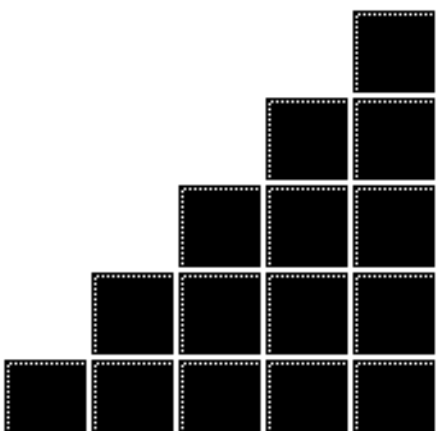

VE
RI
TAS

UNDERSTANDING OR MEMORIZATION: ARE WE TEACHING THE RIGHT THING?

Eric Mazur
Harvard University

HKUST
30 October 1998



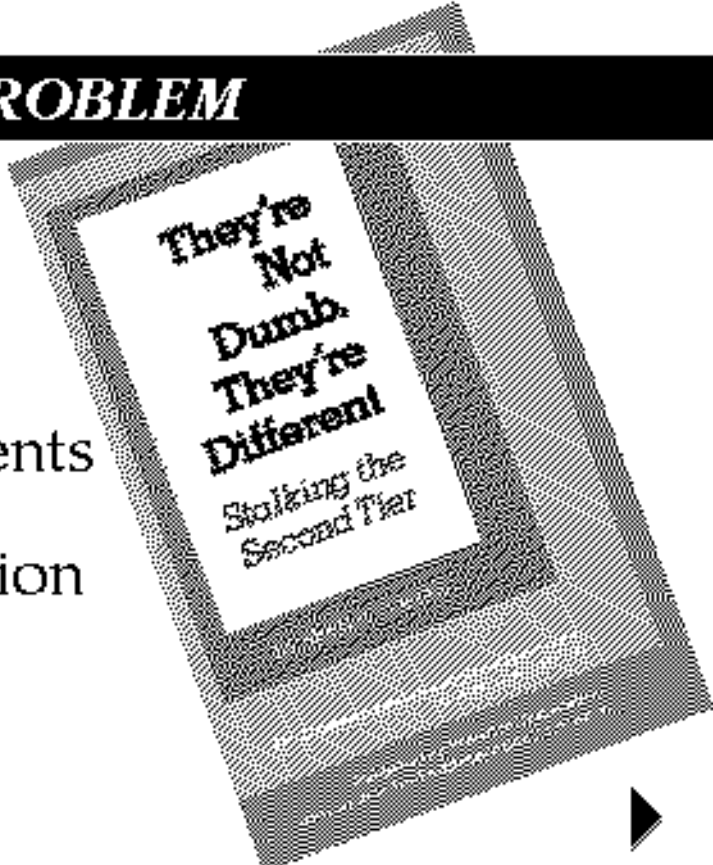
❶ Problem

❷ Cause

❸ Remedy

THE PROBLEM

- frustration
- lower enrollments
- lack of innovation



FRUSTRATION

FRUSTRATION

"In a perfect world...

...algebra *would actually come in handy."*

FRUSTRATION

FRUSTRATION

Hot is a relative term. Given temperatures rise regardless of mass. Galileo observed rising temperatures will decrease with the exposure of an endothermic source. True transparence will persist until this one irresistible calorie interacts thus altering the system.

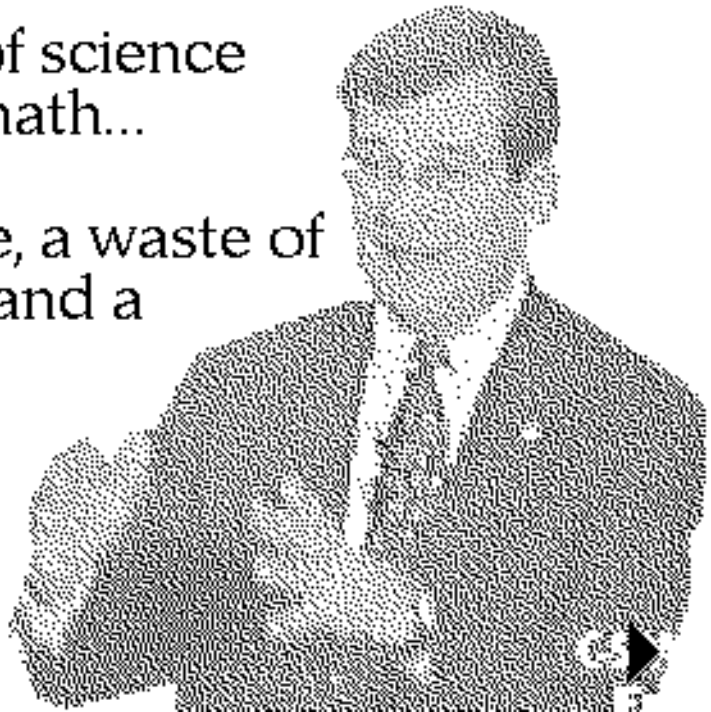
FRUSTRATION

FRUSTRATION

"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*?"



FRUSTRATION

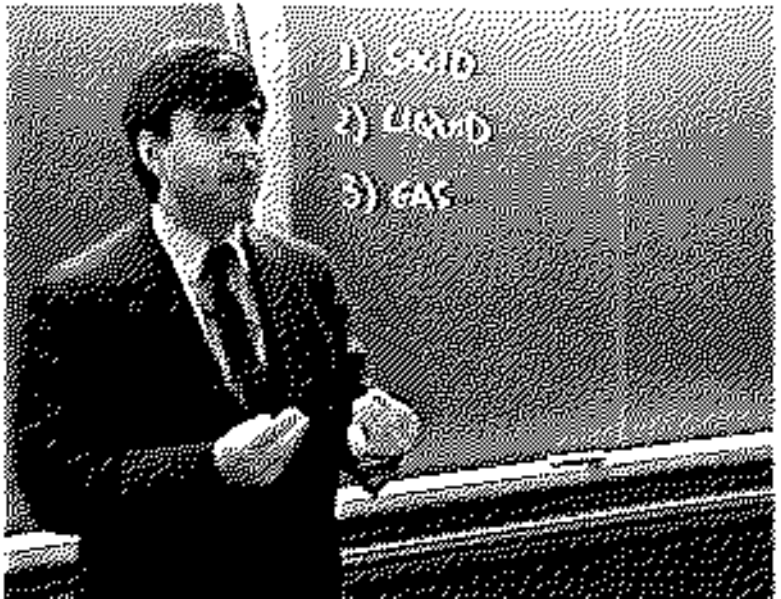
❶ Problem

❷ Cause

❸ Remedy

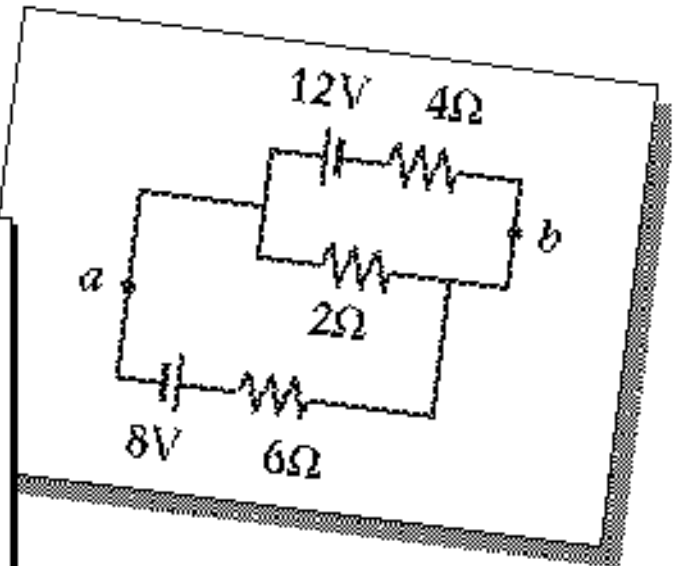
THE CAUSE

Are we teaching the right thing...?



THE CAUSE

Traditional question:



Calculate:

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

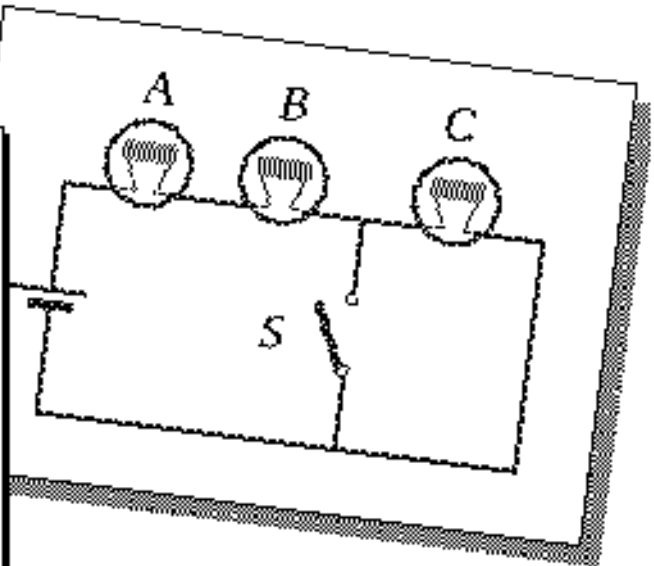
(*b*) the potential difference between points *a* and *b*.

THE CAUSE

Conceptual question:

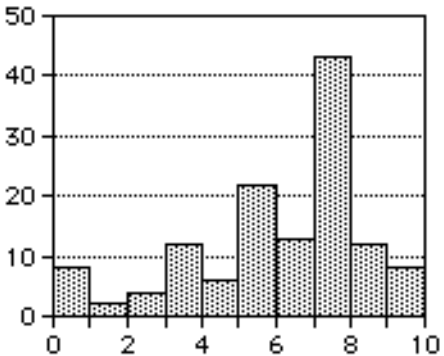
When S is closed, what happens to the:

(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?

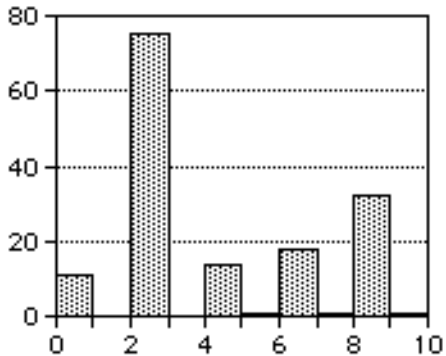


THE CAUSE

Results

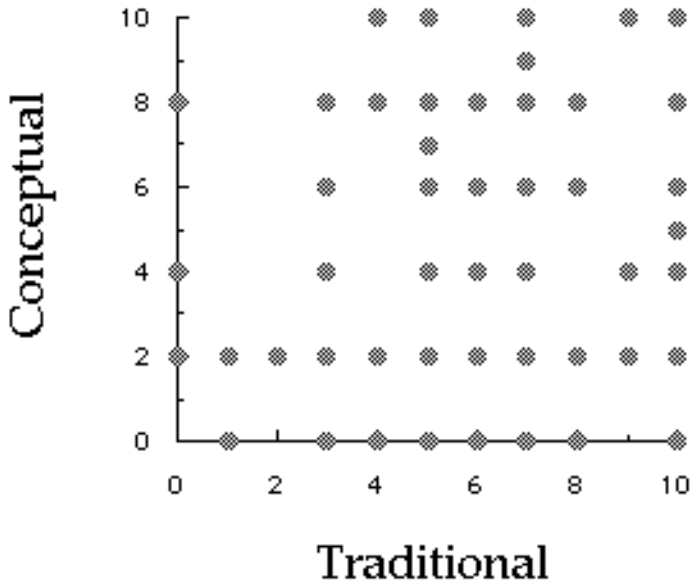


Traditional

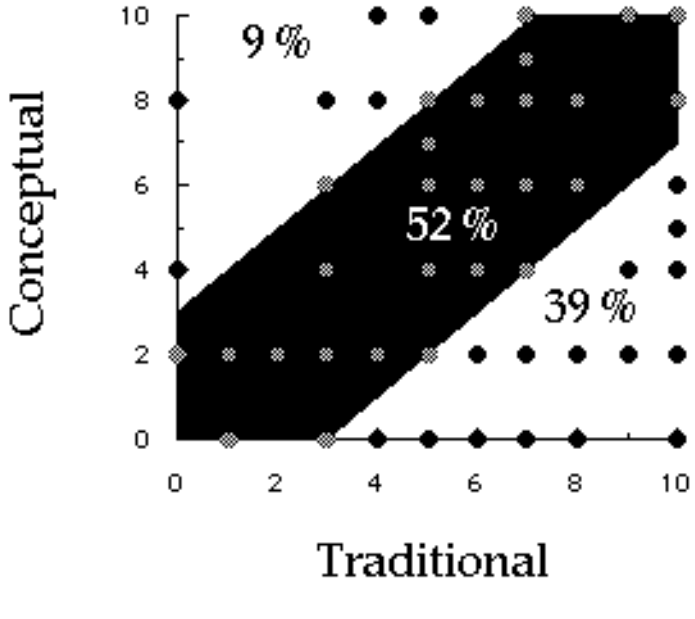


Conceptual

THE CAUSE



THE CAUSE



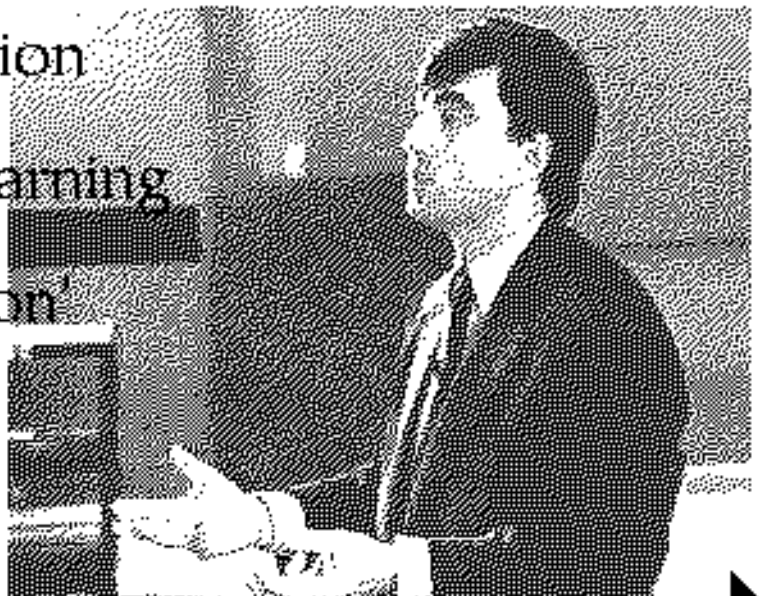
❶ Problem

❷ Cause

❸ Remedy

THE REMEDY

- 1-on-1 instruction
- small group learning
- 'Peer Instruction'



THE REMEDY

Peer Instruction:

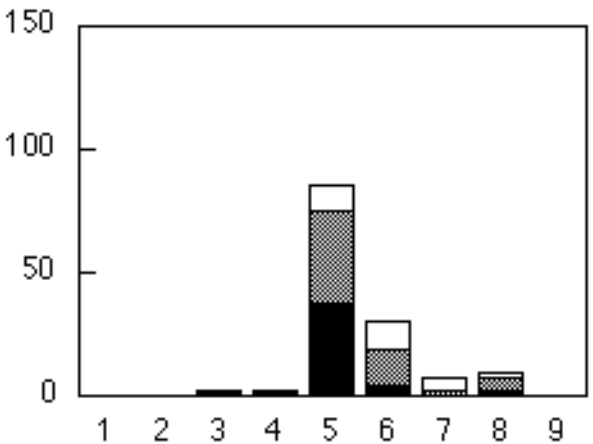
- Reading assignments
- Lectures
- 'ConcepTests'
- Feedback

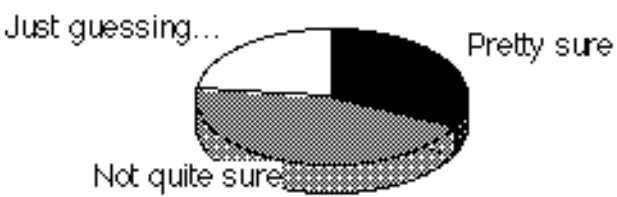
THE REMEDY

PEER INSTRUCTION

PEER INSTRUCTION

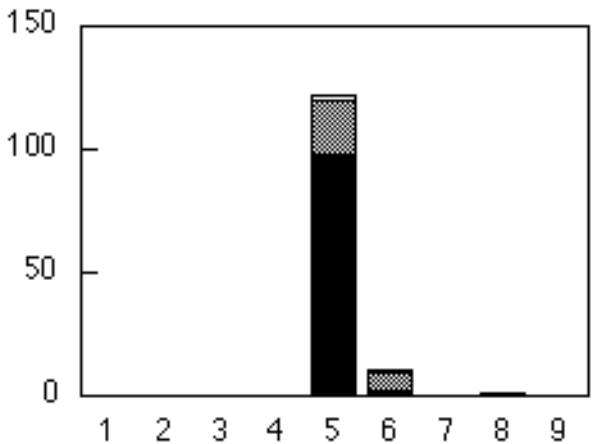
before:

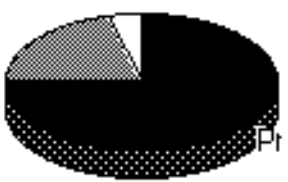




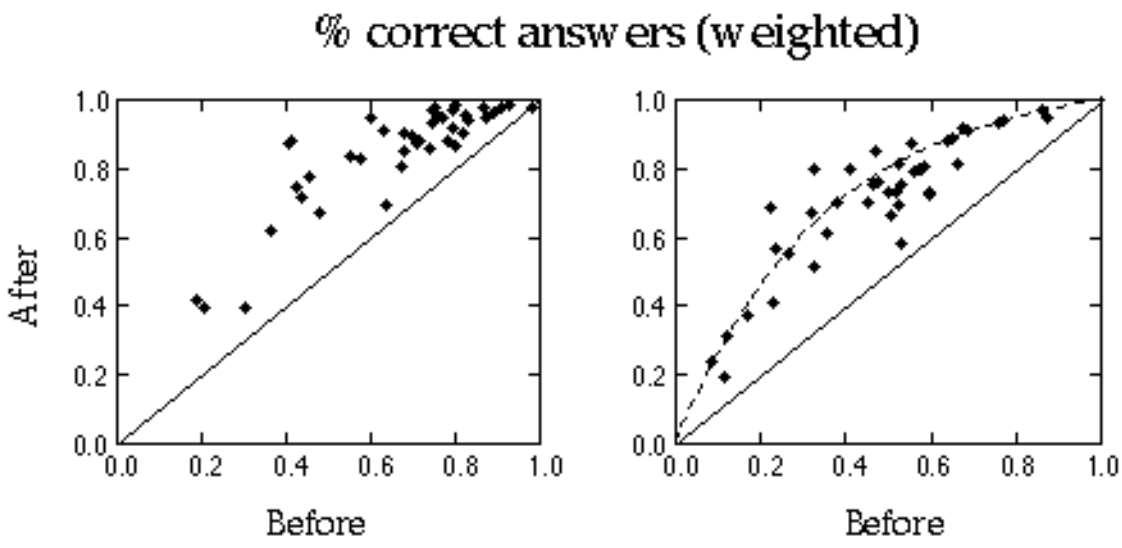
PEER INSTRUCTION

after:





PEER INSTRUCTION



THE REMEDY

Peer Instruction:

- Reading assignments
- Lectures
- 'ConcepTests'
- Feedback

FEEDBACK

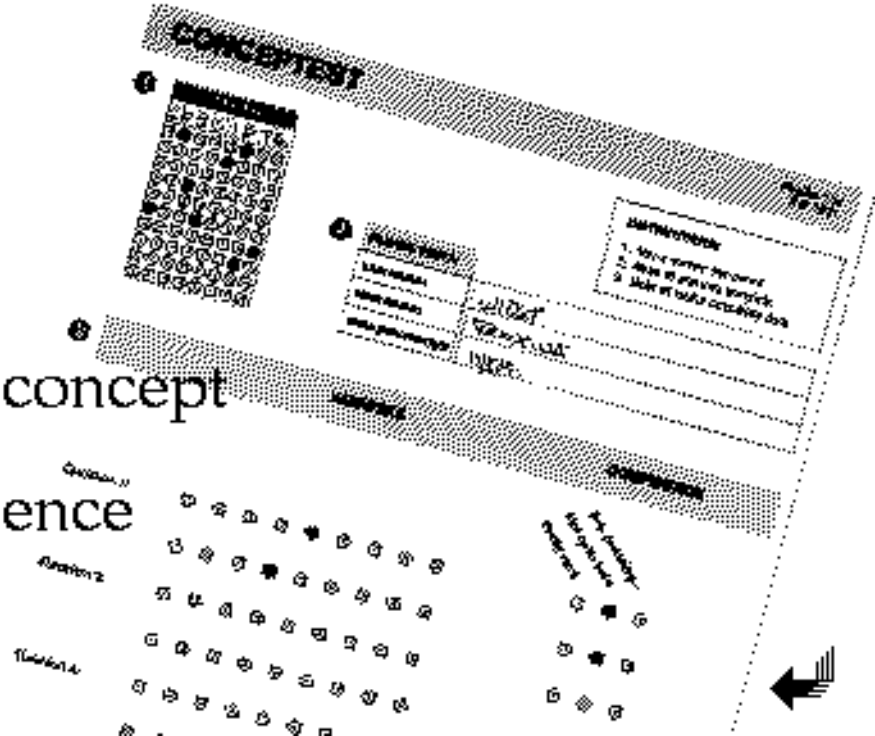
Methods:

- show of hands
- scanning forms
- hand-held computers
- computer testing

FORMS

Design:

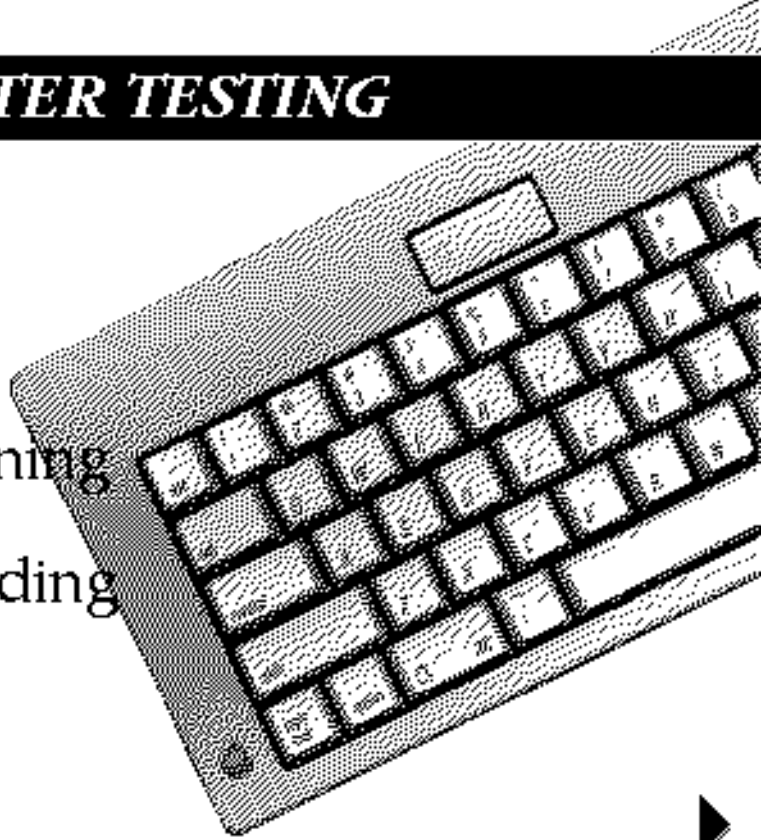
- test single concept
- test confidence



COMPUTER TESTING

Purpose:

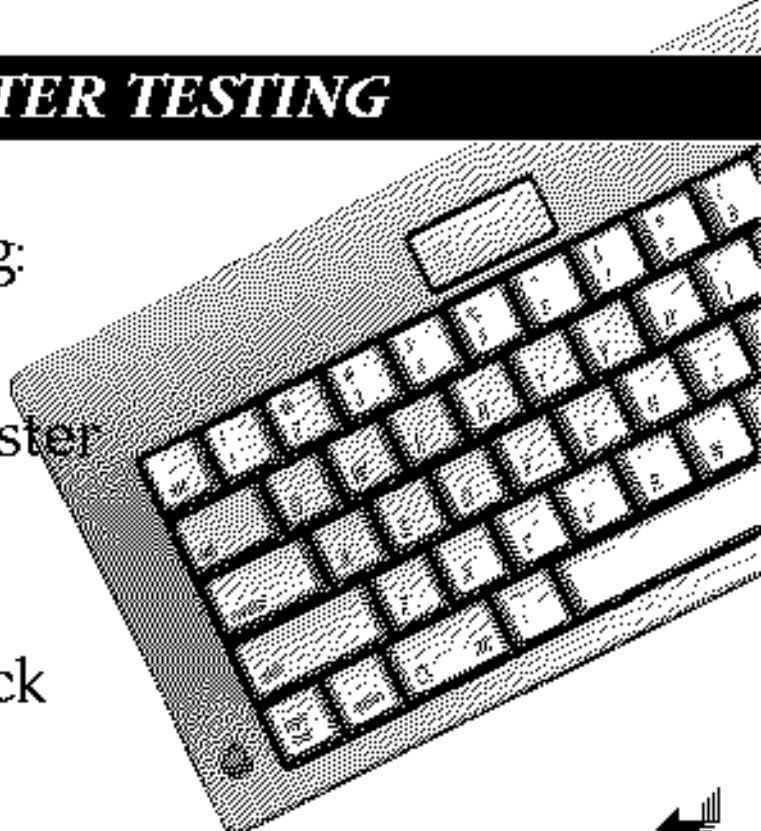
- 'measure' learning
- test understanding



COMPUTER TESTING

Automate testing:

- Easy to administer
- Instant results
- Instant feedback



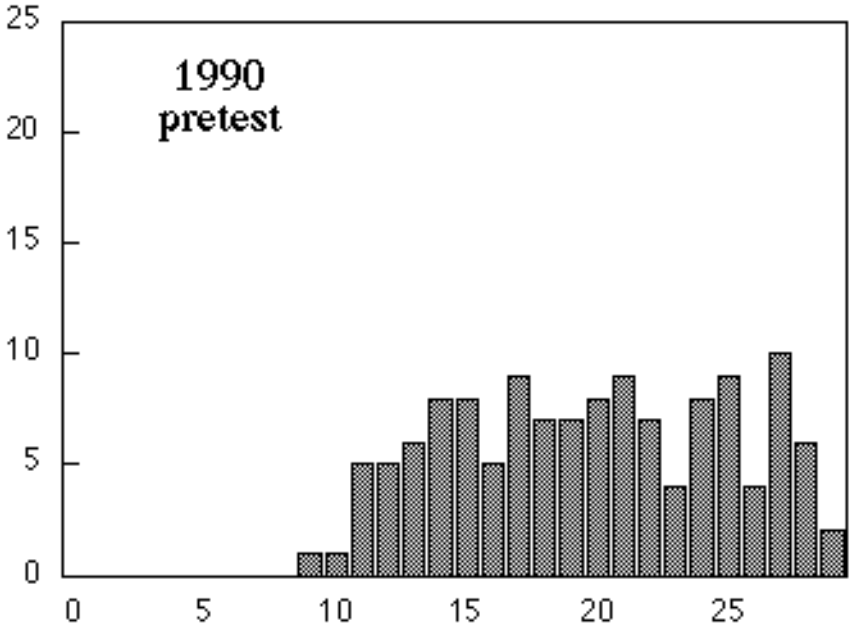
CLASSTALK

HP95LX

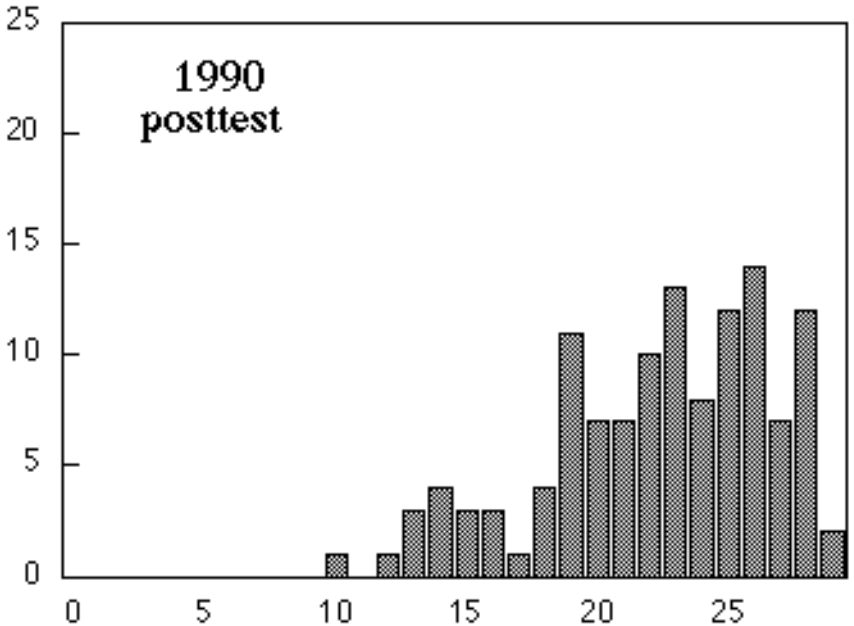
❶ Results

❷ Student reactions

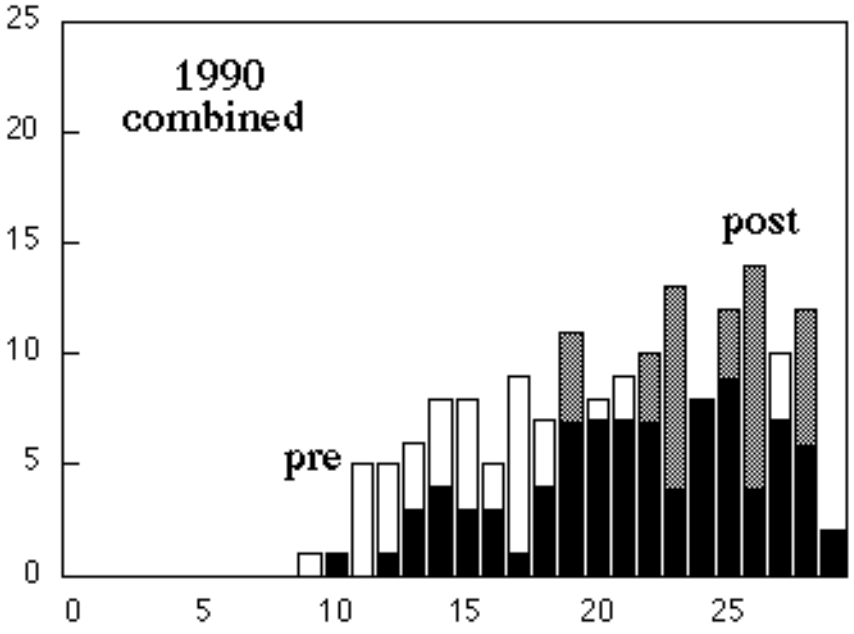
Results



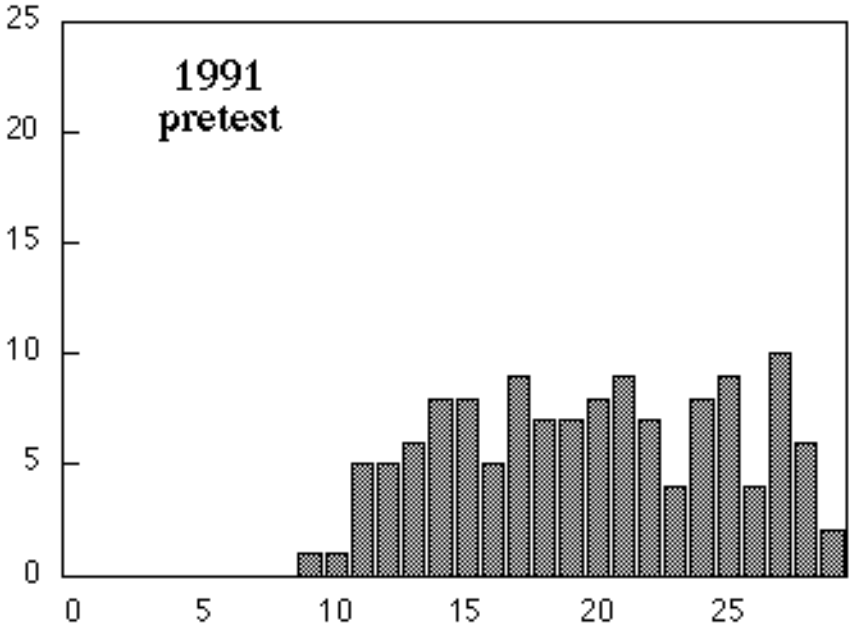
Results



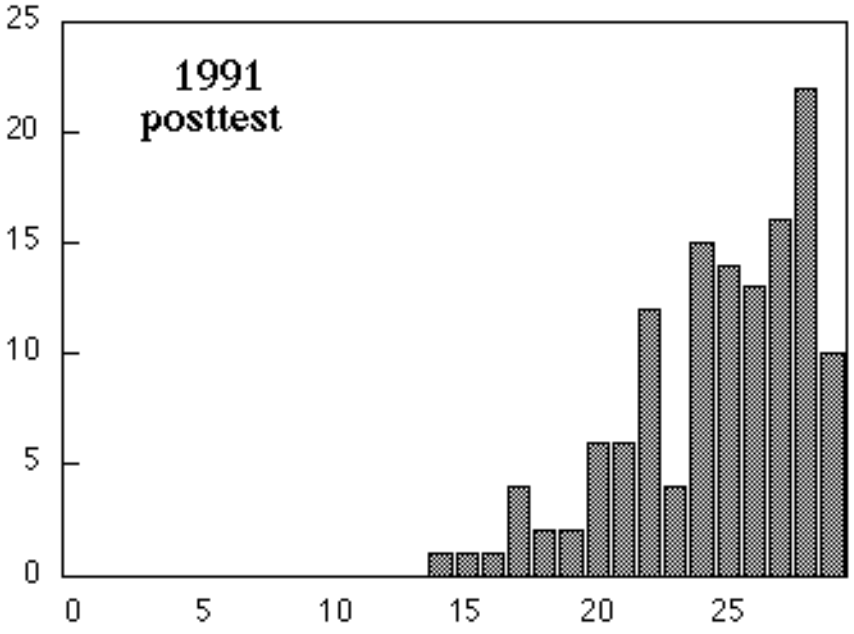
Results



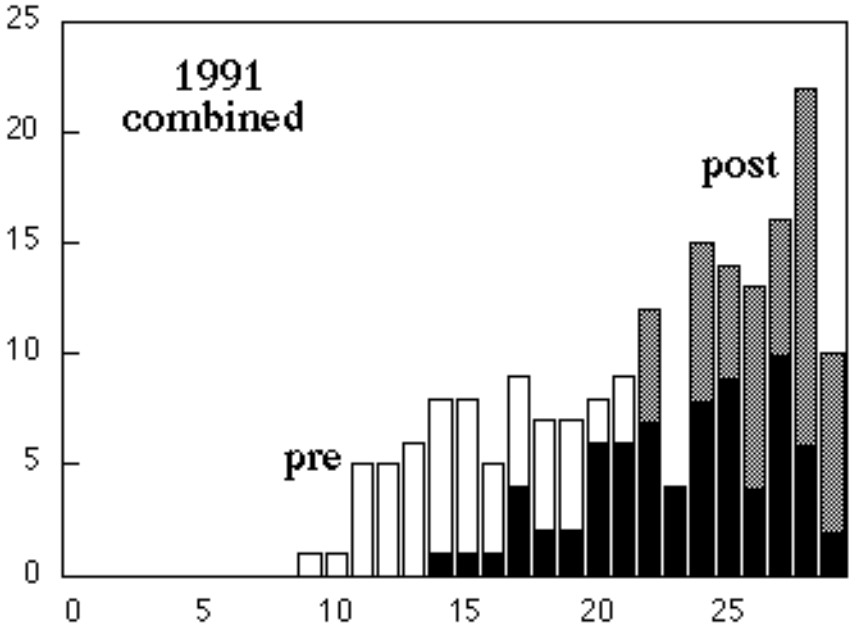
Results



Results



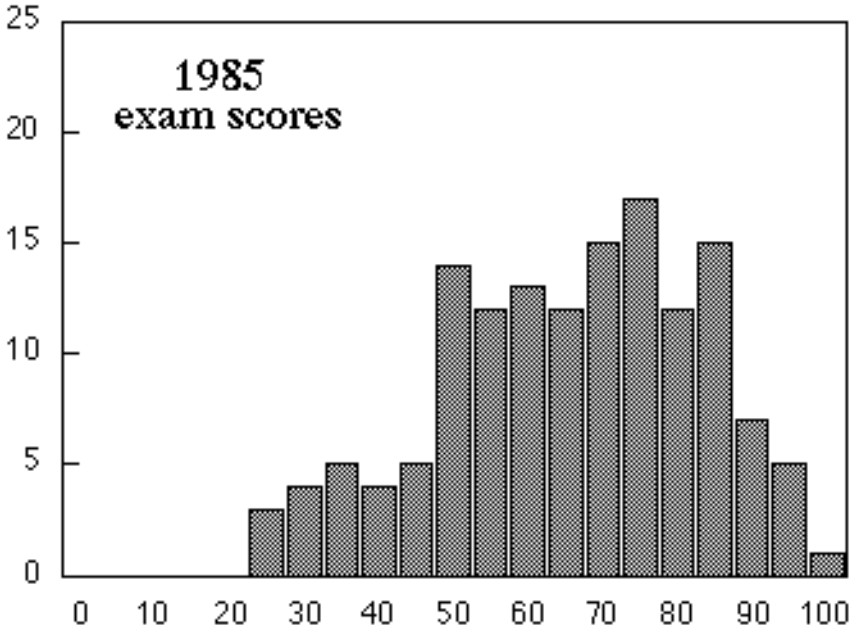
Results



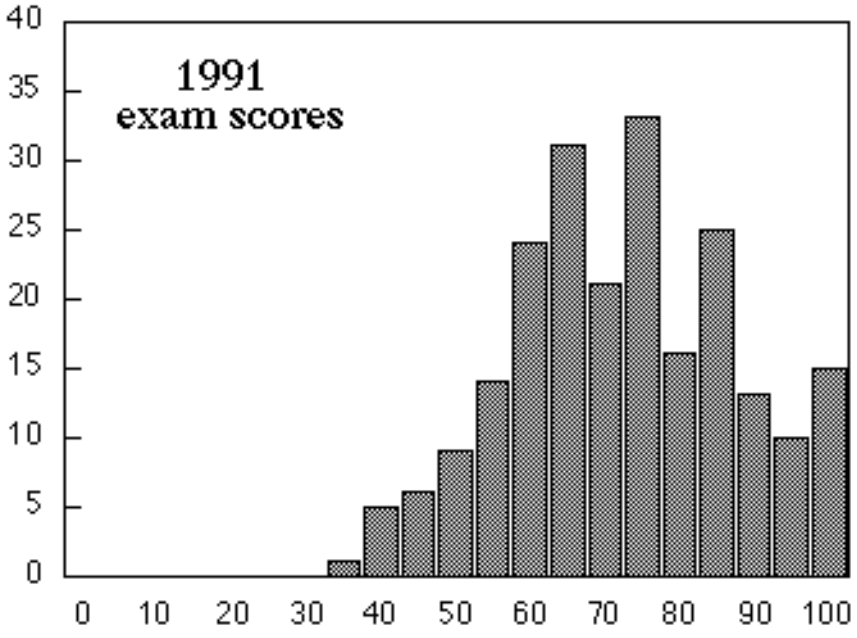
Results

What about problem solving...?

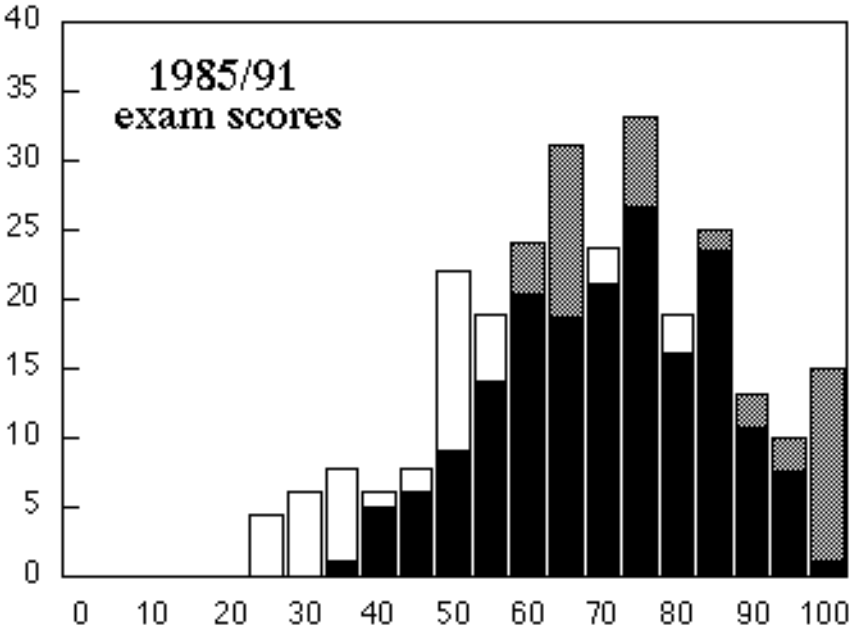
Results



Results


1991
exam scores
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

Results


1985/91
exam scores
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

STUDENT REACTIONS

Acknowledgments

Deborah Alpert (Harvard)
Michael Aziz (Harvard)
David Borthwick (Harvard)
Bob Flaherty (Apple)
David Hestenes (ASU)
Andrew McKinney (Harvard)
William Paul (Harvard)

http://galileo.harvard.edu

Thank you!