Educating the Innovators of the 21st Century

Foro de Presidentes
Harvard University
Cambrige, MA, 3 May 2010

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- no ON/OFF button
- only last "click" counts
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A quick survey…

In my company/university innovation is:

1. very important
2. important
3. neither important nor unimportant
4. unimportant
5. totally unimportant

A quick survey…

My company/university is:

1. very innovative
2. somewhat innovative
3. not innovative at all

Innovation

Innovation

exploiting new ideas leading to a new product or method
(a change in the thought process for doing something)

Innovation

innovation requires whole-brain thinking:

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

Innovation

how can we foster/teach innovation?

How do we learn?

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

Adapted from: *The Lecturer's Toolkit* by Phil Race and Sally Brown (1998)

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?**

Adapted from: *The Lecturer's Toolkit* by Phil Race and Sally Brown (1998)

How do we learn?

Became good at it by:

- practicing
- doing it
- trial and error
- getting it wrong at first and learning from mistakes

How do we learn?

Probably NOT by:

- being trained
- being taught
- listening to experts
- reading about it

How do we learn?

Think of something about yourself that you feel good about — a personal attritube or quality.

How do we learn?

Think of something about yourself that you feel good about — a personal attritube or quality.

How do you *know* you that you can feel good about that?

How do we learn?

Feel good because of:

- reactions of other people
- feedback
- compliments
- seeing the results

How do we learn?

Doing + Feedback = Successful learning?

How do we learn?

Think of something you *don't* do well — perhaps the result of an unsatisfactory learning experience.

How do we learn?

Think of something you *don't* do well — perhaps the result of an unsatisfactory learning experience.

Write down:

a) what went wrong when you tried to learn it and
b) whose fault it was (yours? someone else? whose?)

How do we learn?

What went wrong:

- lack of motivation
- lack of time to make sense of it
- fear of failure
- couldn’t see why it was worth doing
- unable to understand before moving on

How do we learn?

Think of something you *did* learn successfully, but at the time didn't want to learn — something you are now *glad* you learned.

How do we learn?

Think of something you *did* learn successfully, but at the time didn't want to learn — something you are now *glad* you learned.

Write down what kept you at it when your motivation was low.

How do we learn?

What kept you at:

- **need**
- **pressure**

How do we learn?

We learn by:

- doing
- positive feedback
- wanting to learn
- needing to learn

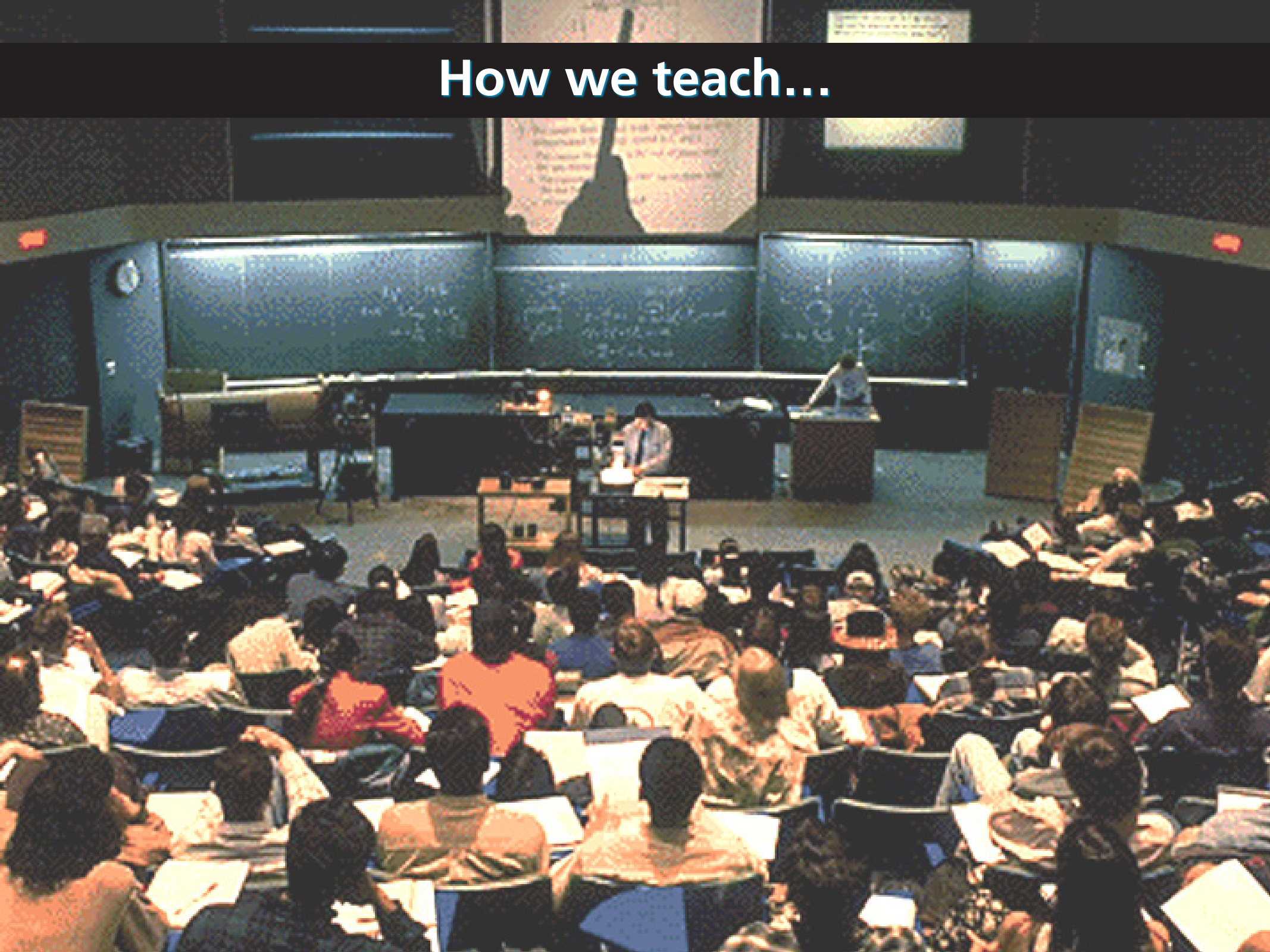
How do we learn?

We learn by:

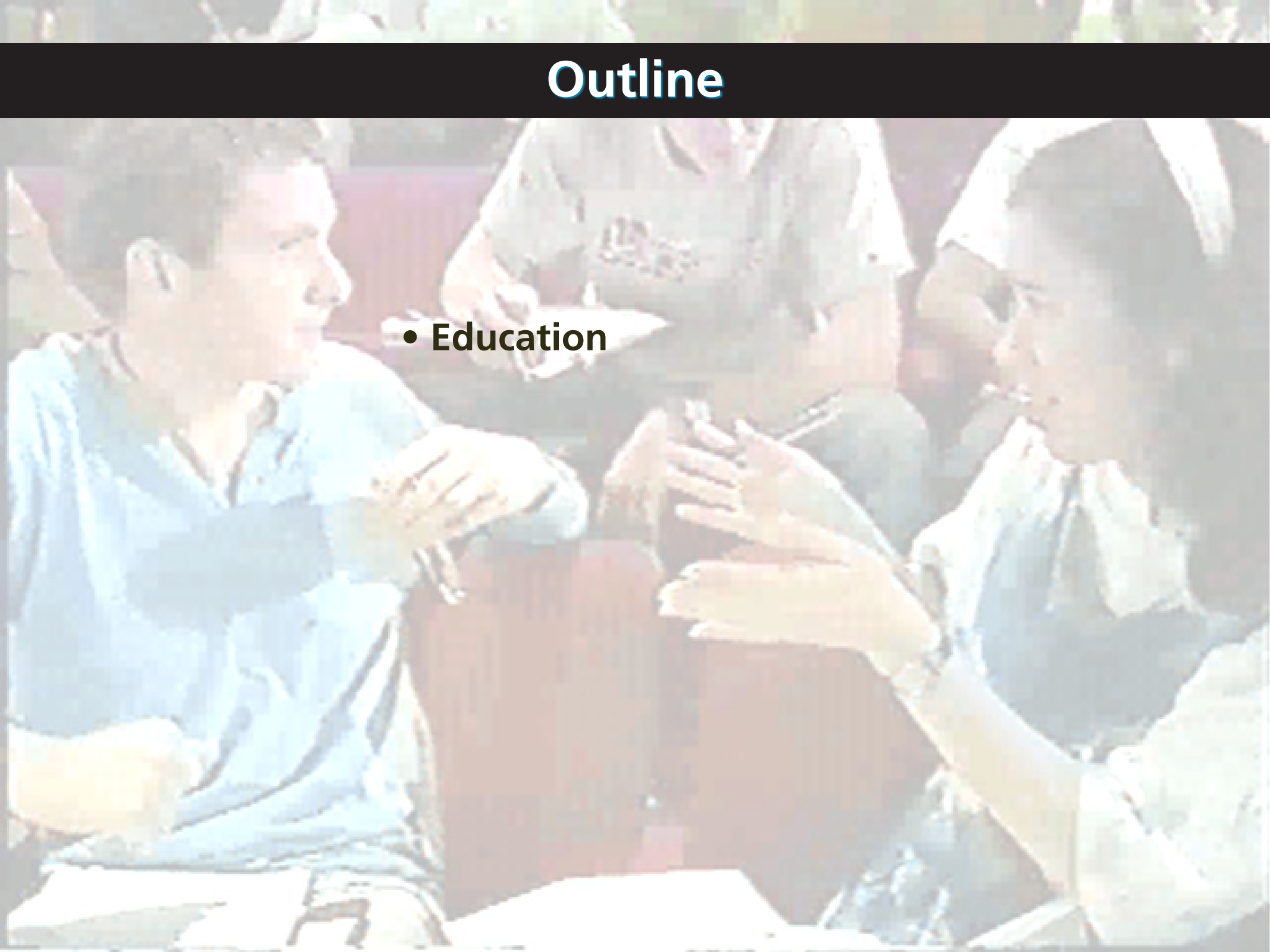
- doing
- positive feedback
- wanting to learn
- needing to learn

and how do we teach...?

How we teach…

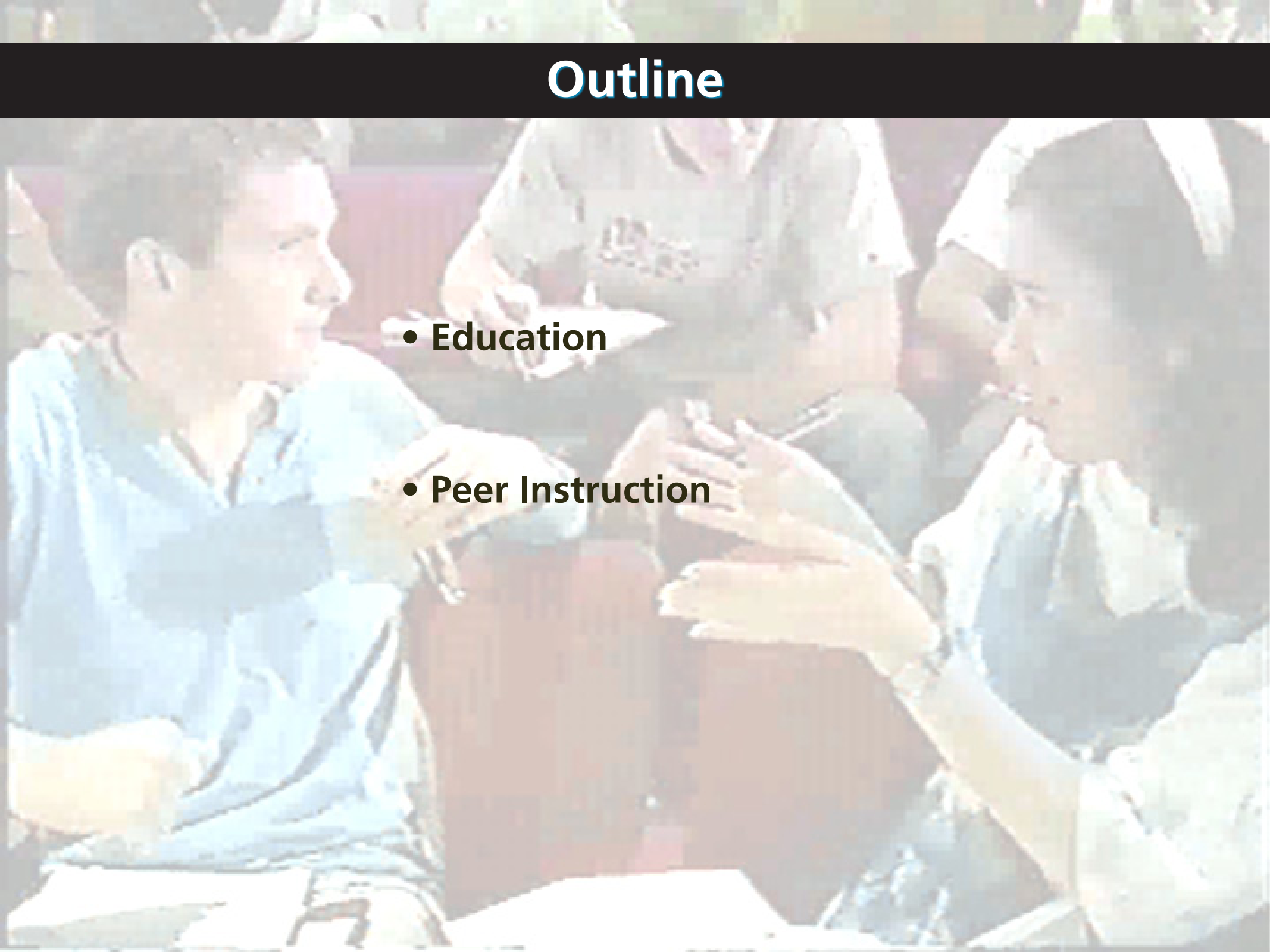


Outline



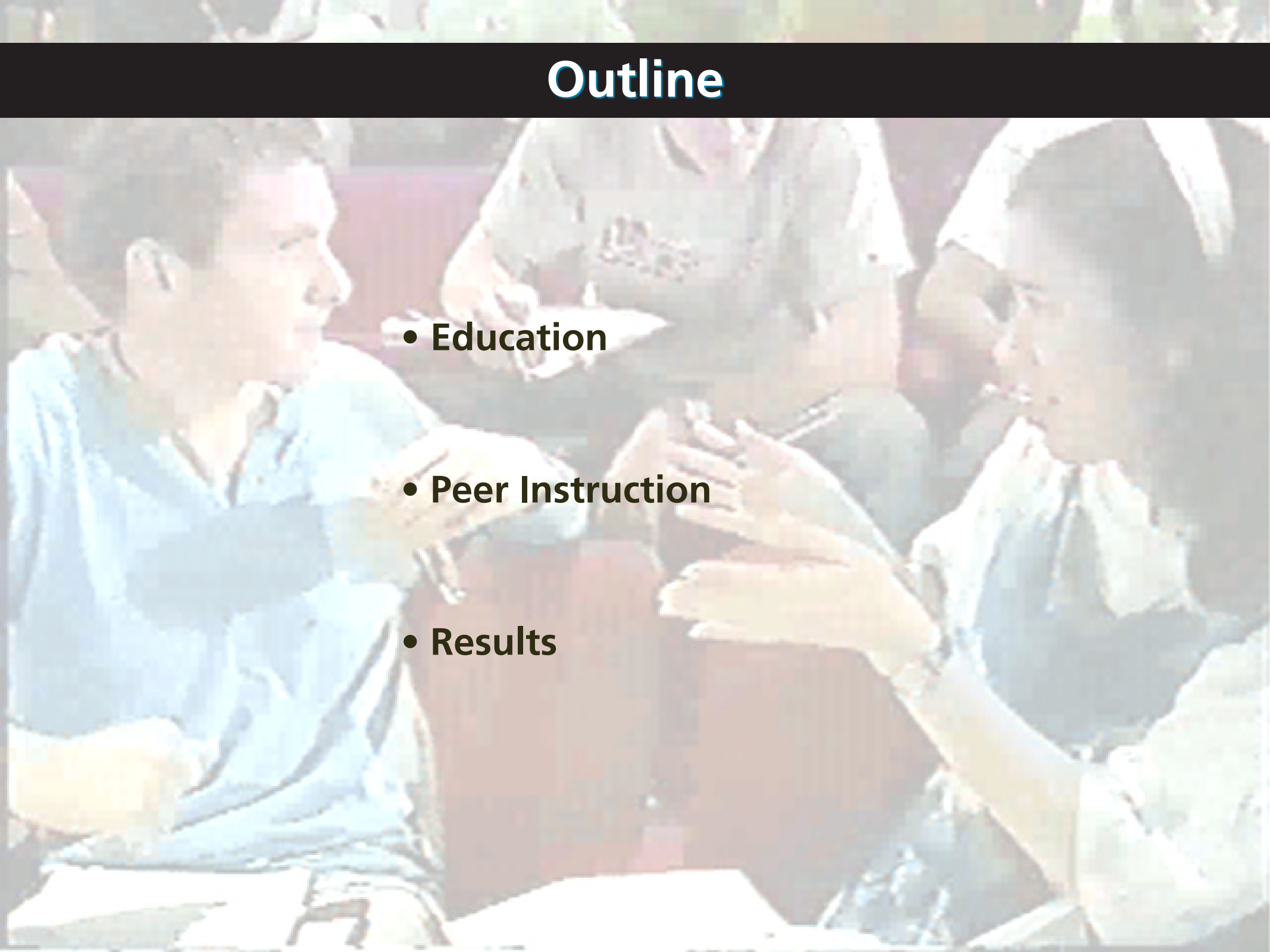
- Education

Outline



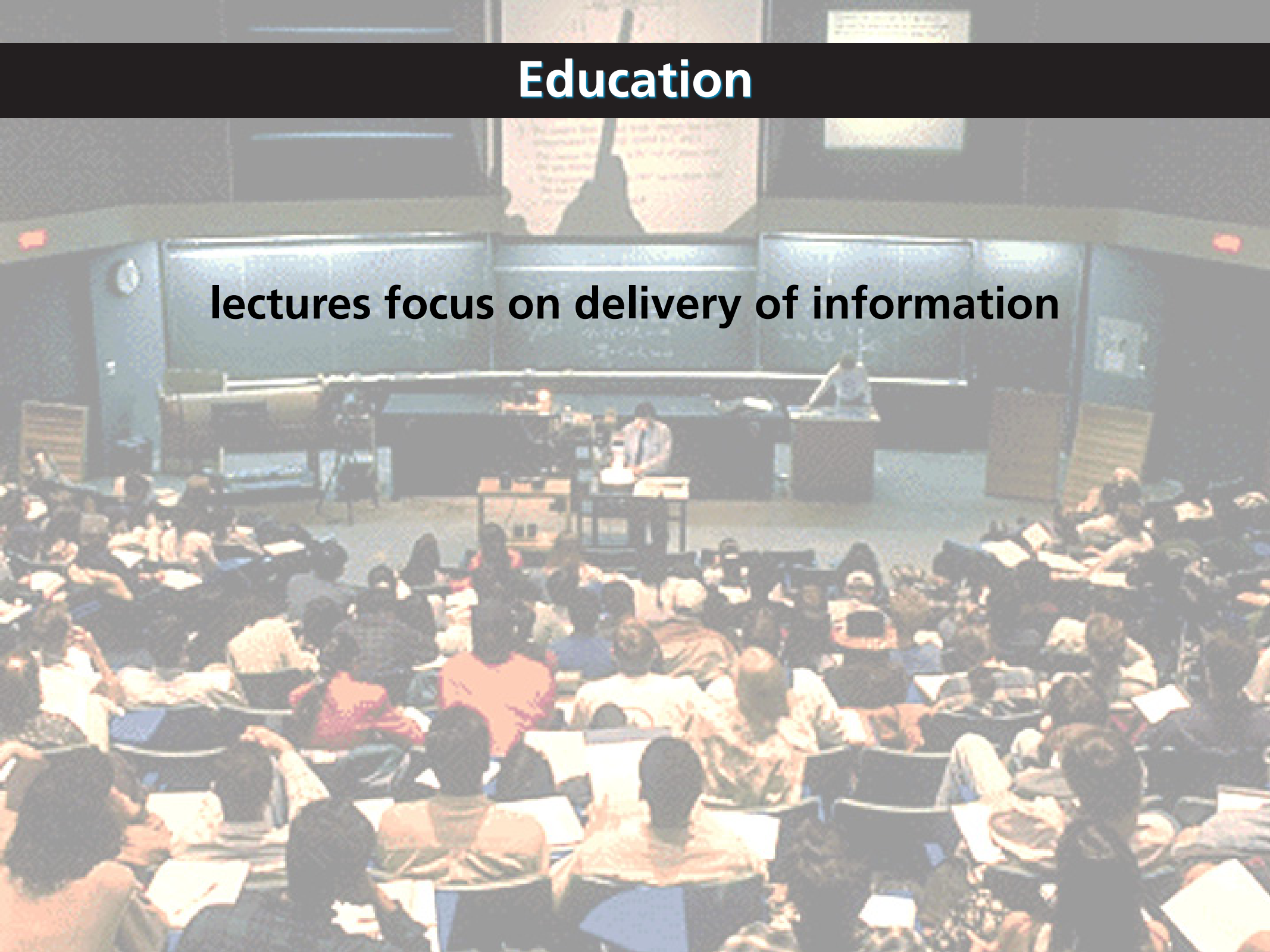
- Education
- Peer Instruction

Outline



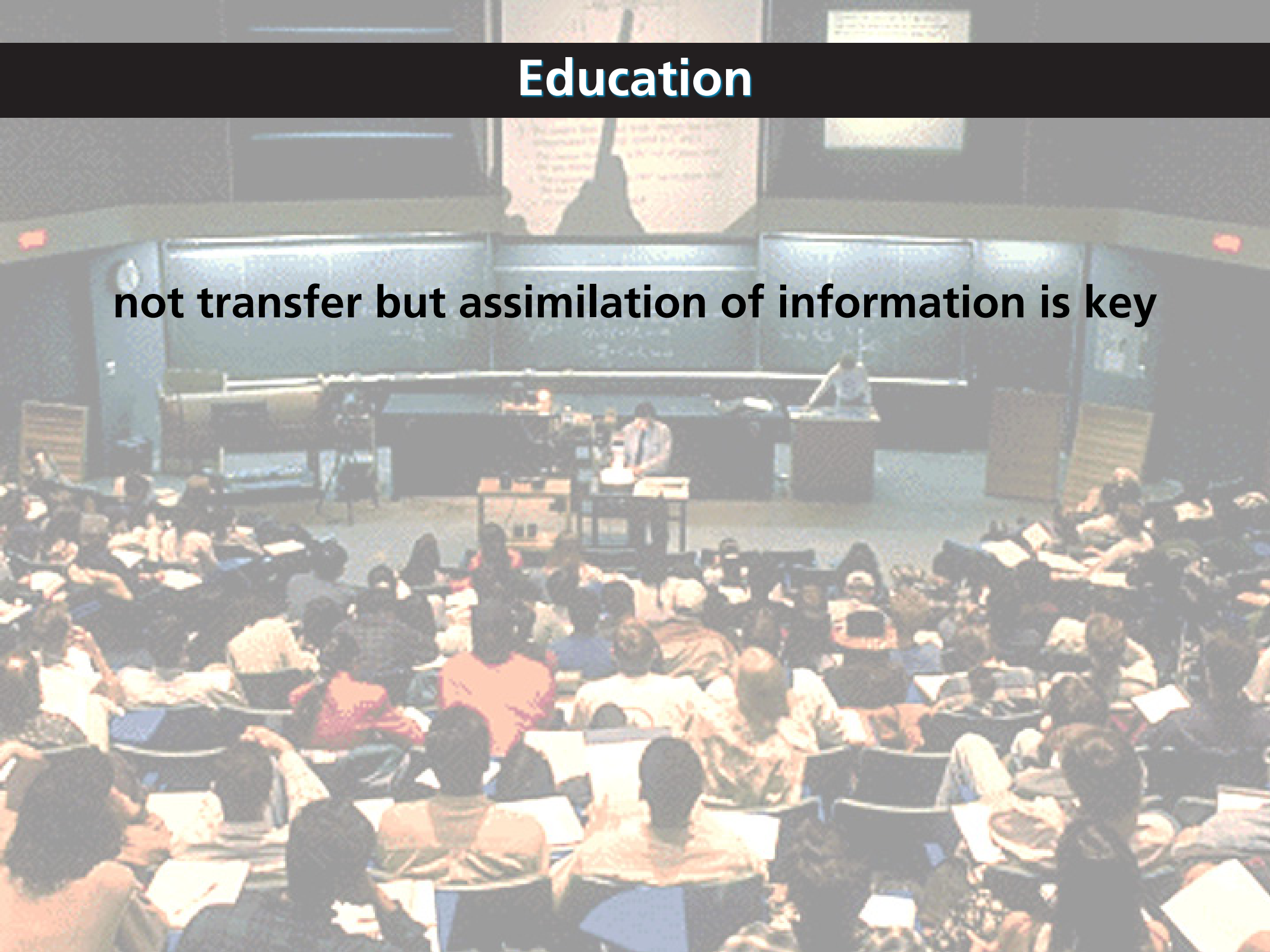
- Education
- Peer Instruction
- Results

Education



lectures focus on delivery of information

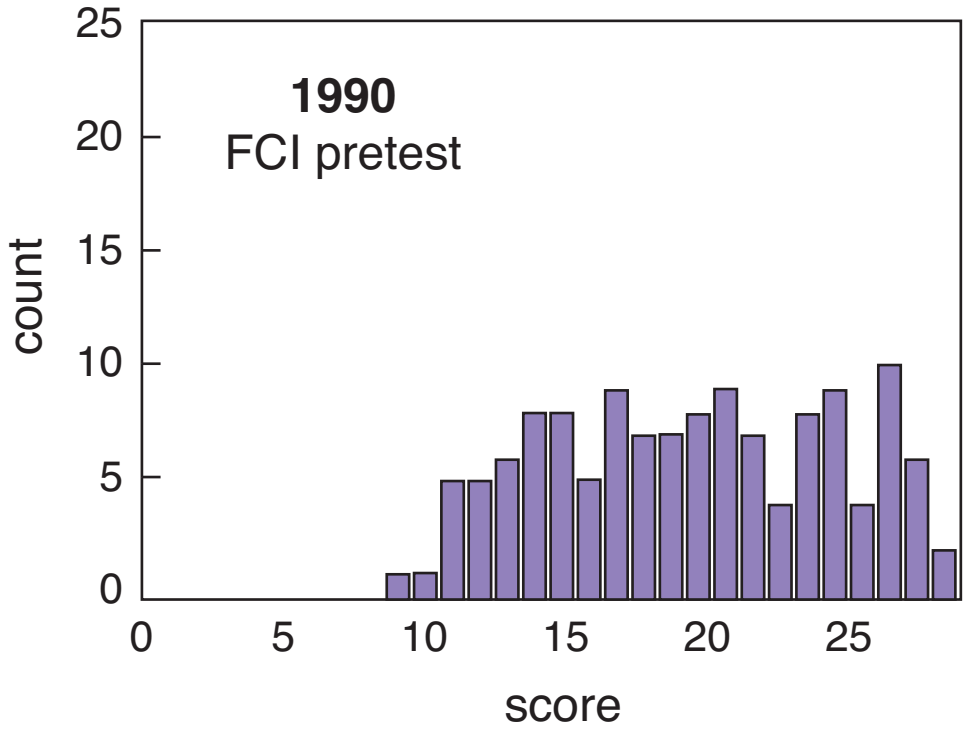
Education



not transfer but assimilation of information is key

Education

education is not just information transfer



Education

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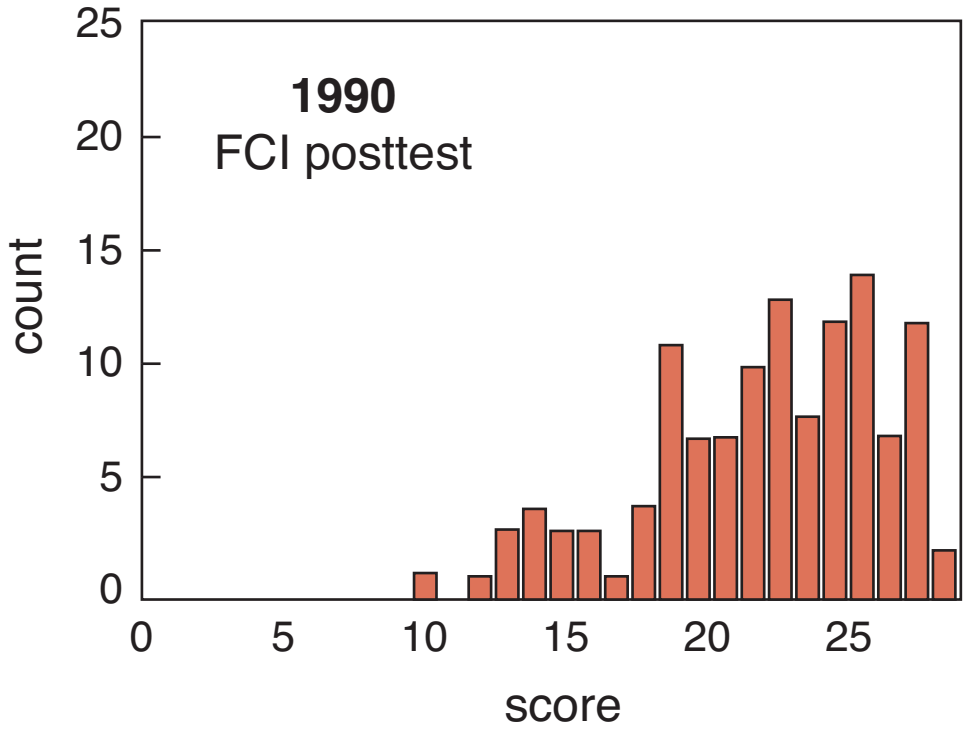

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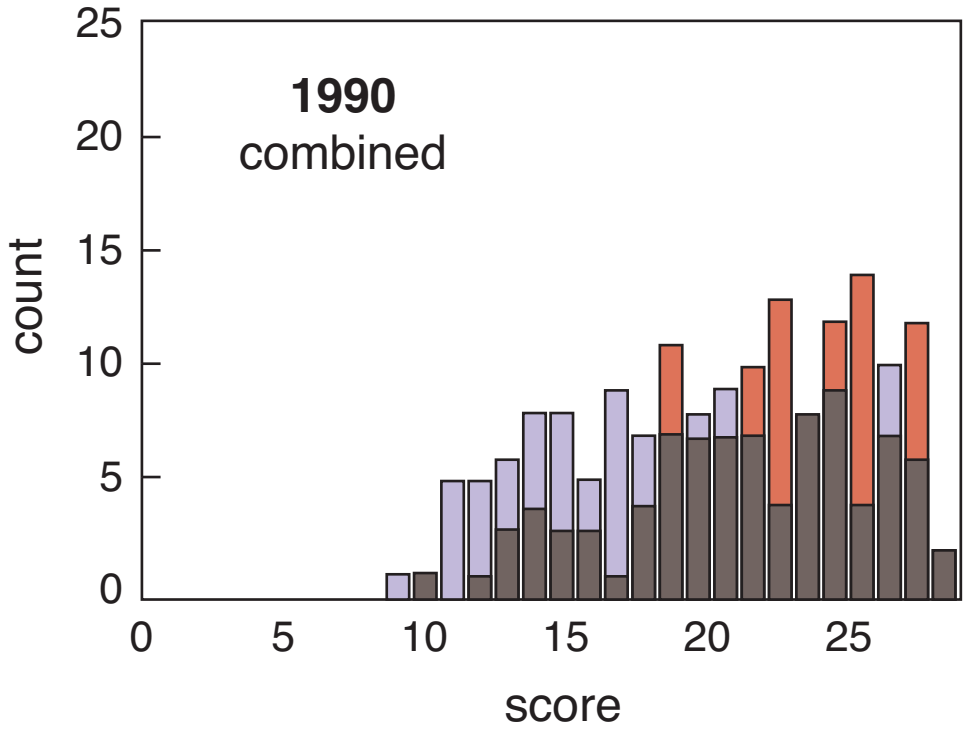
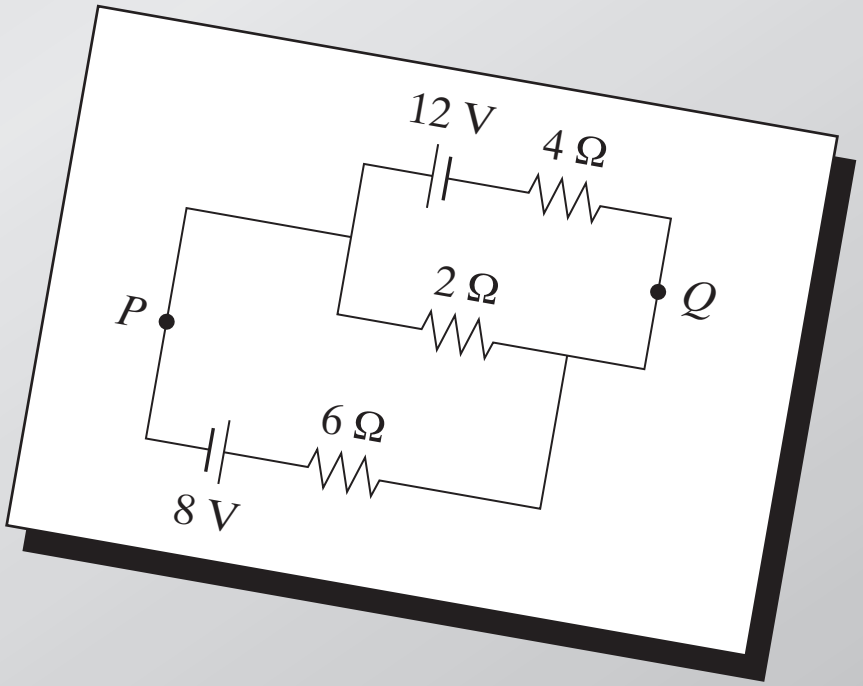


Education

conventional problems misleading



Education

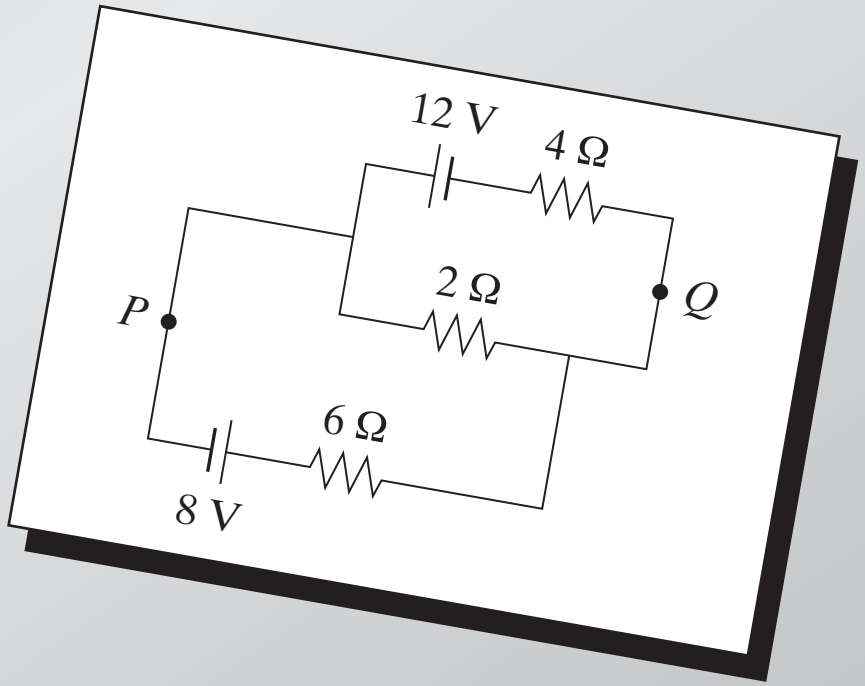
conventional problems misleading

Calculate:

(*a*) current in 2-Ω resistor

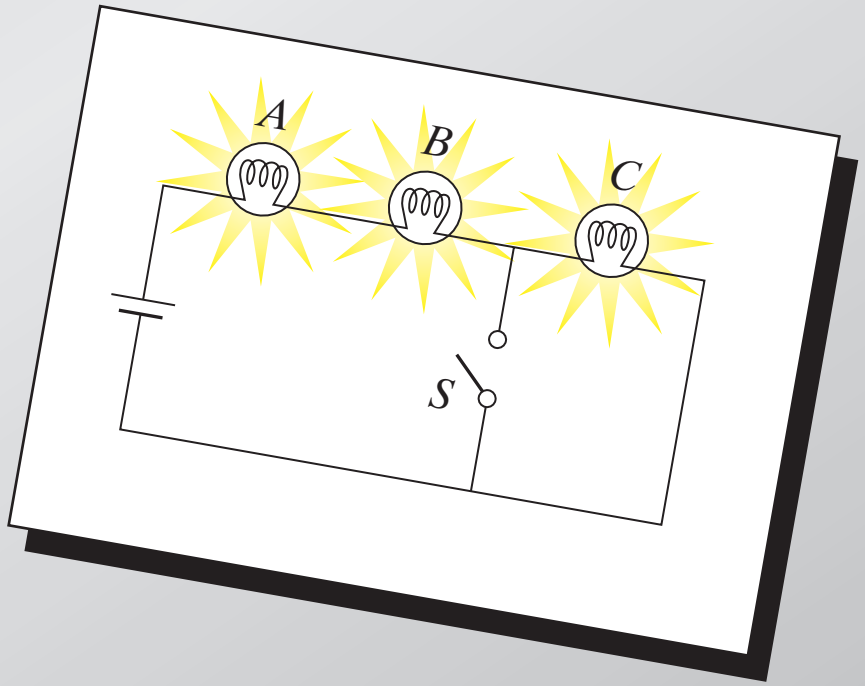
(*b*) potential difference

between *P* and *Q*



Education

are the basic principles understood?



Education

are the basic principles understood?

When *S* is closed, what happens to:

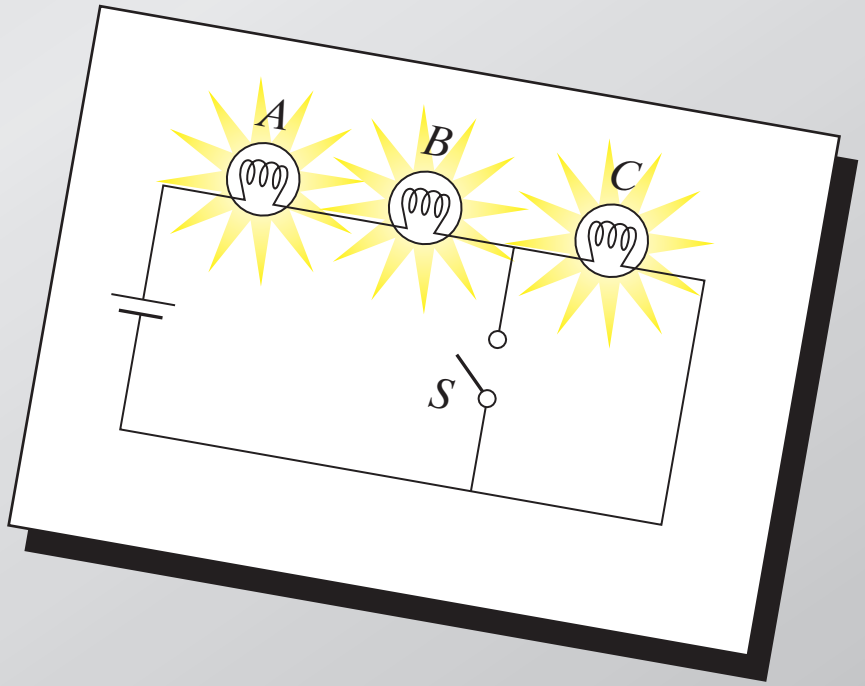
(*a*) intensities of A and B?

(*b*) intensity of C?

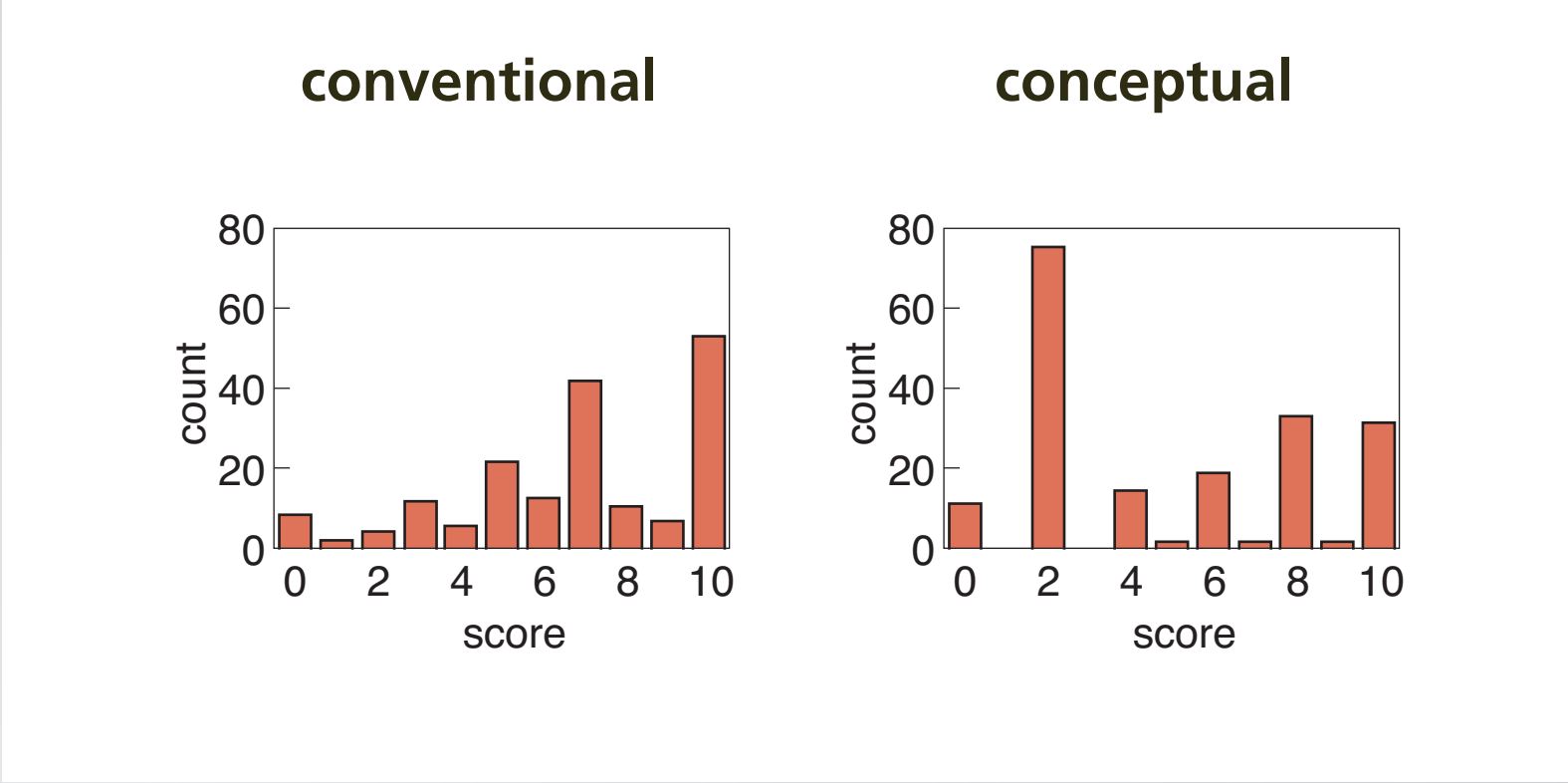
(*c*) current through battery?

(*d*) potential difference across *A*, *B*, and *C*?

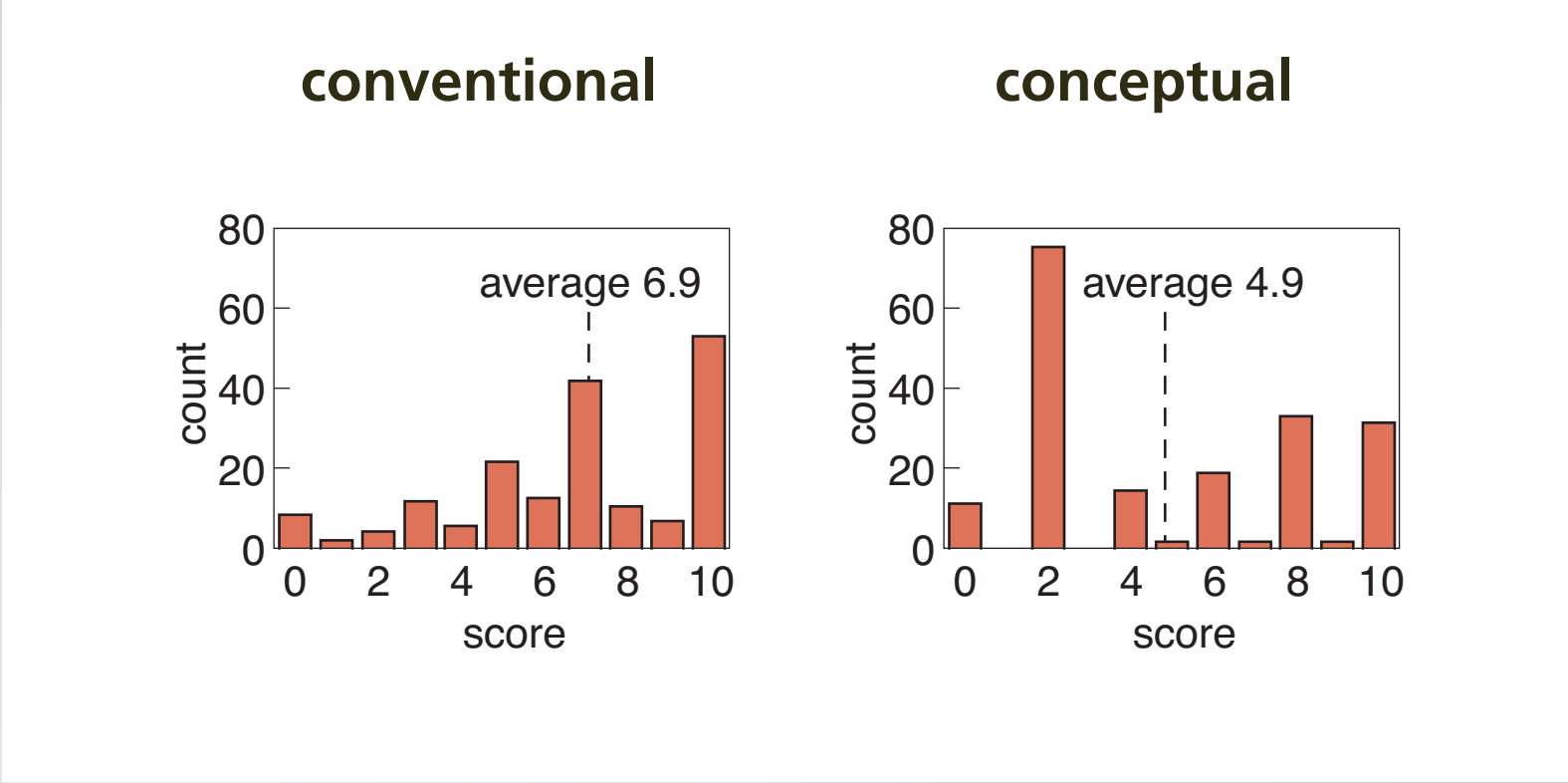
(*e*) the total power dissipated?



Education



Education


conventional
conceptual
80
60
40
20
0
count
average 6.9
average 4.9
0
2
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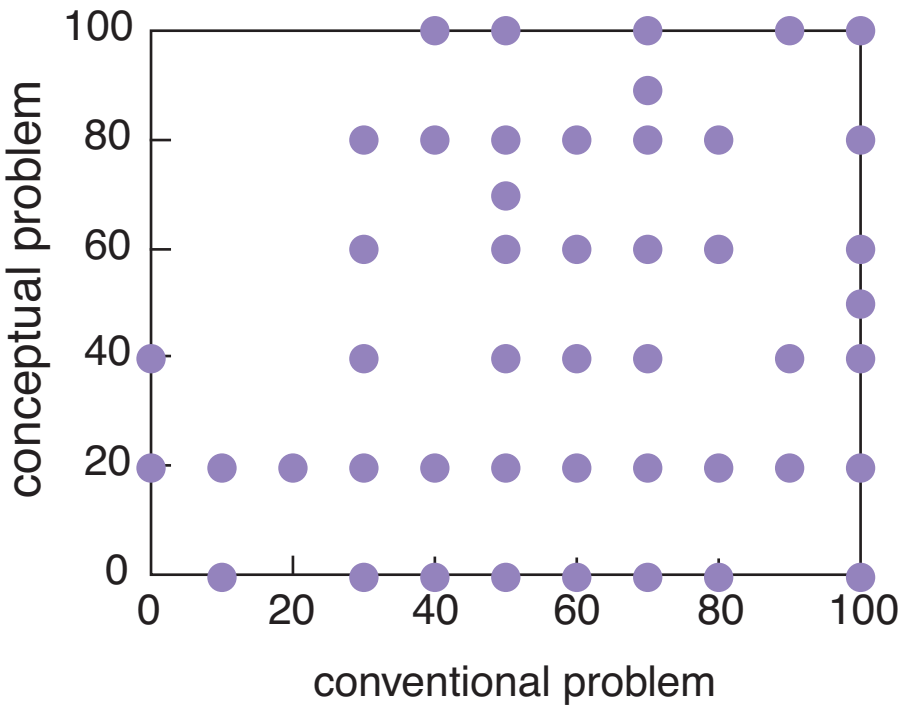
6
8
10
score

Education


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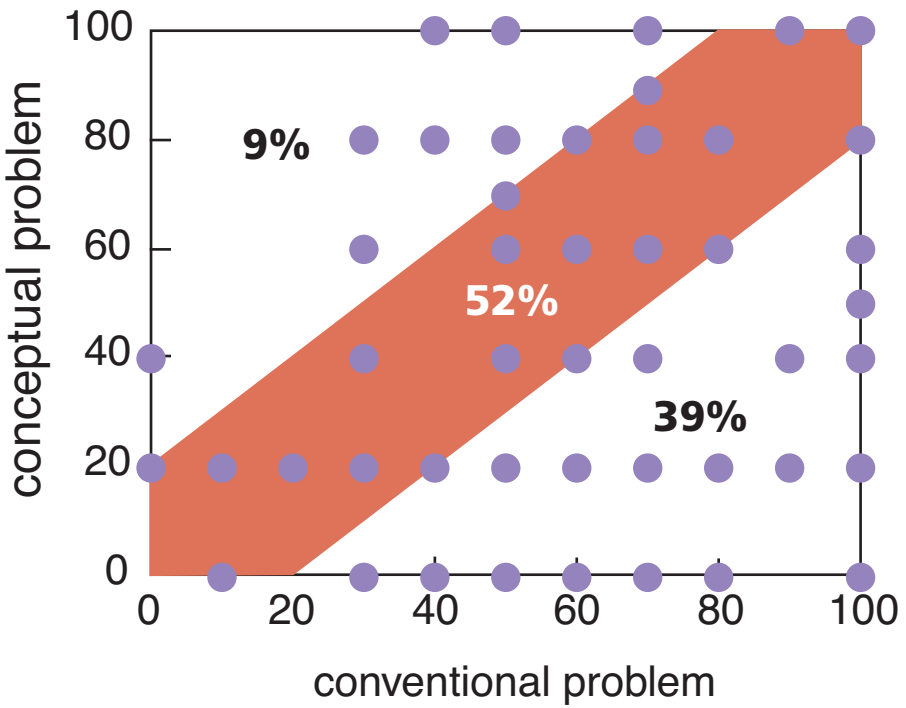
20
0
conceptual problem
0
20
40
60
80
100
conventional problem

Education


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


So what should we do?

Peer Instruction

Give students more responsibility for gathering information…

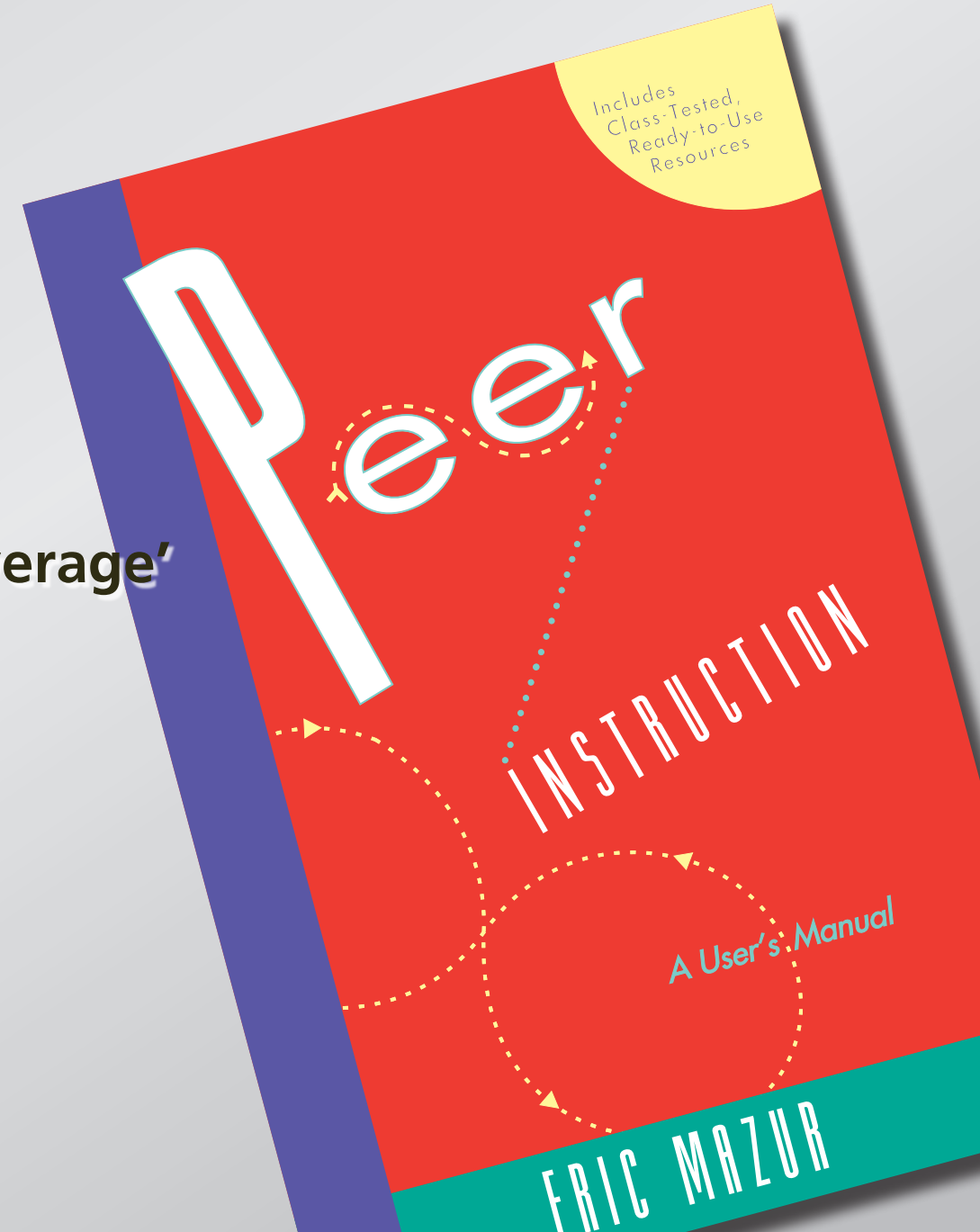
Peer Instruction

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

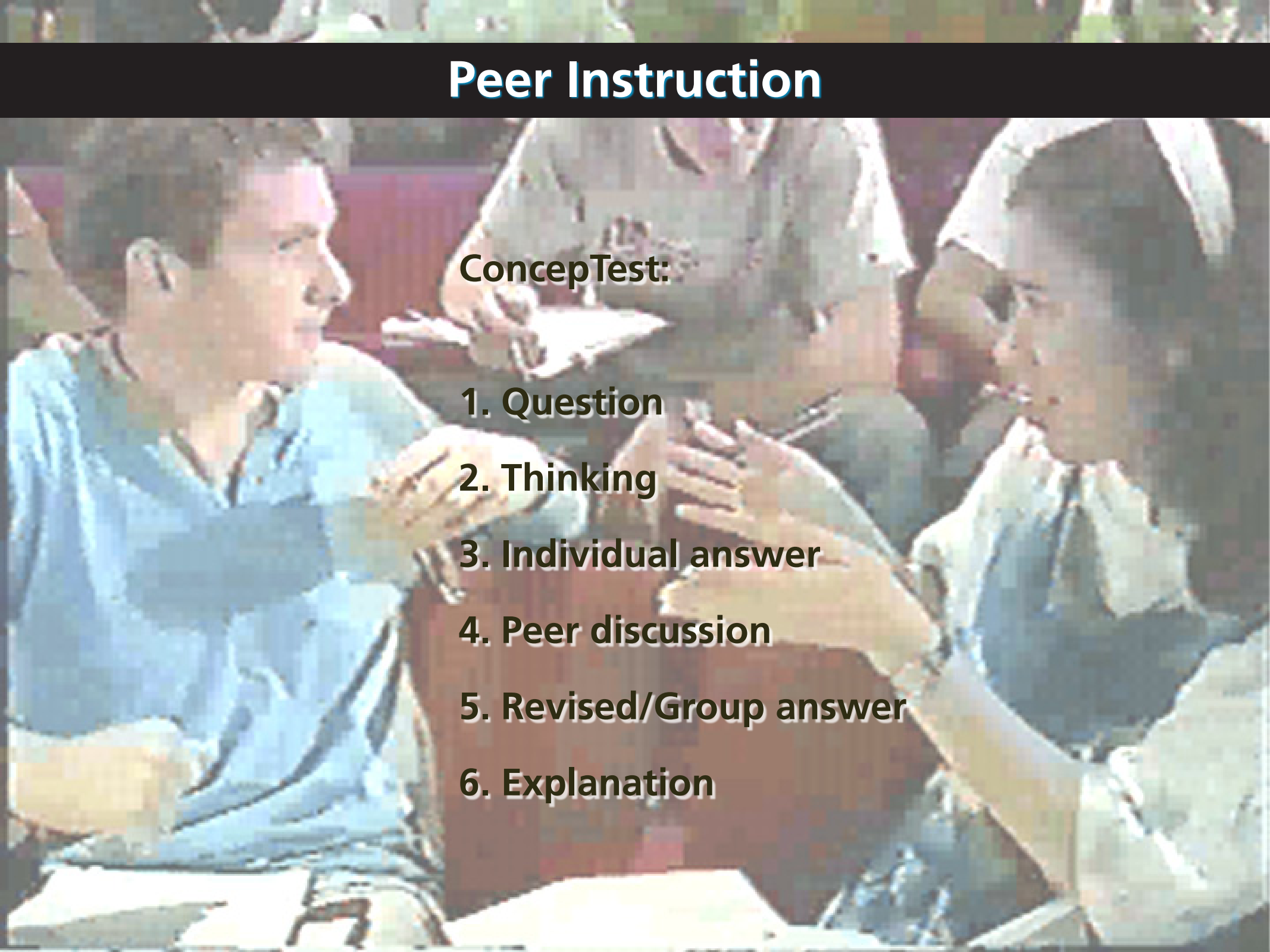
Peer Instruction

Main features:

- **pre-class reading**
- **in-class: depth, not ‘coverage’**
- **ConcepTests**



Peer Instruction

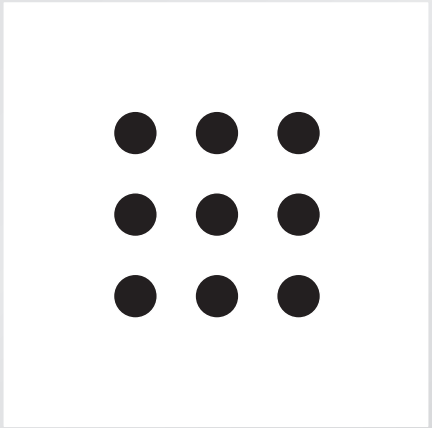


ConcepTest:

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

Let's try it!

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



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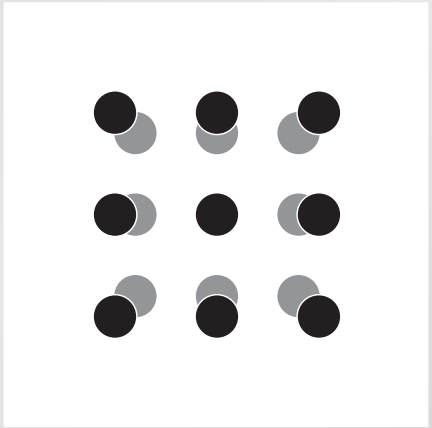
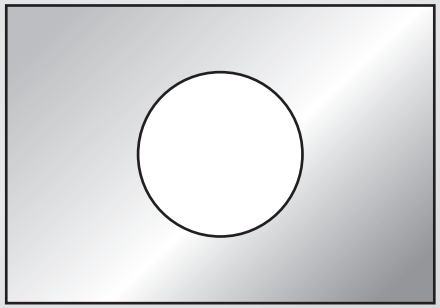


Let's try it!

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



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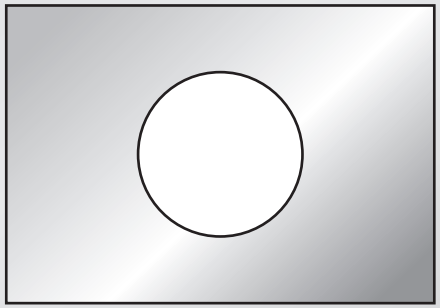


When the plate is uniformly heated, the diameter of the hole

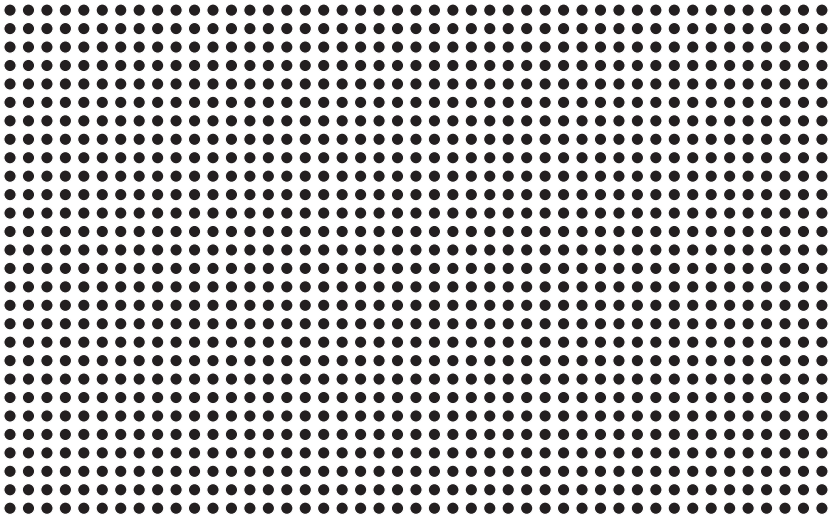
1. increases.
2. stays the same.
3. decreases.

Let's try it!

It's easy to fire up the audience!

Let's try it!

remember: all atoms must get farther away from each other!



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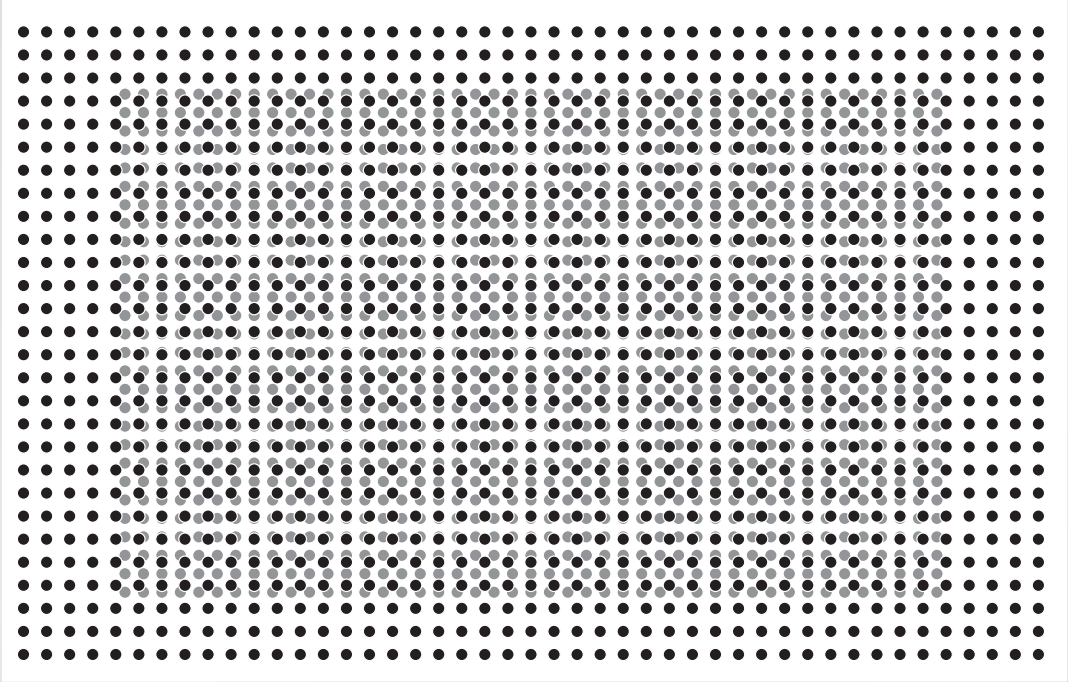
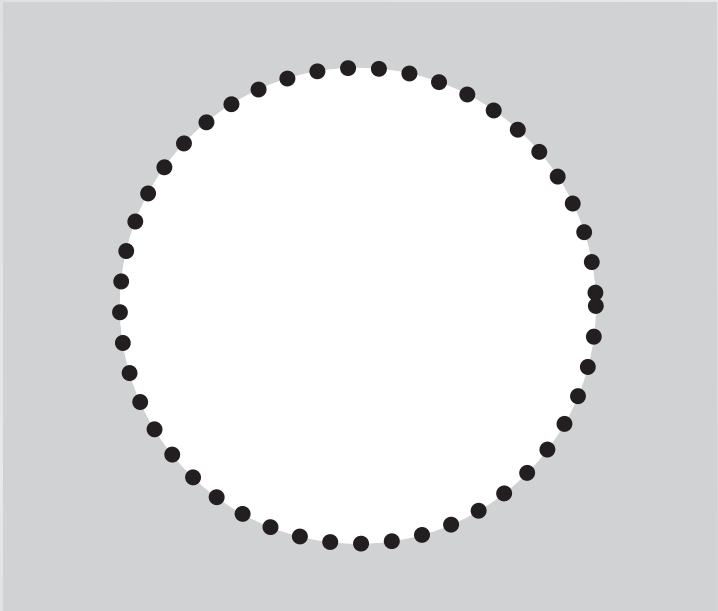


Let's try it!

consider the atoms at the rim of the hole



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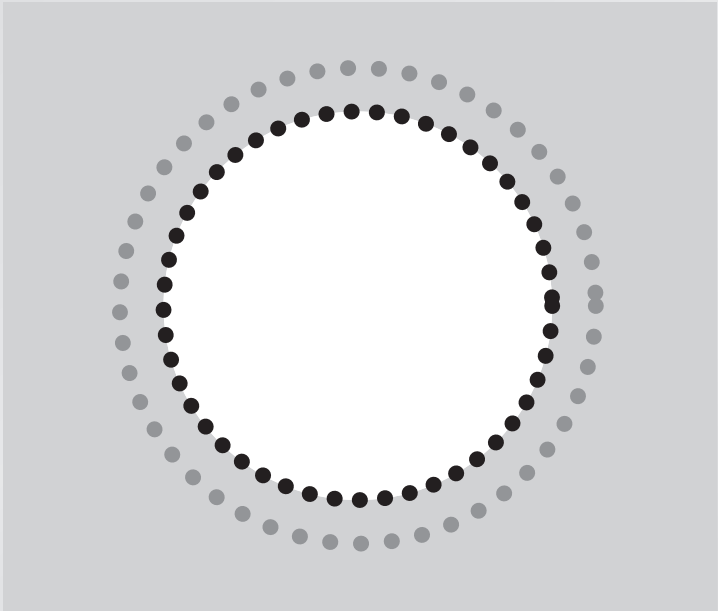

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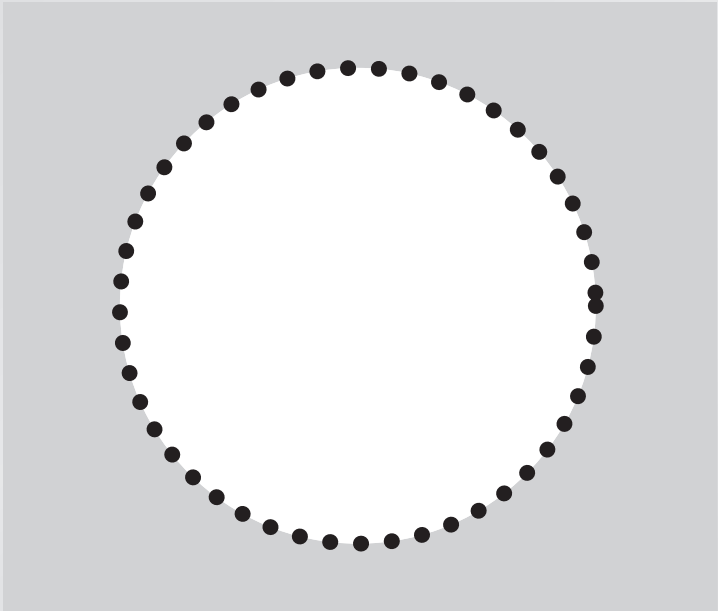

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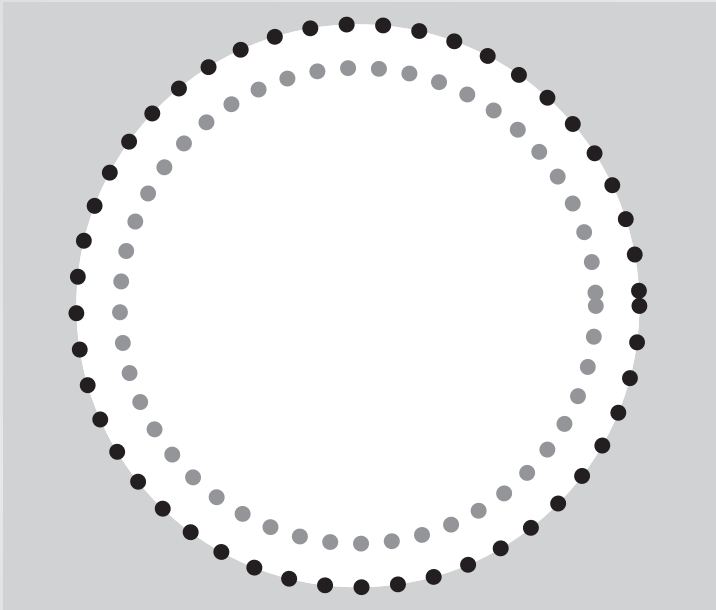
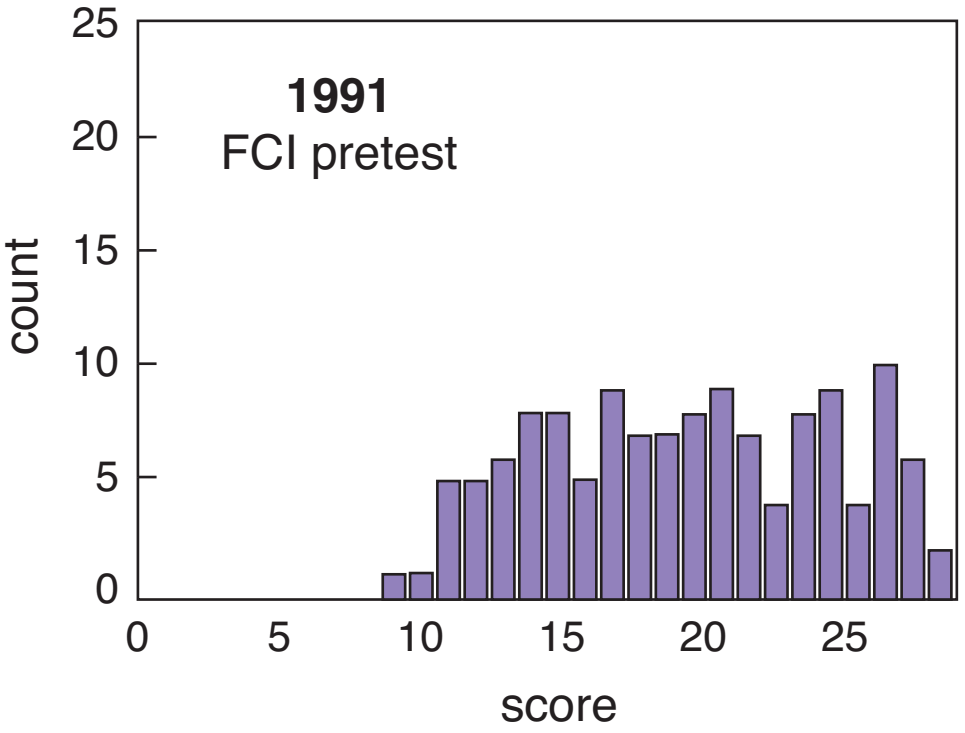


Results

is it any good?

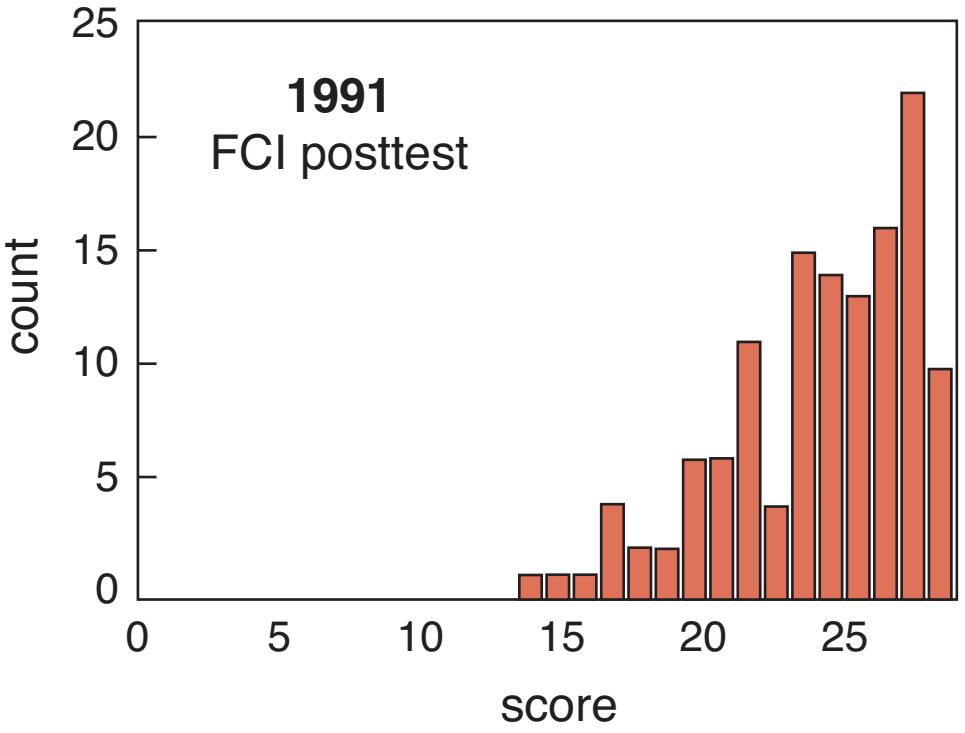
Results

first year of implementing PI



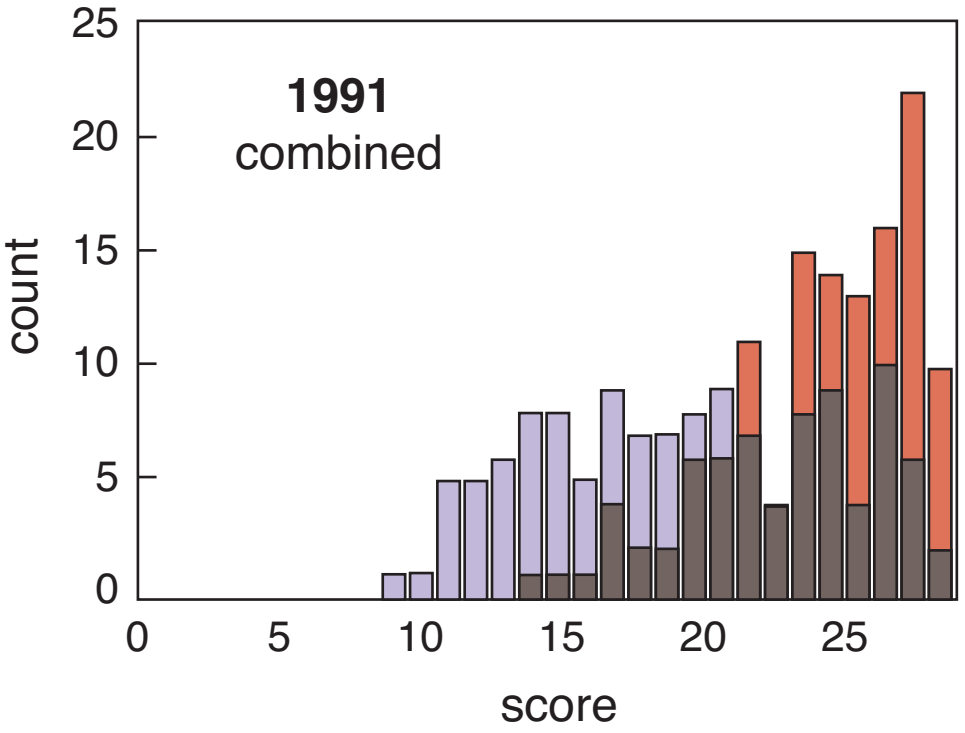
Results

first year of implementing PI



Results

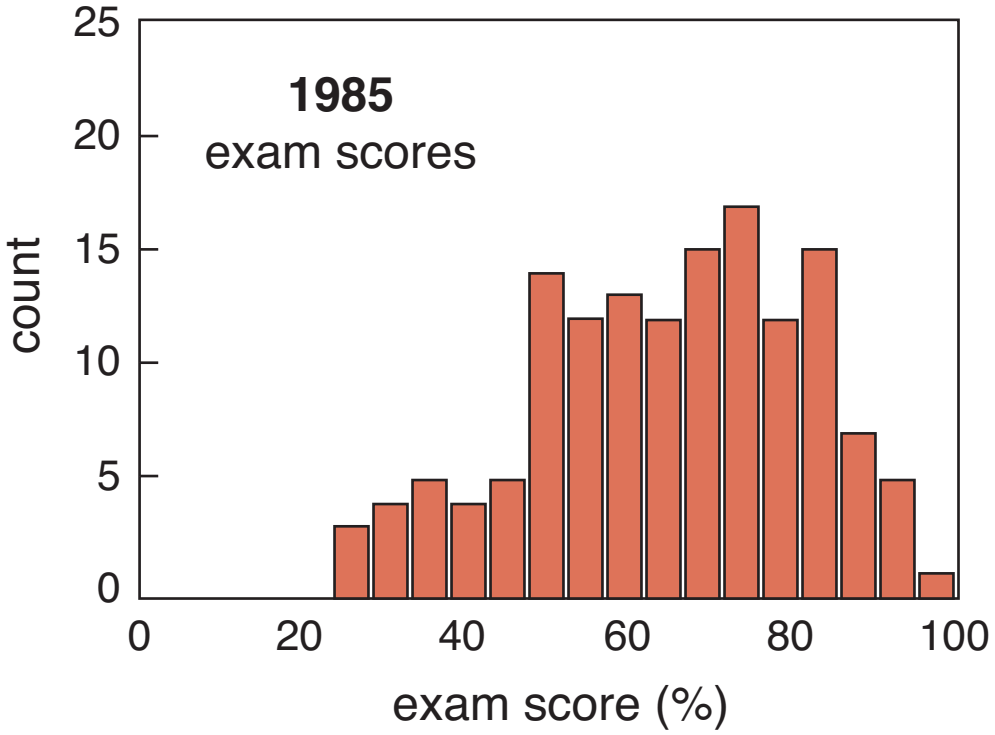
first year of implementing PI



Results

what about problem solving?

Results


1985
exam scores
count
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40
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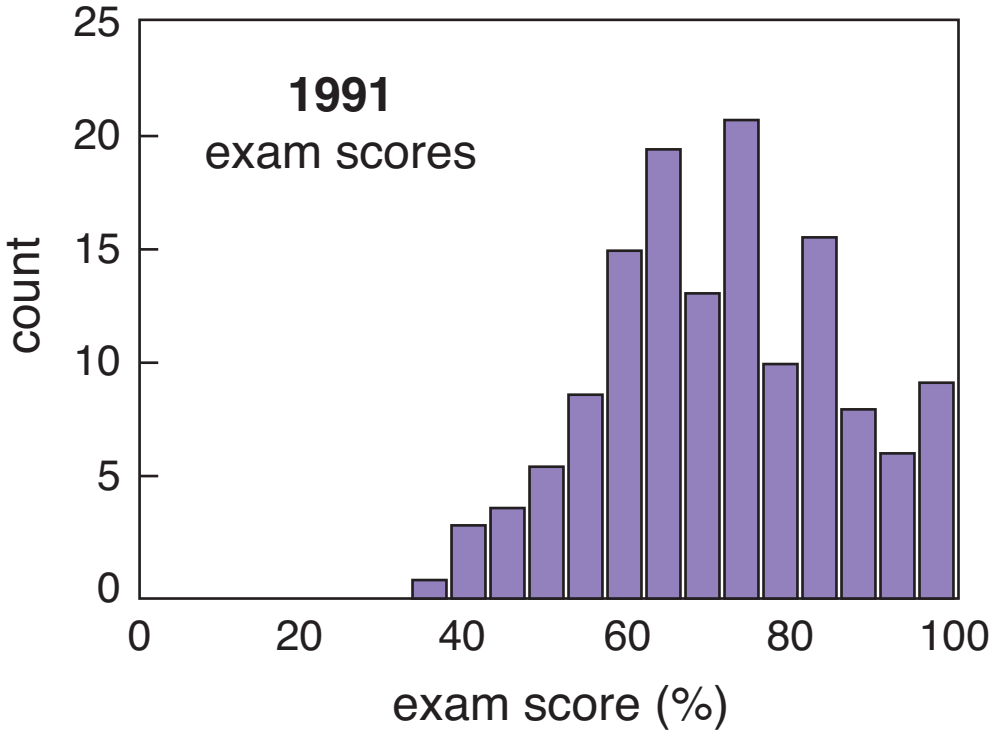
100
exam score (%)

Results


1991
exam scores
count
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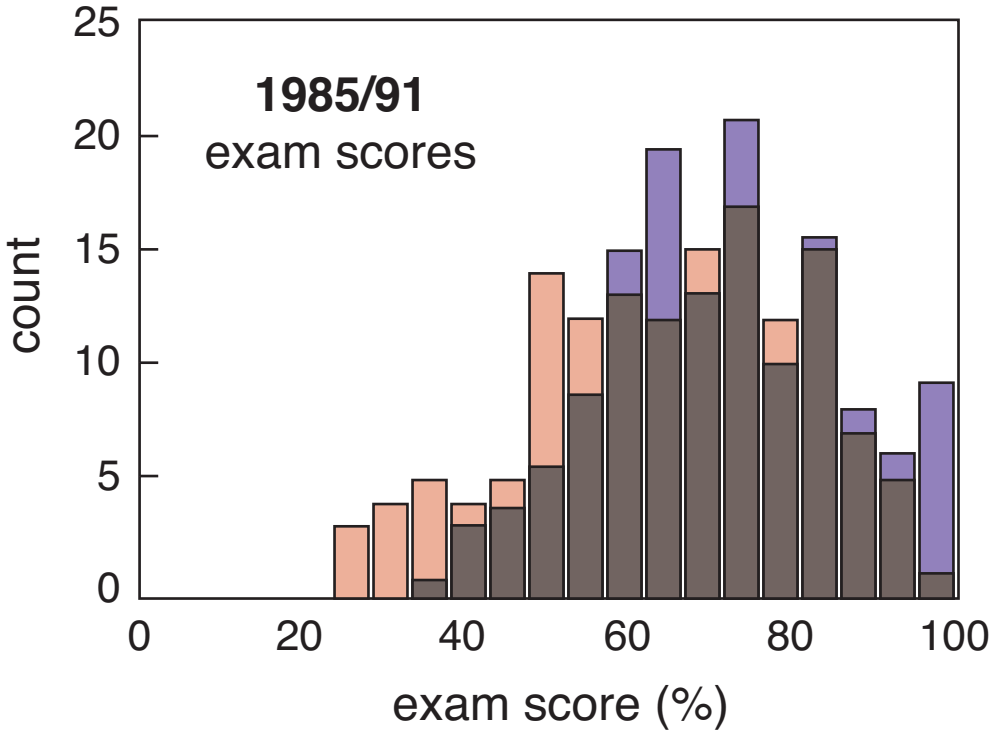
80
100
exam score (%)

Results


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

Conclusion

So better understanding leads to better problem solving!

Conclusion

So better understanding leads to better problem solving!

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

Summary

Education is no longer about transferring information

Nurture innovation by

- making students develop arguments
- stimulating creativity and teamwork

Funding:

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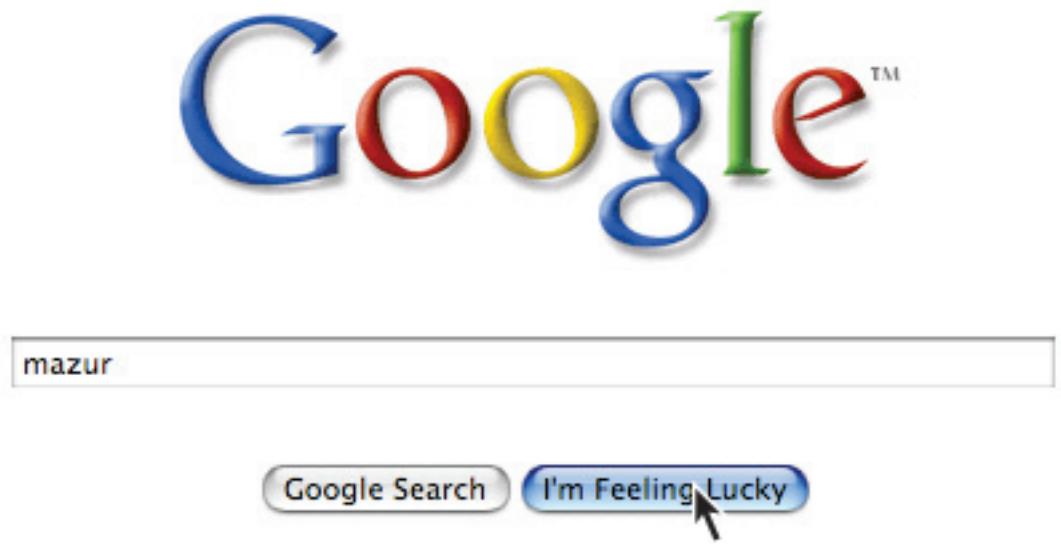
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