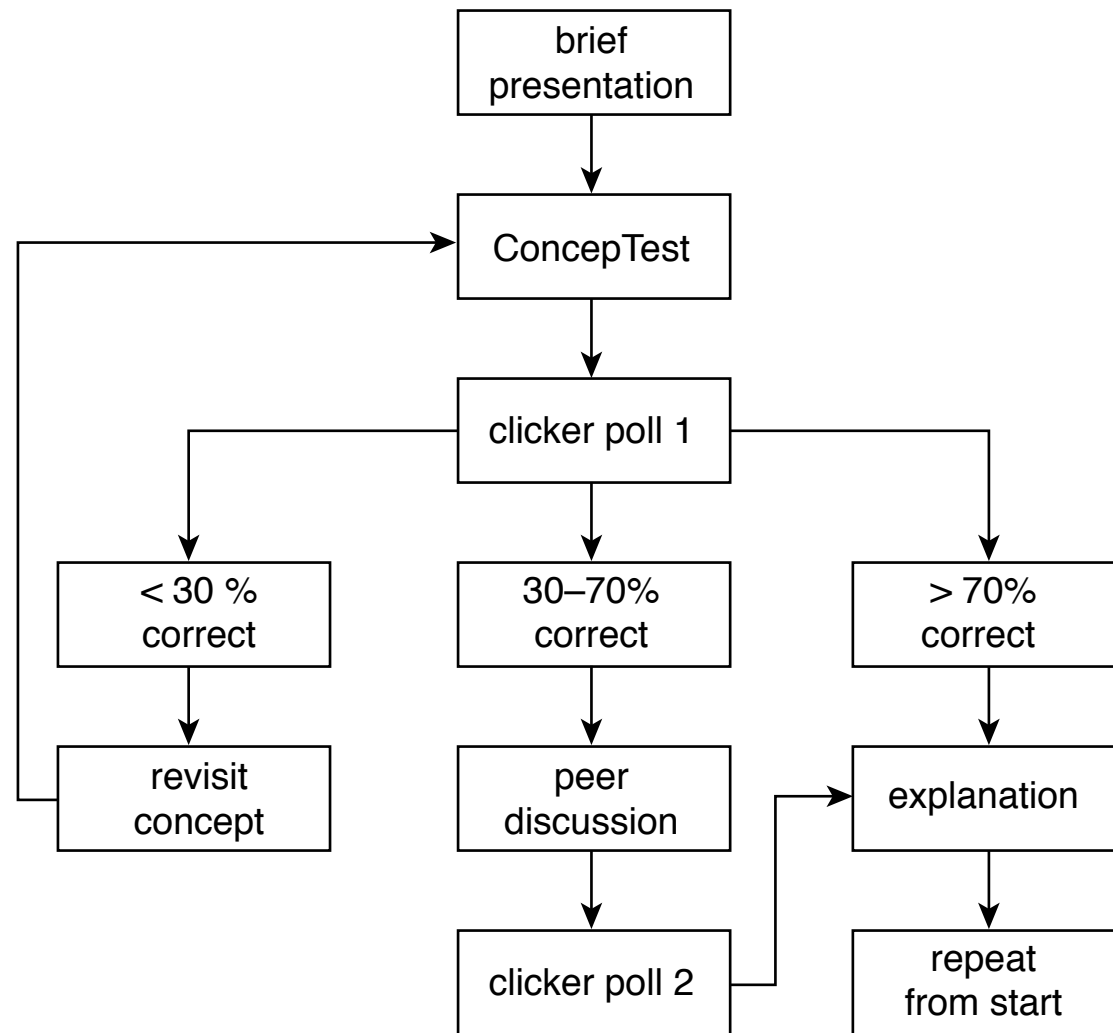
Peer Instruction



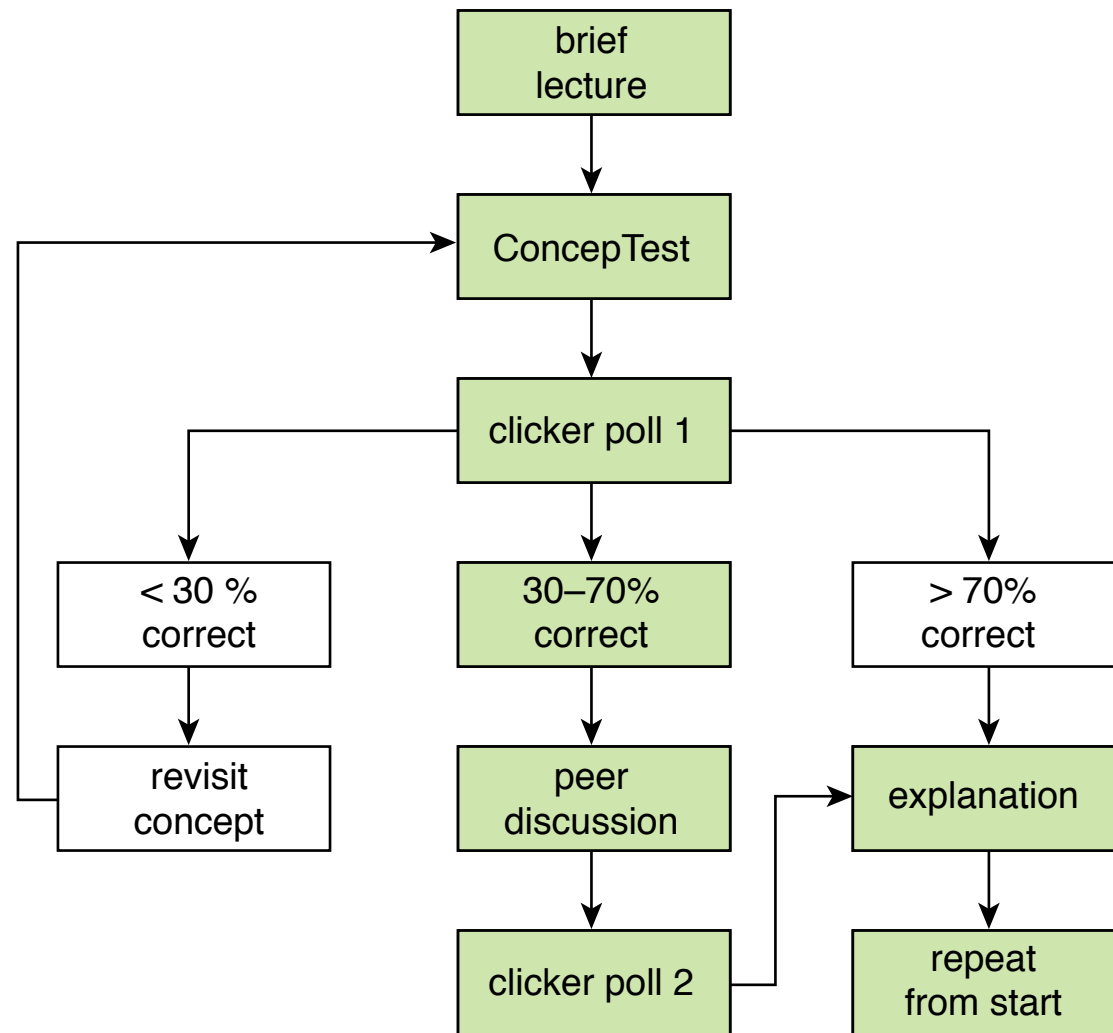
Peer Instruction



Peer Instruction

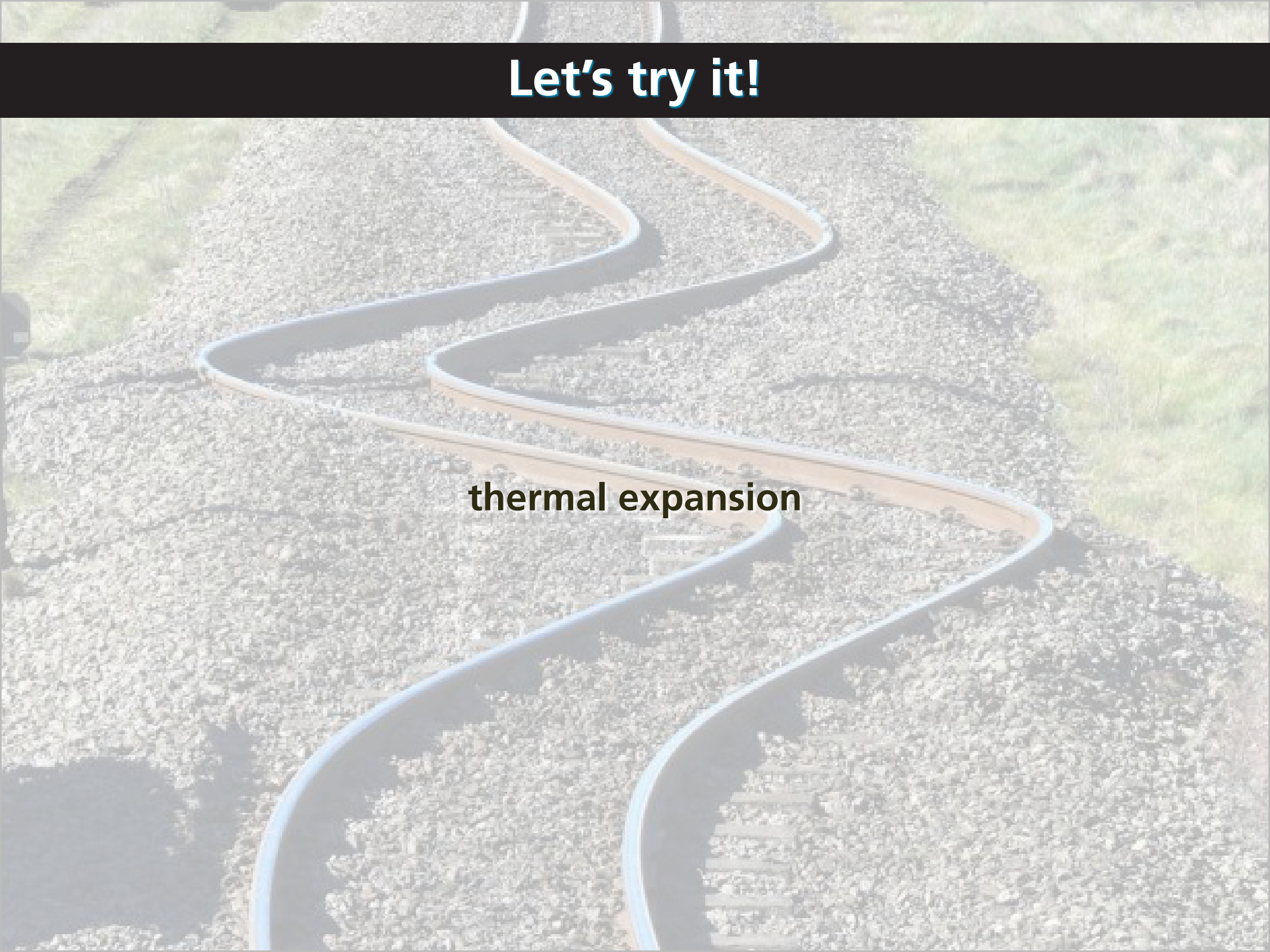


Peer Instruction



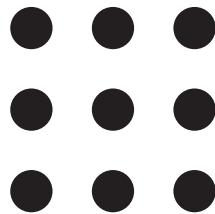
Let's try it!

thermal expansion



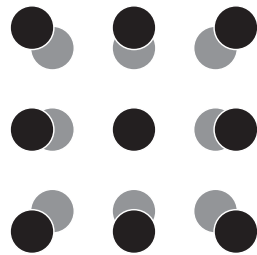
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When metals heat up, they expand because all atoms get farther away from each other.



Let's try it!


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Let's try it!

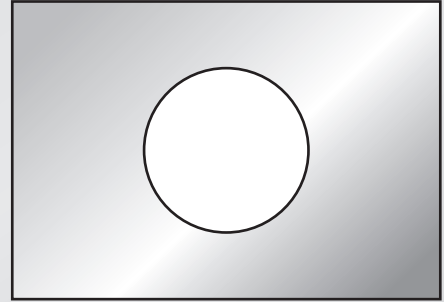
When metals heat up, they expand because all atoms get farther away from each other.

all of them



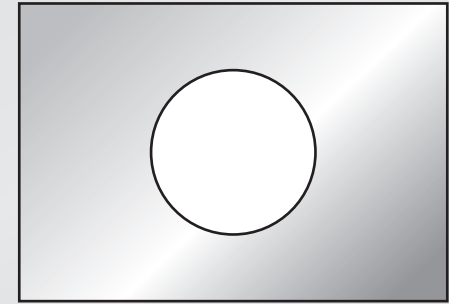
Let's try it!

Consider a rectangular metal plate with a circular hole in it.



Let's try it!

Consider a rectangular metal plate with a circular hole in it.



When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.



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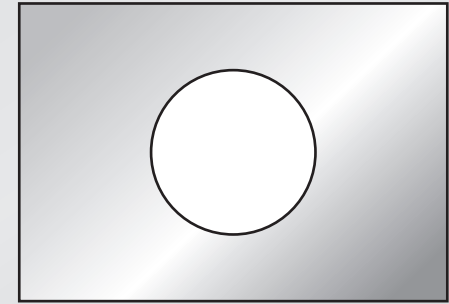


you got all fired up!



Let's try it!

Consider a rectangular metal plate with a circular hole in it.



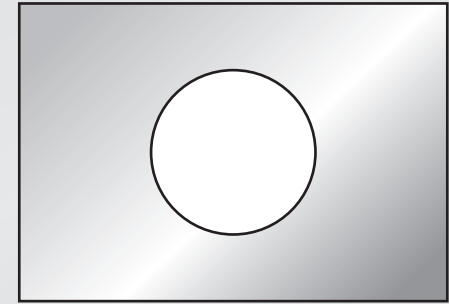
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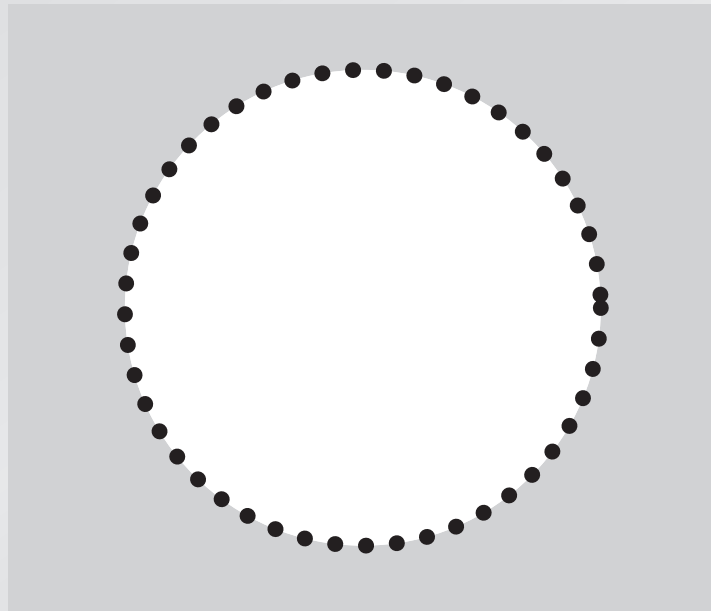
When the plate is uniformly heated, the diameter of the hole

- 1. increases. ✓
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- 3. decreases.



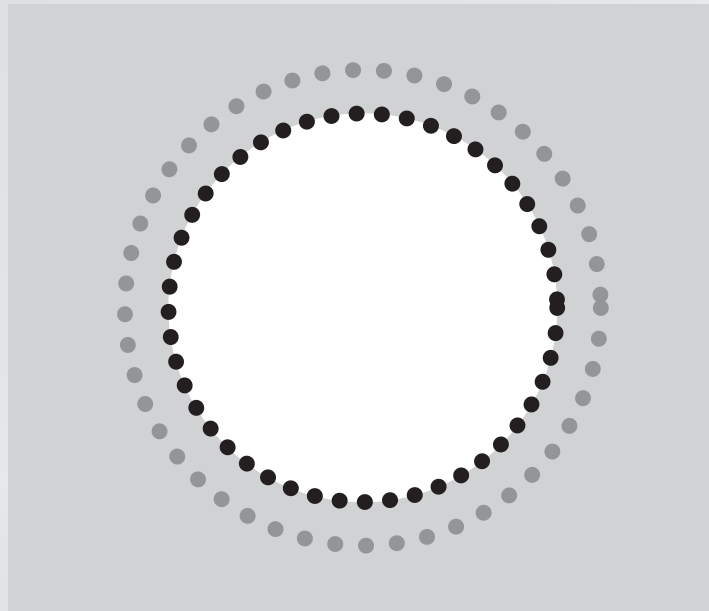
Let's try it!

consider the atoms at the rim of the hole



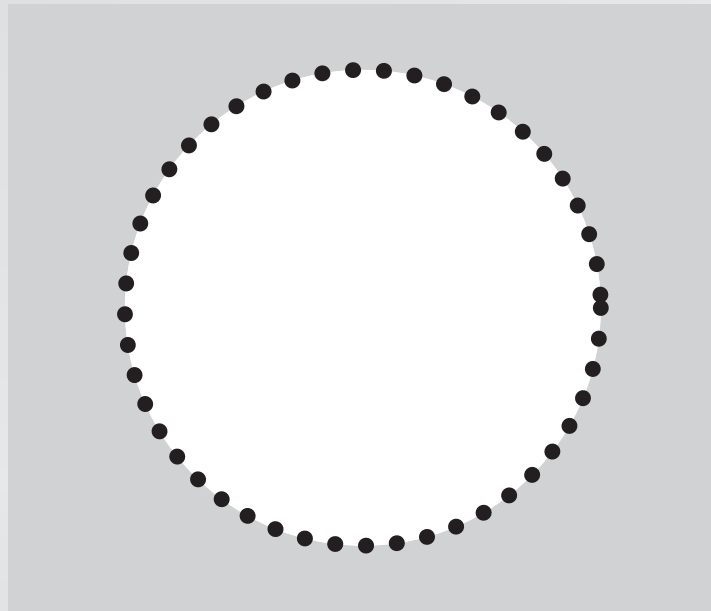
Let's try it!

consider the atoms at the rim of the hole



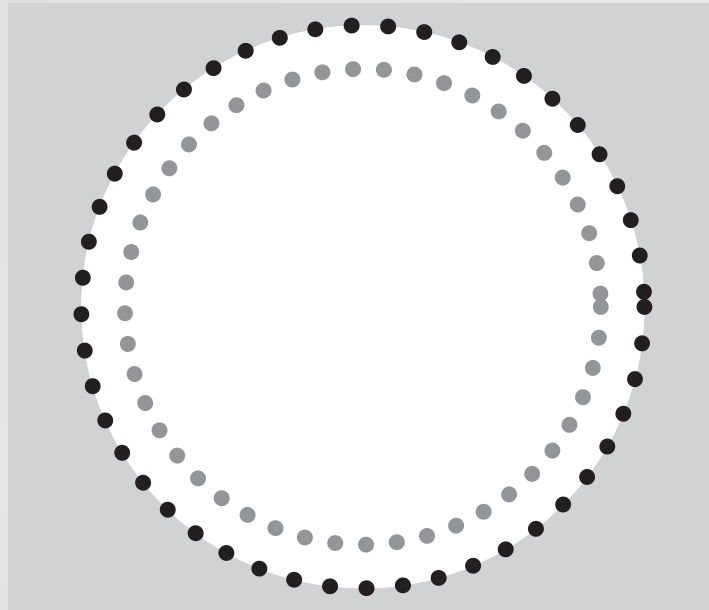
Let's try it!

consider the atoms at the rim of the hole



Let's try it!

consider the atoms at the rim of the hole



Let's try it!

consider the atoms at the rim of the hole

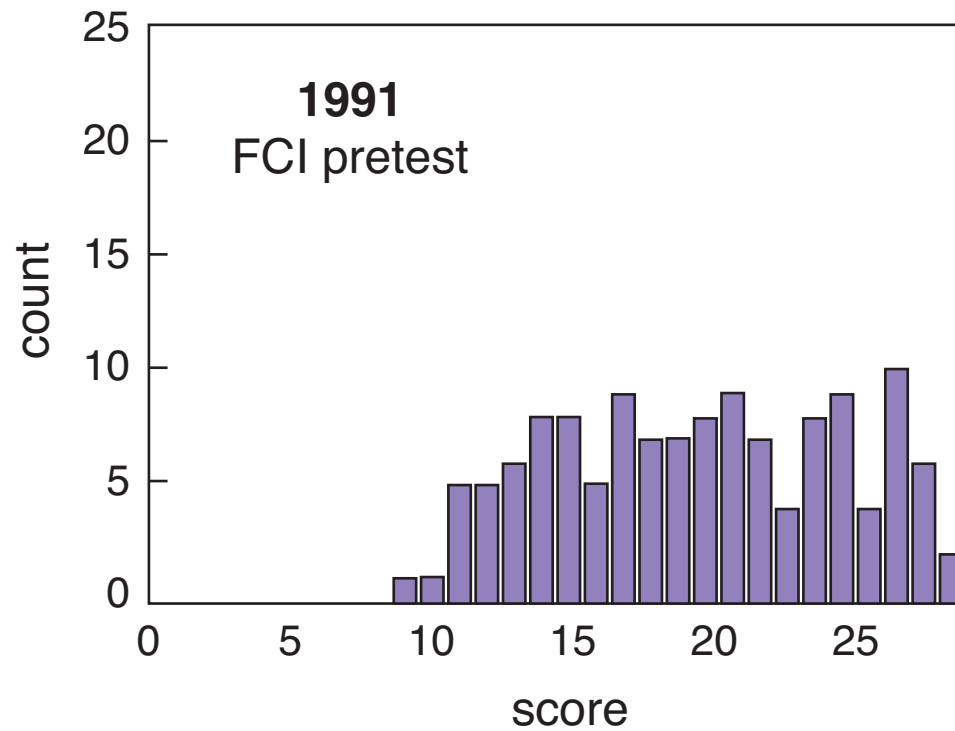


Results

is it any good?

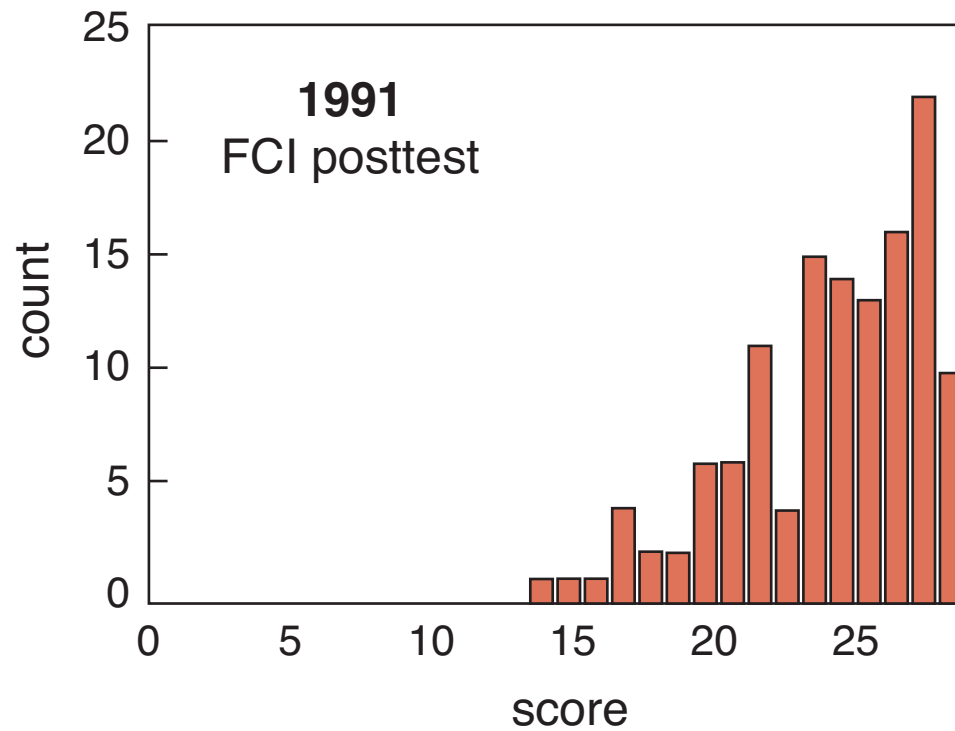
Results

first year of implementing PI



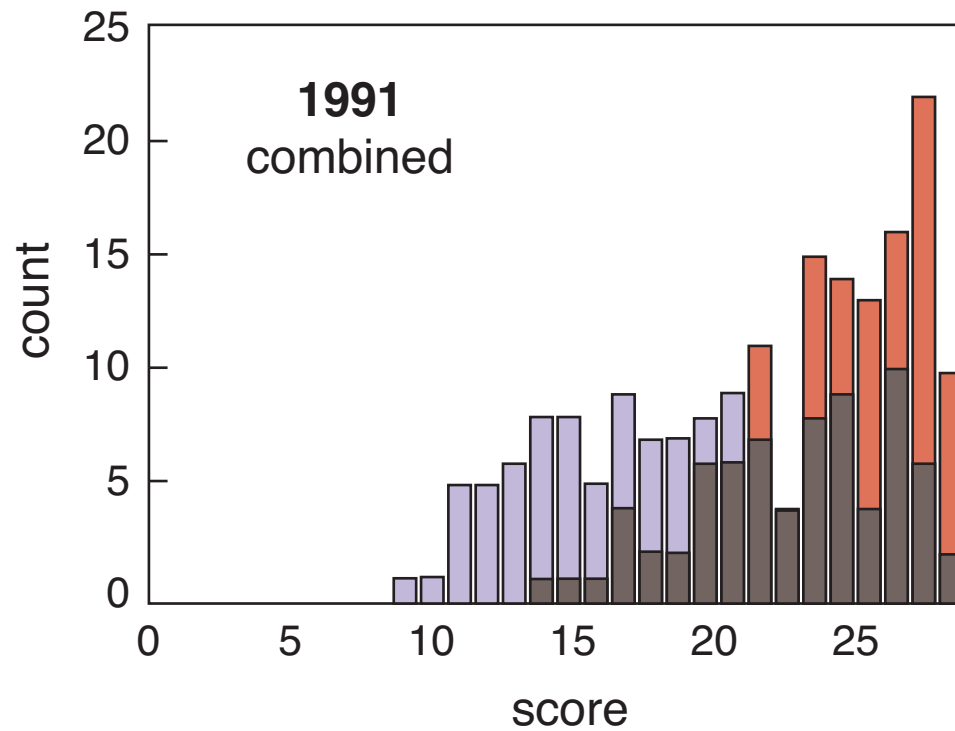
Results

first year of implementing PI



Results

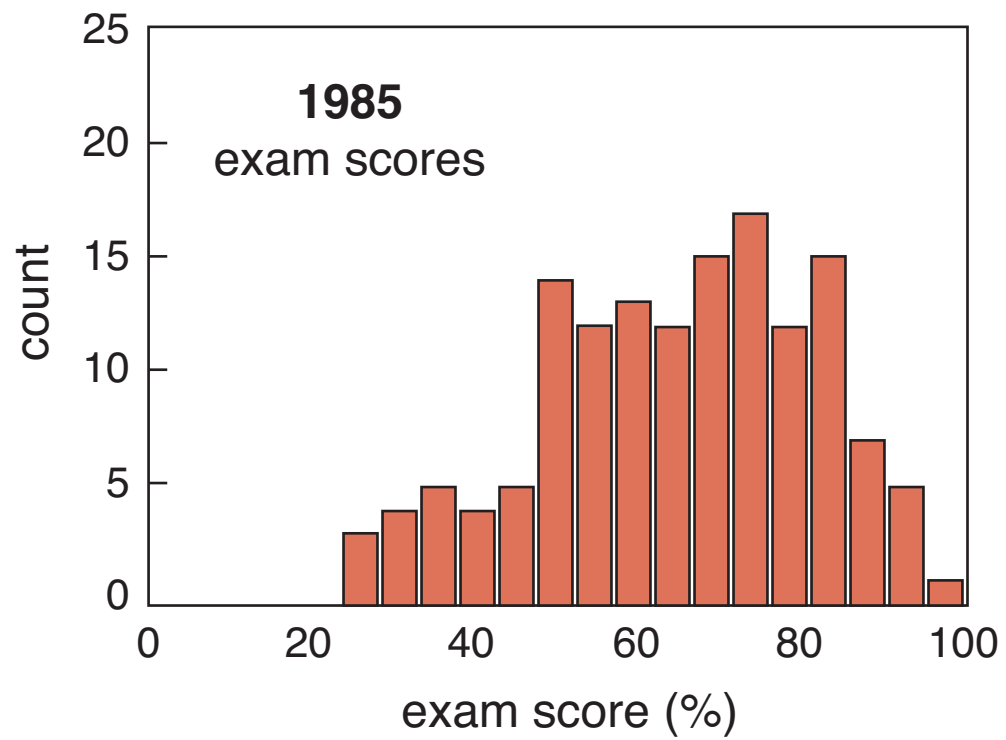
first year of implementing PI



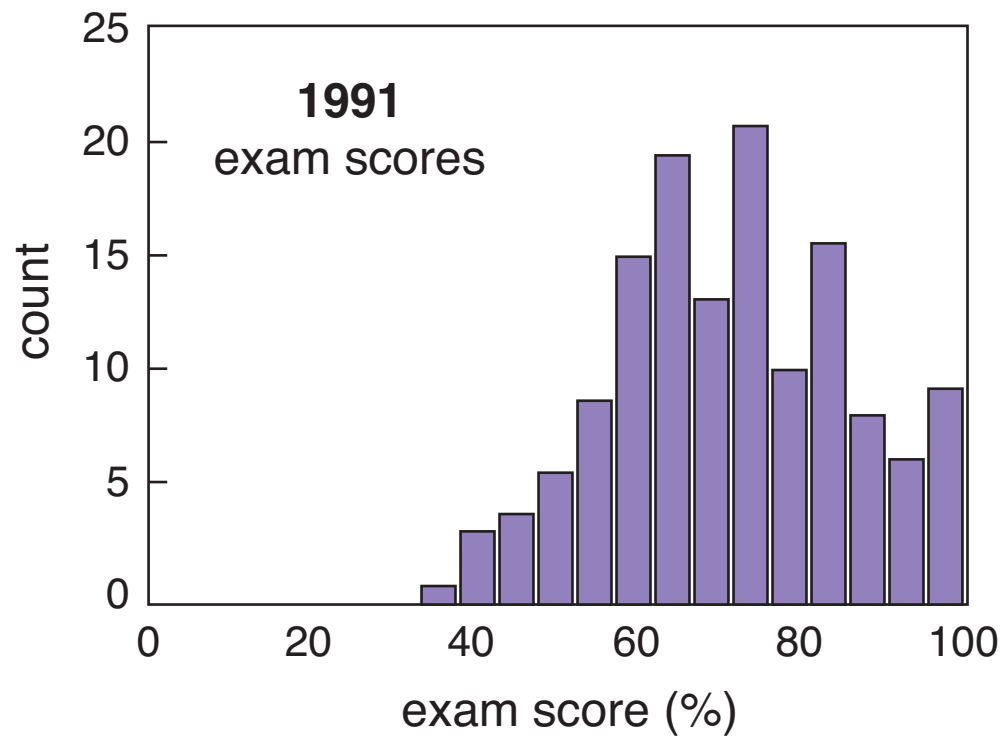
Results

what about problem solving?

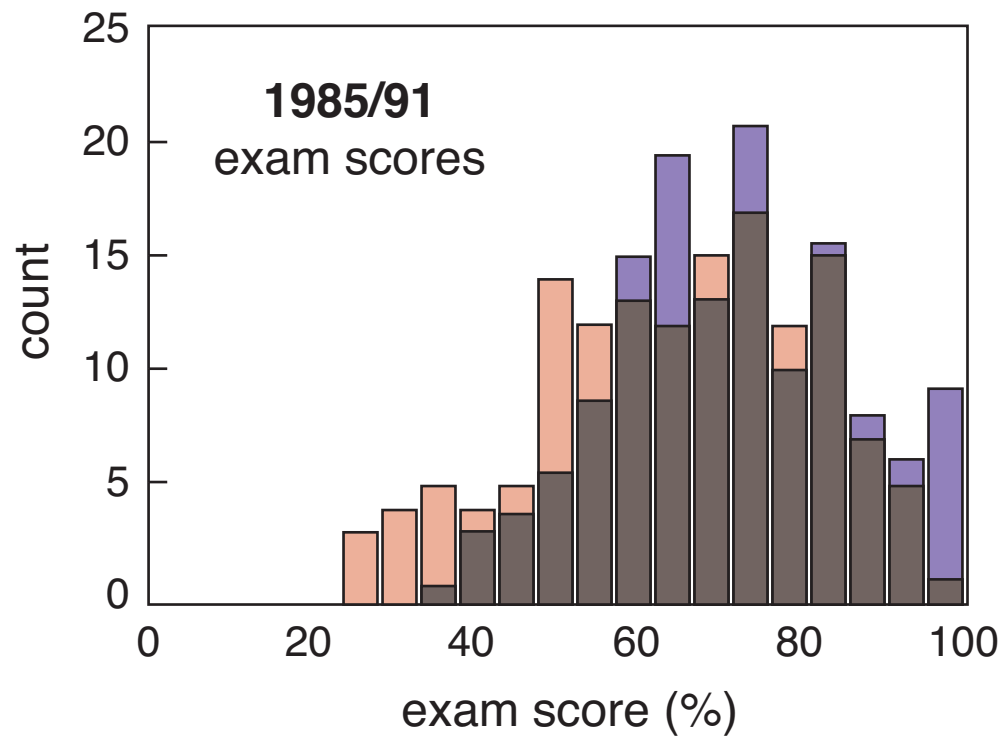
Results



Results



Results



Conclusion

So better understanding leads to better problem solving!

Summary

So better understanding leads to better problem solving!

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

Conclusion

With a simple change, Peer Instruction...

- **teaches *real* problem solving**
- **encourages risk taking**

Funding:

National Science Foundation

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