Memorization or understanding: are we teaching the right thing?
Get your clickers ready!

- no ON/OFF button
- only last “click” counts
- display shows recorded answer

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unique ID on back of clicker

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Think of something you are good at — something that you know you do well.
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. trial and error
2. lectures
3. practicing
4. apprenticeship
5. other
How we teach...
Learning spaces
Learning spaces
Some people talk in their sleep.
Some people talk in their sleep.

Lecturers talk while other people are sleeping.

Albert Camus
Education
lectures focus on information transfer...
education is not just information transfer

[Bar chart showing data from 1990 FCI pretest]
education is not just information transfer
education is not just information transfer
conventional problems misleading
conventional problems misleading

Calculate:

(a) current in 2-Ω resistor
(b) potential difference between $P$ and $Q$
are the basic principles understood?
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?
conventional

conceptual

average 6.9

average 4.9
Education

A graph comparing conceptual and conventional problem-solving abilities shows the following:

- 9% of students solve both types of problems.
- 52% of students solve conventional problems but not conceptual problems.
- 39% of students solve conceptual problems but not conventional problems.

The graph illustrates a noticeable gap between the two types of problem-solving abilities, with a higher percentage of students performing better in conventional problems than in conceptual problems.
So what should we do?
Give students more responsibility for gathering information...
Give students more responsibility for gathering information... so we can better help them assimilate it.
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

ConcepTest
Peer Instruction

- brief presentation
- ConcepTest
- clicker poll 1
Peer Instruction

brief presentation

ConcepTest

clicker poll 1

> 70% correct
Peer Instruction

brief presentation

ConcepTest

clicker poll 1

> 70% correct

explanation
Peer Instruction

1. Brief presentation
2. Concept Test
3. Clicker poll 1
   - If > 70% correct:
     - Explanation
     - Repeat from start
Peer Instruction

brief presentation

ConcepTest

clicker poll 1

30–70% correct

> 70% correct

explanation

repeat from start
Peer Instruction

1. Brief presentation
2. ConcepTest
3. Clicker poll 1
   - 30–70% correct: Peer discussion
   - > 70% correct: Explanation, repeat from start
Peer Instruction

- Brief presentation
- ConceptTest
- Clicker poll 1
  - 30–70% correct
  - > 70% correct
  - Explanation
  - Repeat from start
- Peer discussion
- Clicker poll 2
Peer Instruction

brief presentation

ConcepTest

clicker poll 1

< 30% correct

30–70% correct

peer discussion

> 70% correct

explanation

repeat from start

clicker poll 2
Peer Instruction

brief presentation

ConcepTest

clicker poll 1

< 30 % correct

revisit concept

30–70% correct

peer discussion

> 70% correct

explanation

revisit concept

clicker poll 2

repeat from start
Peer Instruction

brief lecture

ConcepTest

clicker poll 1

< 30% correct

revisit concept

30–70% correct

peer discussion

> 70% correct

explanation

repeat from start

clicker poll 2
Let’s try it!

thermal expansion
Let's try it!

When metals heat up, they expand because all atoms get farther away from each other.
Let’s try it!

When metals heat up, they expand because all atoms get farther away from each other.
Let’s try it!

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

you got all fired up!
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.
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.
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

you won't forget this
is it any good?
Results

first year of implementing PI

![Bar chart showing 1991 FCI pretest results](chart.png)
Results

First year of implementing PI

1991 FCI posttest
Results

first year of implementing PI

![Graph showing the results for the first year of implementing PI]
what about problem solving?
Results

Exam scores for 1985:

- 1985 exam scores
- Count
- Exam score (%)
Results

1991 exam scores

25 20 15 10 5 0

0 20 40 60 80 100

exam score (%)

count

0 5 10 15 20 25
1985/91 exam scores
So better understanding leads to better problem solving!
So better understanding leads to better problem solving!

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