NC STATE UNIVERSITY
Physics Education R & D Group

Multiple Technologies to Address Multiple Instructional Needs

Robert Beichner

Overview

- What are the problems ?
- What is the best way to respond ?
- How did we get into this situation ?
- An “outside the (black) box” solution

What is the problem ?

Students don’t learn as much as we’d like.

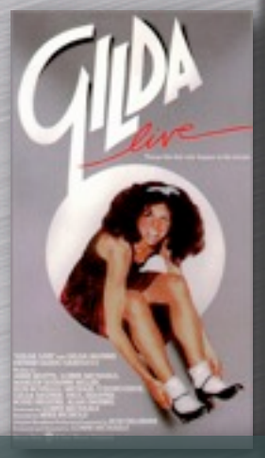
What is the problem ?

Sorry, video not available

Search YouTube for “Five Minute University”

“The 5-Minute University”

Don Novello as Father Guido Sarducci



from Gilda Live (1980)

Students don’t learn as much as we’d like.

What is the problem ?

Education is one of the few things a person is willing to pay for and not get.

William Lowe Bryan

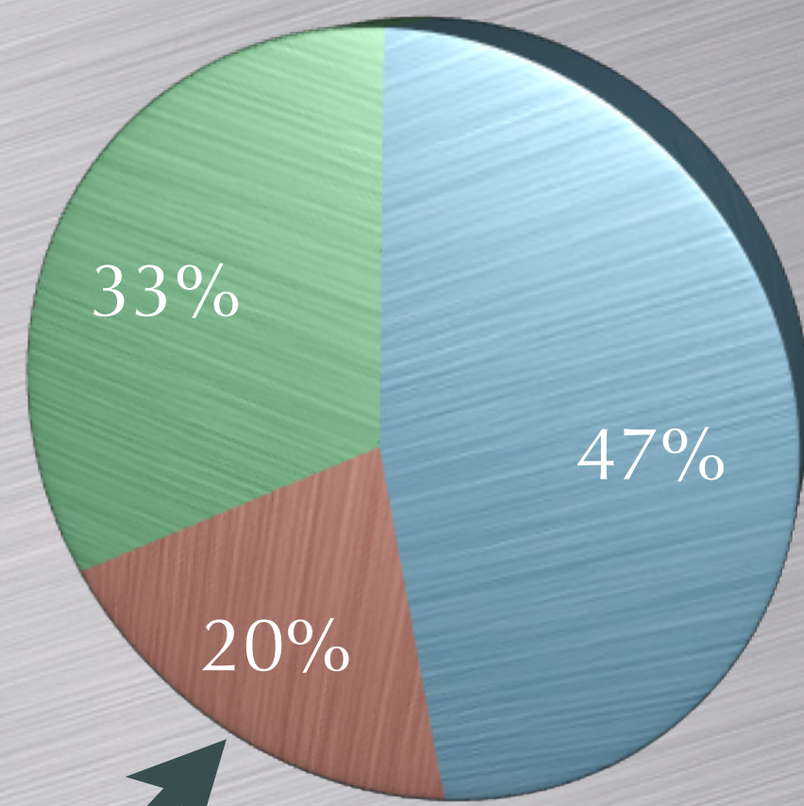
Students don’t enjoy it as much as we’d like.

What is the problem ?

New demographics

1972: 47% of all high school graduates immediately enrolled in college.

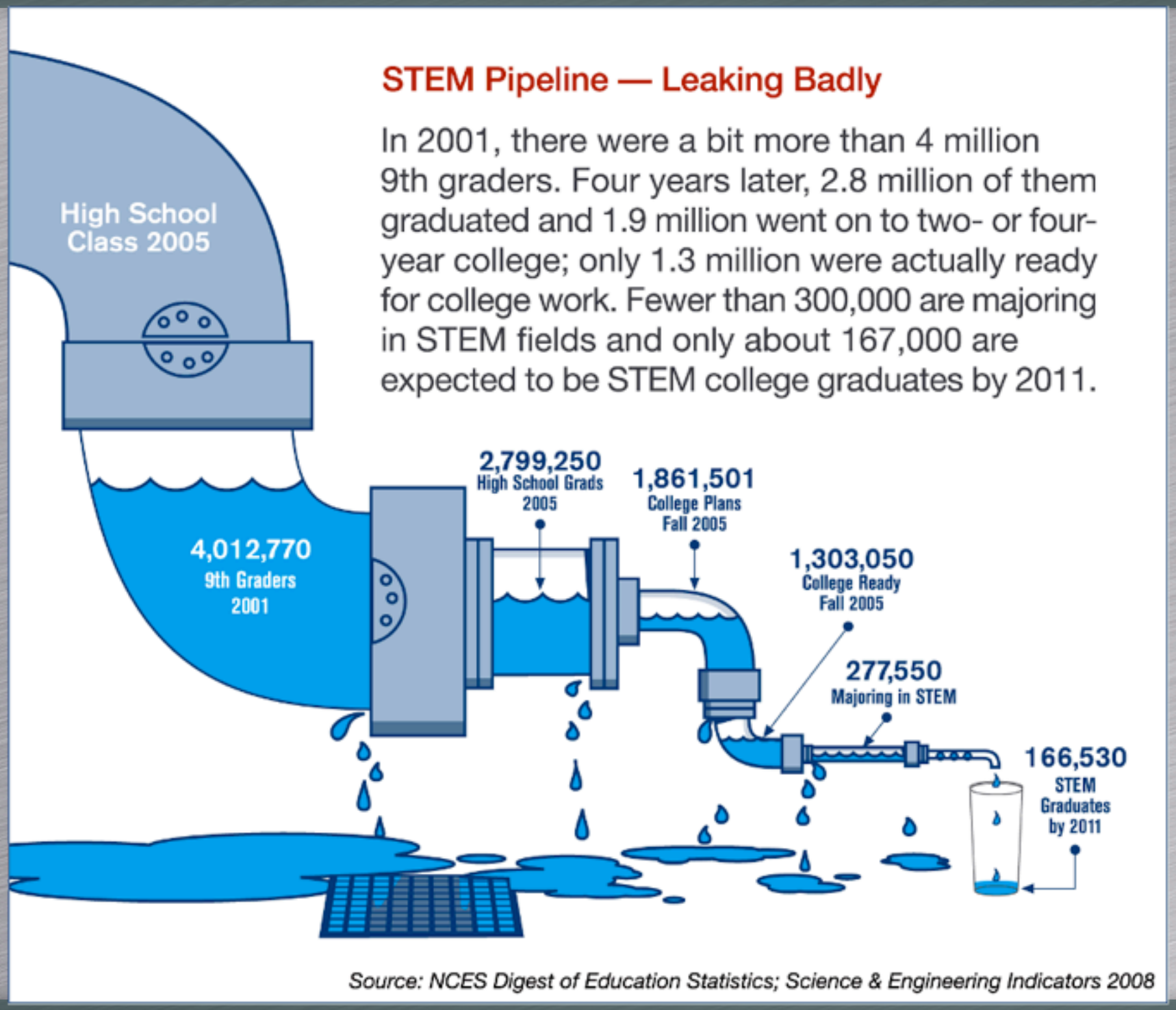
2007: **67%** (2 M of 3 M) ...and it is still rising.



What do we do with these folks?

Students are more diverse than we'd like.

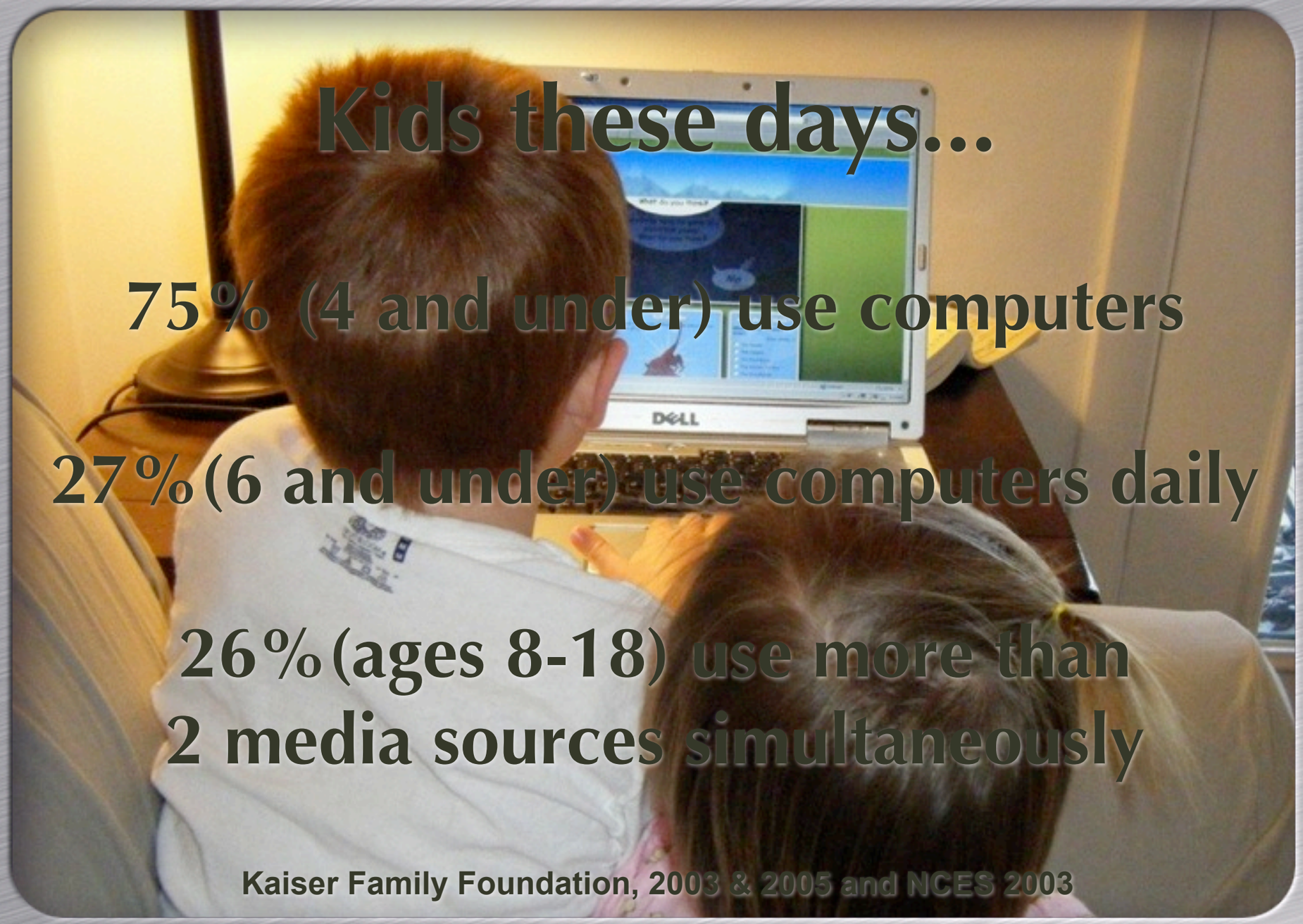
What is the problem ?



graphic from Bill & Melinda Gates Foundation

...and they don't make it through the system.

What is the problem ?



Kids these days...

75% (4 and under) use computers

27%(6 and under) use computers daily

26%(ages 8-18) use more than
2 media sources simultaneously

Kaiser Family Foundation, 2003 & 2005 and NCES 2003

Students are digital natives. We aren't.

What is the problem ?

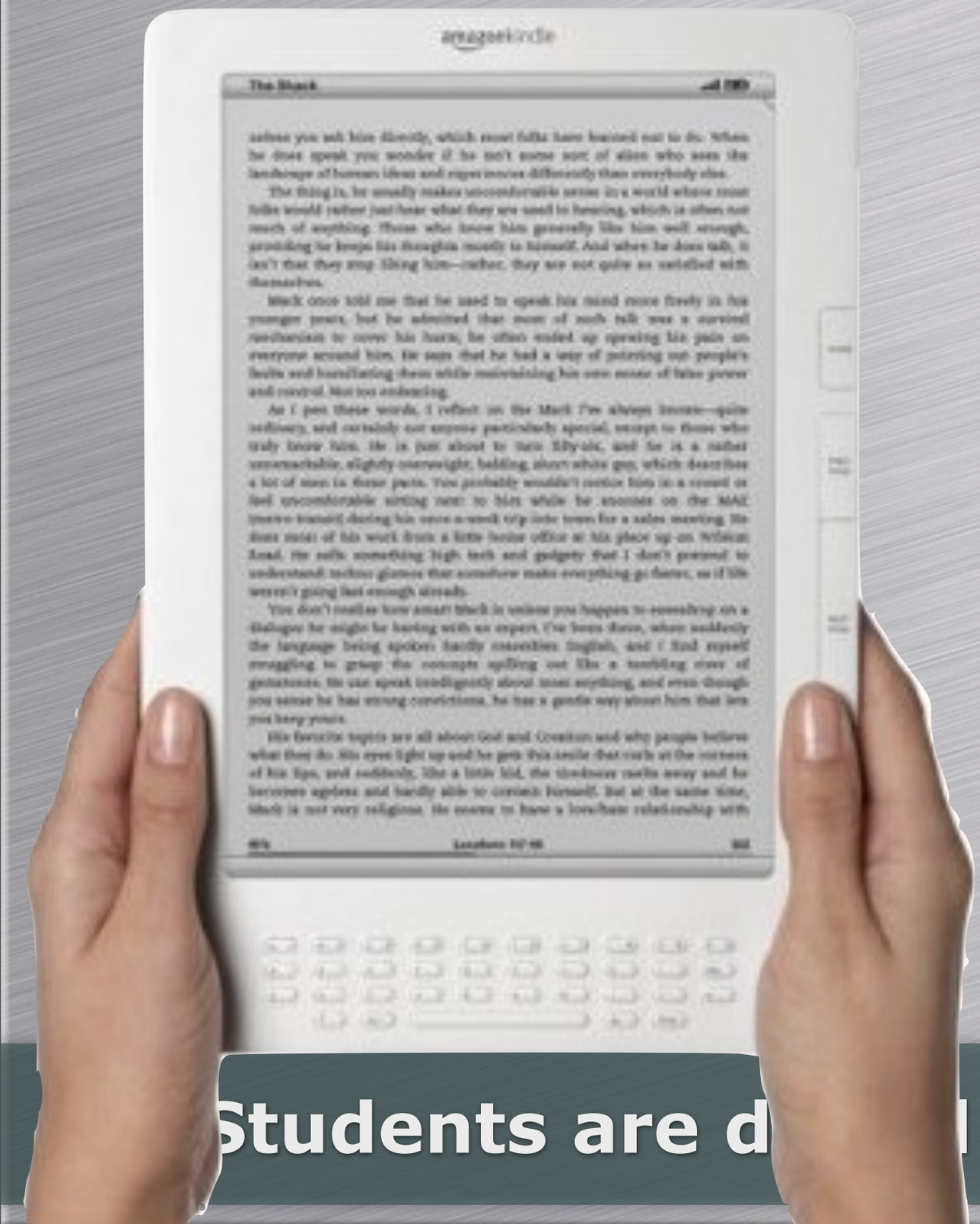
Today's College Grads

Television	>20,000 hrs
Video Games	>10,000 hrs
Reading	< 5,000 hrs

Mark Prensky, *(2001). Digital natives, digital immigrants*

Students are digital natives. We aren't.

What is the problem ?



In June, Amazon's e-books outsold paper by nearly a factor of two

Students are d l natives. We aren't.

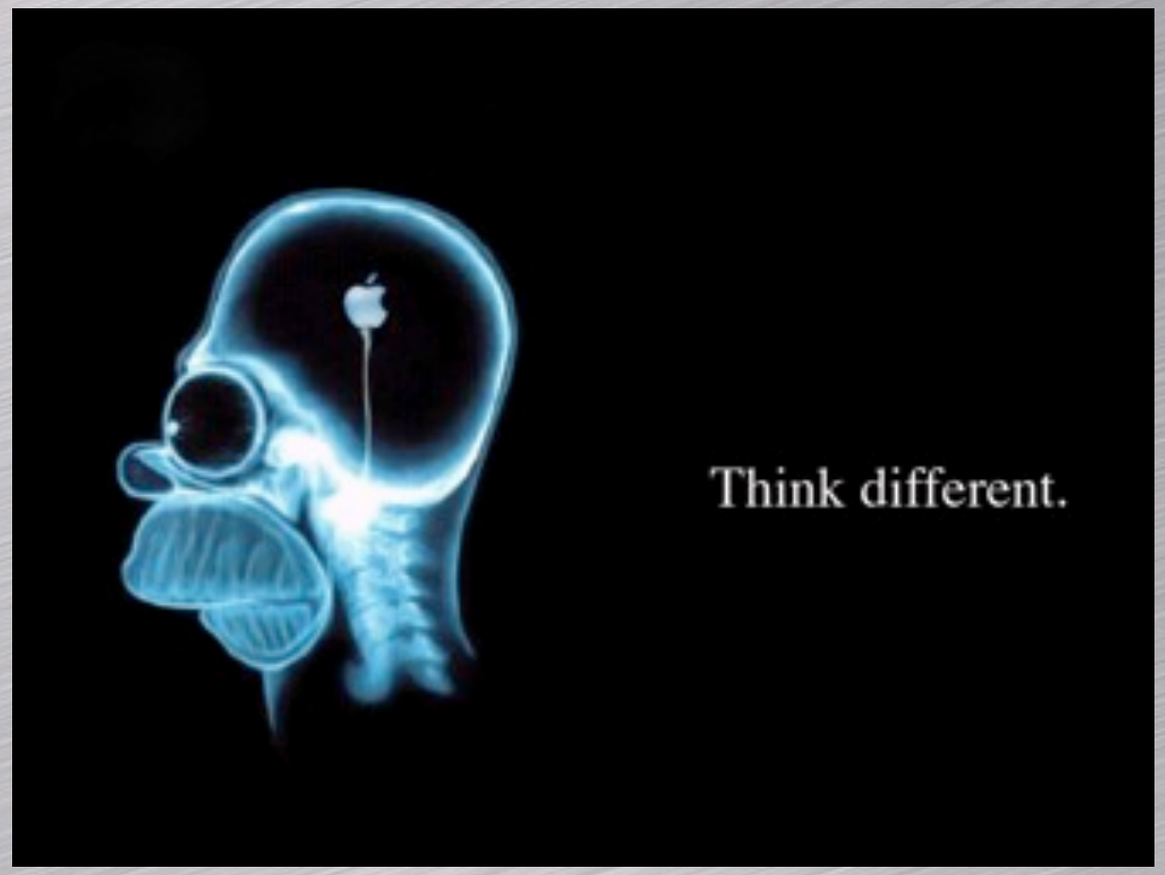
What is the problem ?

They've been using Google since they first learned to read

Students are digital natives. We aren't.

What is the problem ?

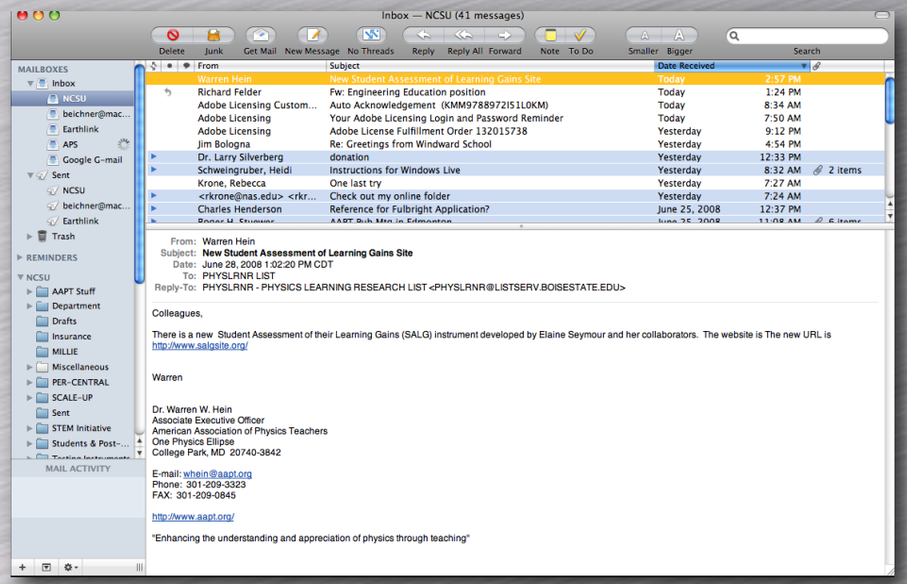
They think differently about technology



Students are digital natives. We aren't.

What is the problem ?

Do you do most of your electronic communication through e-mail...



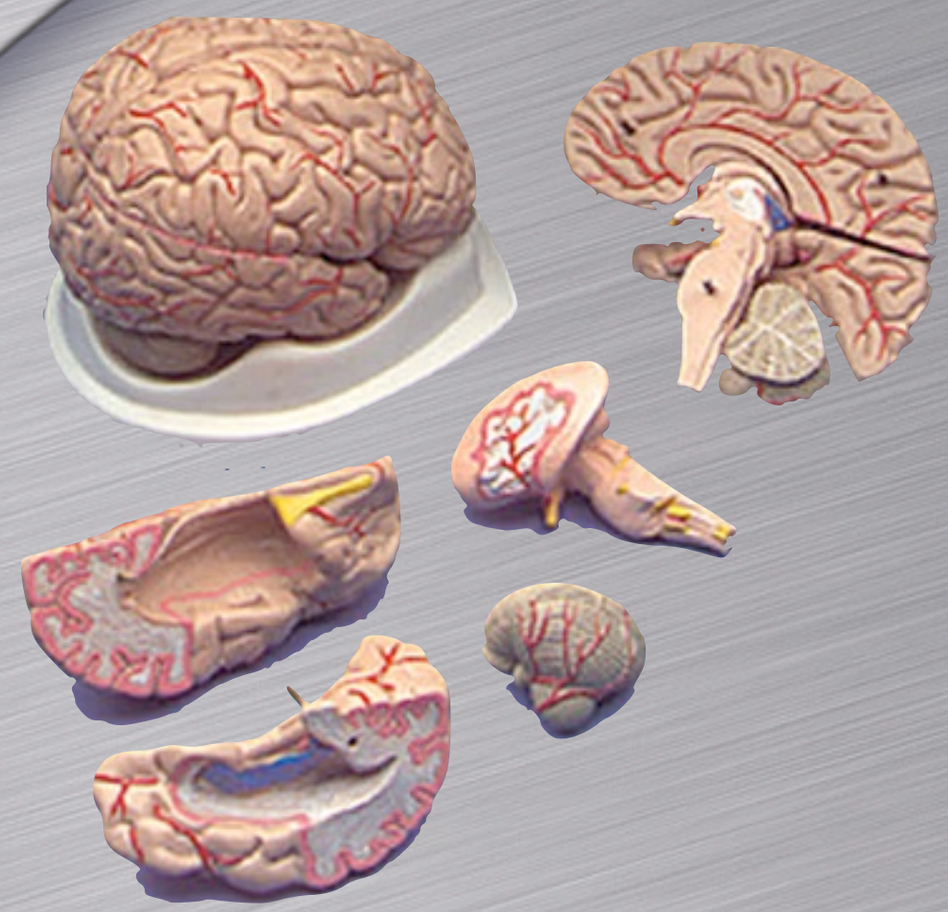
...or via texting, IM and FaceBook ?

Students are digital natives. We aren't.

What is the problem ?

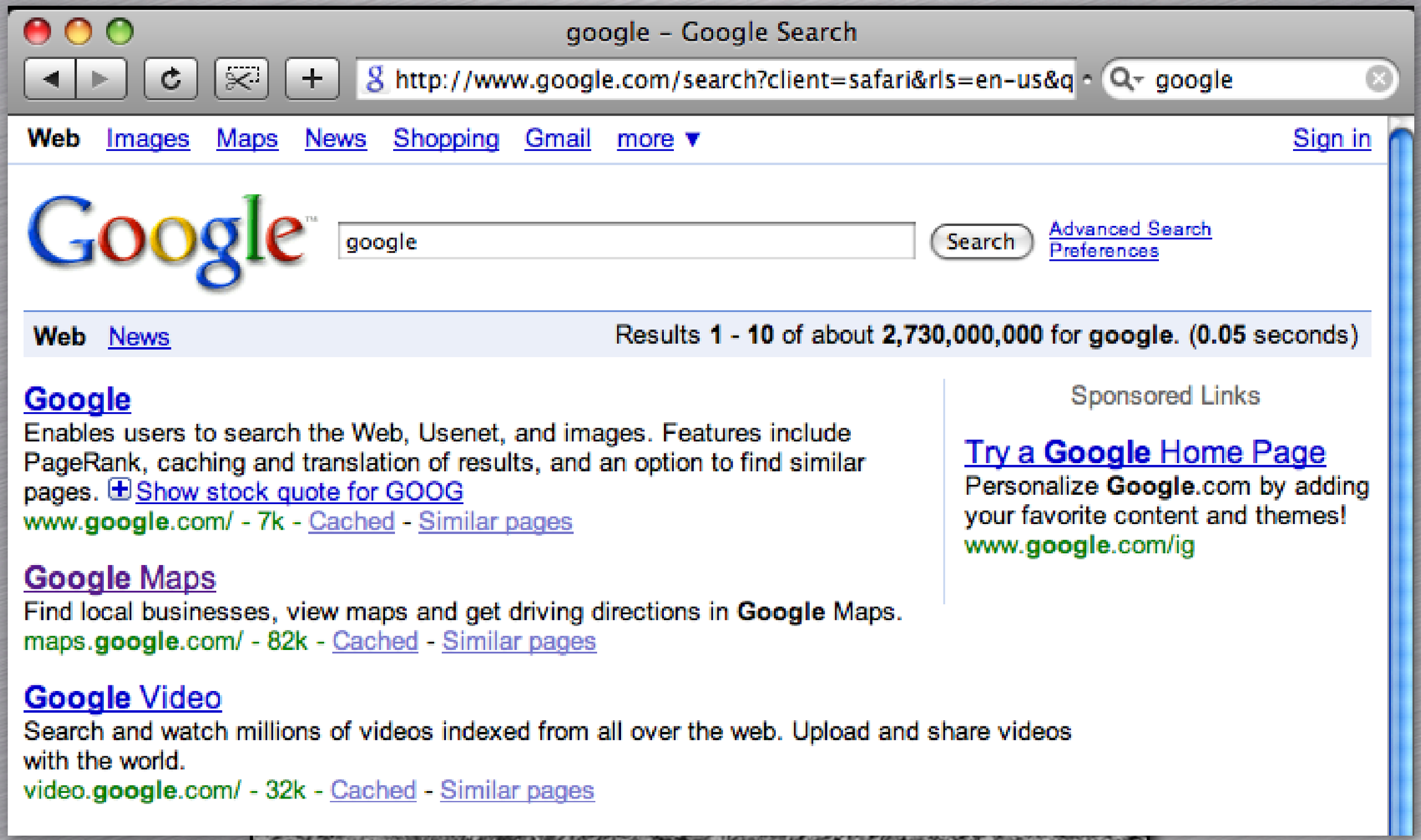
The brain is plastic !

Hebb's Rule: Neurons that fire together, wire together.



Students are digital natives. We aren't.

What is the problem ?



Information scarcity to abundance

What em ?

y to abundance

What is the problem ?

A student voice: "...we have the world at our fingertips — and the world has been at our fingertips for our entire lives.

I think this access to information seriously undermines this generation's view of authority, especially traditional scholastic authority."

Tim Clydesdale , "Wake Up and Smell the New Epistemology," January 23, 2009 *Chronicle of Higher Education*

Information access changes everything

What is the problem ?

400,000 Students

Accredited

$1B Venture Capital

Students have options.

What is the problem ?

More than 20% of all current students are taking an online course right now.

Students have options…

What is the problem ?

Students have options. And this isn’t the best one.

How can we respond ?

When was the last time you watched a lecture on TV ?

Given a choice…

Overview

- What are the problems ?
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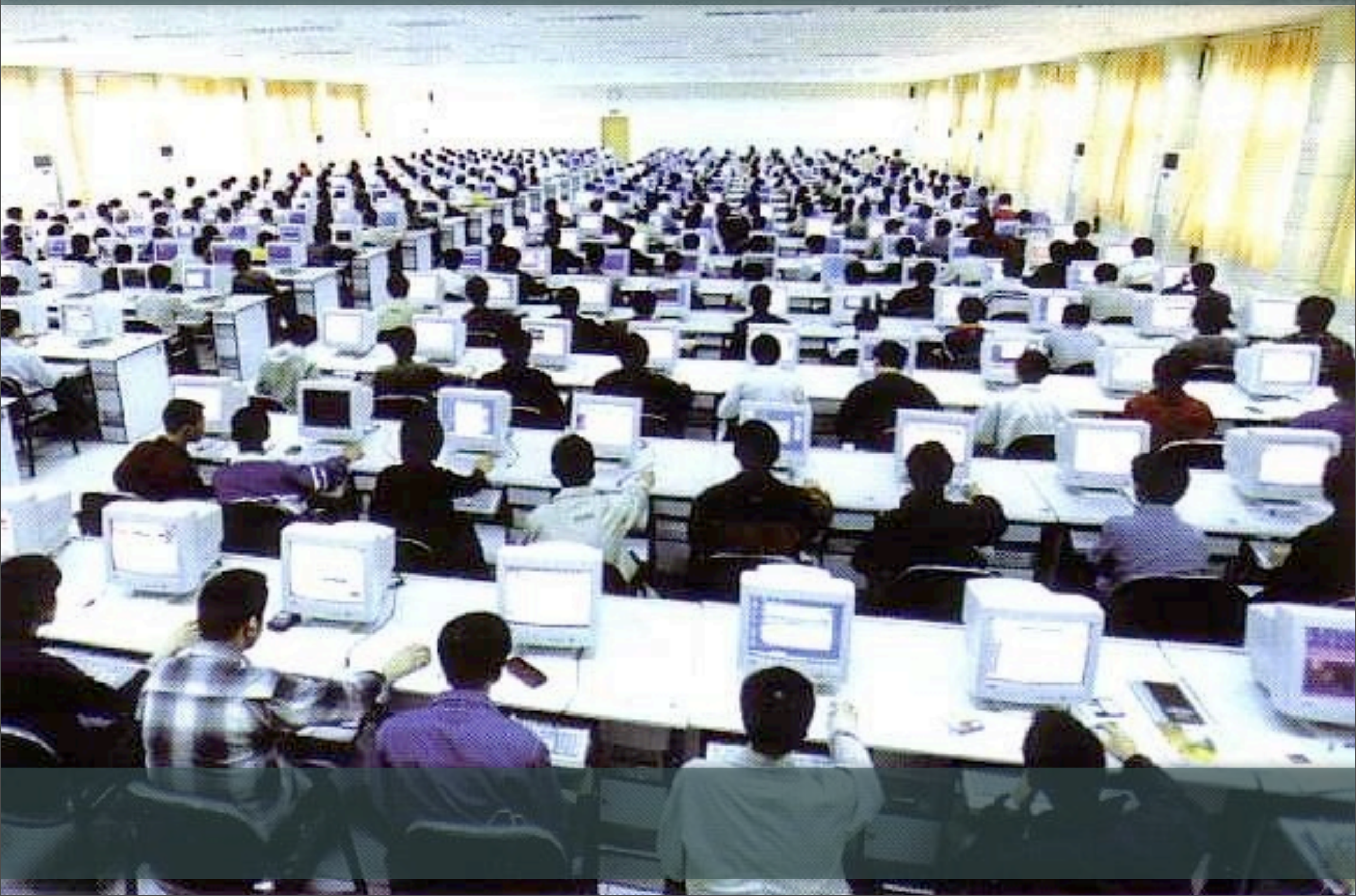
What should we NOT do ?

What should we NOT do ?

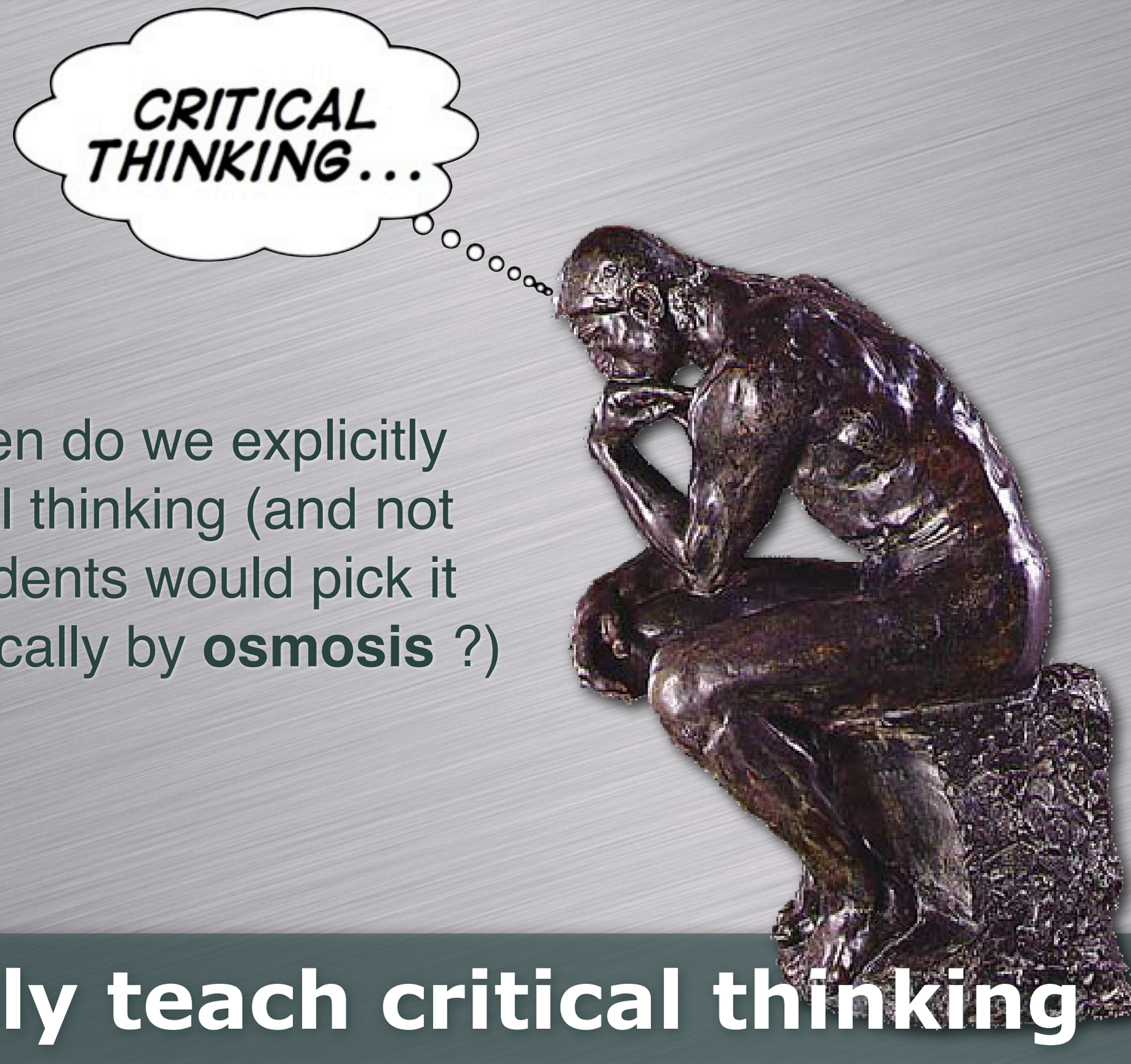


How can we respond ?

≠

Recognize that information ≠ knowledge

How can we respond ?



But how often do we explicitly teach critical thinking (and not assume students would pick it up automatically by **osmosis** ?)

Actually teach critical thinking

How can we respond ?

The *Journal of Higher Education* has called Alexander Astin's book *Four Critical Years* the most frequently cited work in the higher education literature.

In *What Matters in College?* Astin presents a completely new and expanded study of how students change and develop in college — and reveals how colleges can enhance that development. Based on a study of more than 20,000 students, 25,000 faculty members, and 200 institutions, the book shows how curriculum, programs, faculty, student peer groups, and other variables affect students' college experiences, and how these factors can shape students' personalities and behavior; values and beliefs; and academic, cognitive, and career development.

This paperback edition includes a new introduction that revisits the findings of the original work in light of the author's most recent investigations on college students.

The Author

Alexander W. Astin is professor of higher education and director of the Higher Education Research Institute at the University of California, Los Angeles. He is also founding director of the Cooperative Institutional Research Program and author of more than one hundred articles and seventeen books, including *Assessment for Excellence* (1991) and *Achieving Educational Excellence* (Jossey-Bass, 1985). In 1992 he received the American Association for Higher Education and Development's Extended Research Award.

EDUCATION

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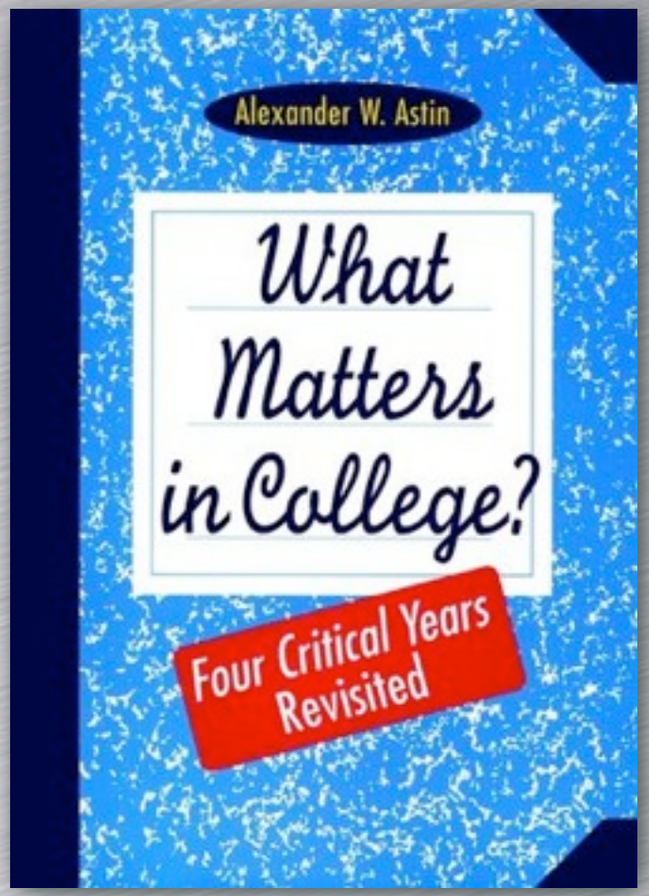
Quality of RELATIONSHIPS (faculty to student and student to student) is *What Matters*



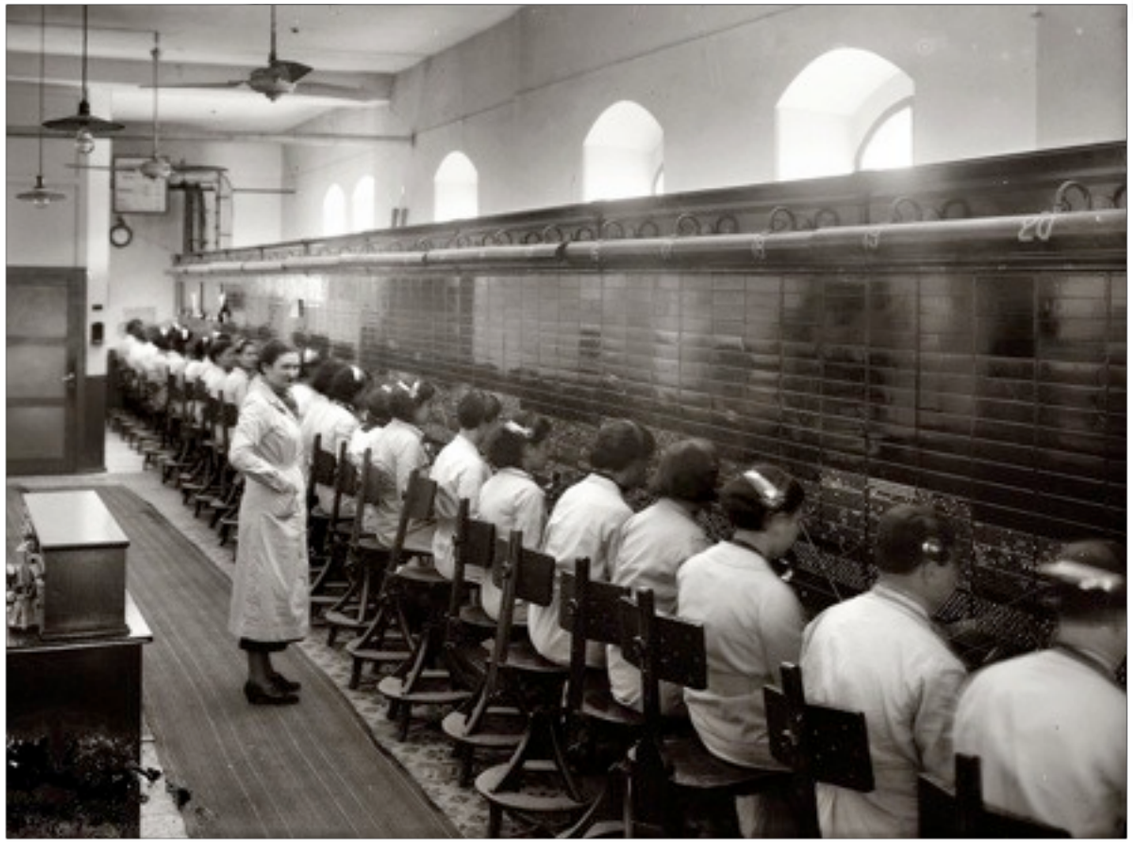
Play our trump card

How can we respond ?

What do students prefer ?

Play our trump card

How can we respond ?



Network Routers

Computers

Don’t waste peoples’ talents

How can we respond ?

If you *can* be replaced by an iPod, you *will* be !

Don’t waste peoples’ talents

Overview

- What are the problems ?
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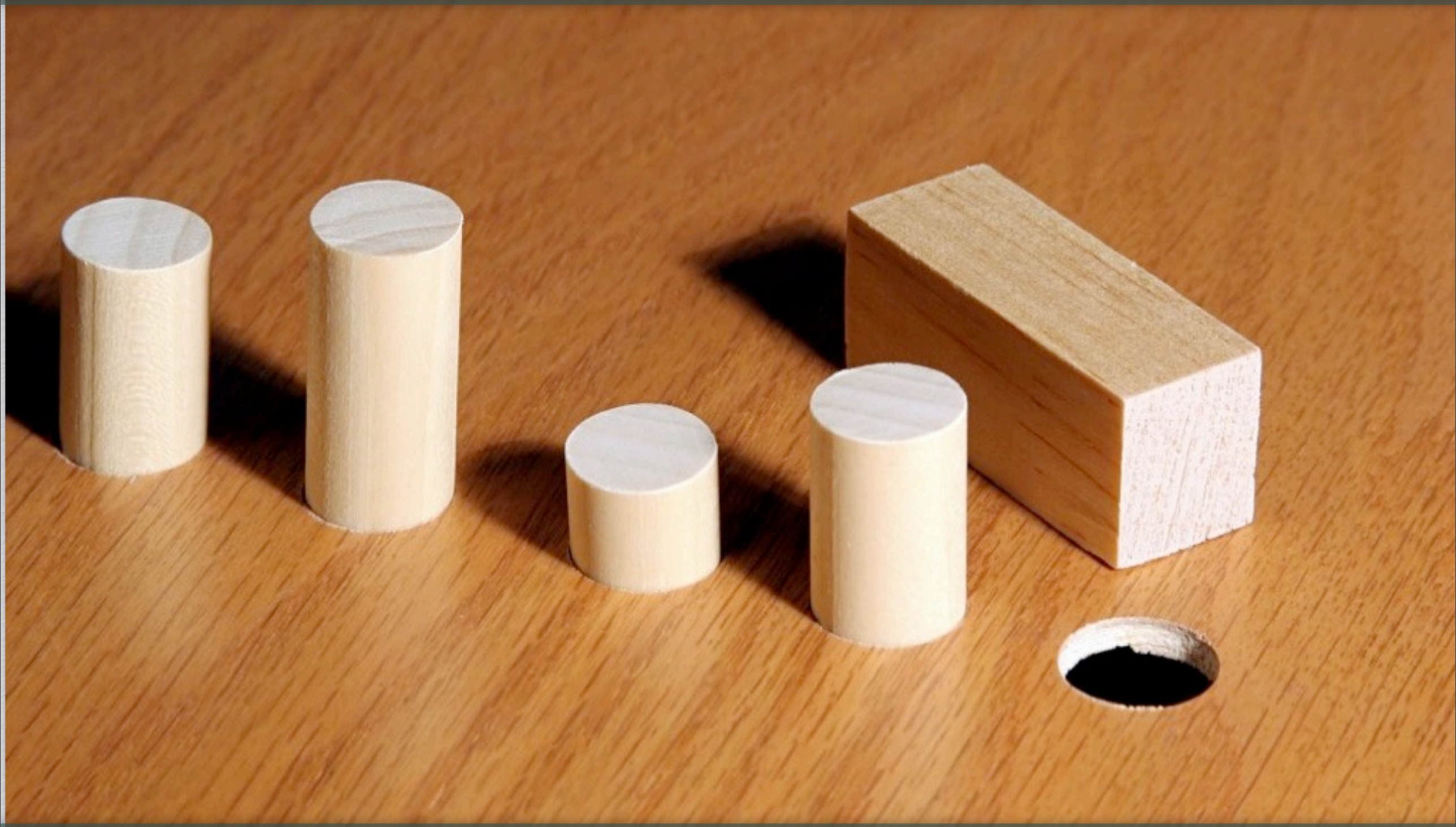
What happened ?

θέατρον

auditorium

Greeks invented viewing/listening places

What happened ?



Auditoriums weren’t designed for education

What happened ?

"What Matters" is Social Interaction

Greeks did education differently

How did we get here ?

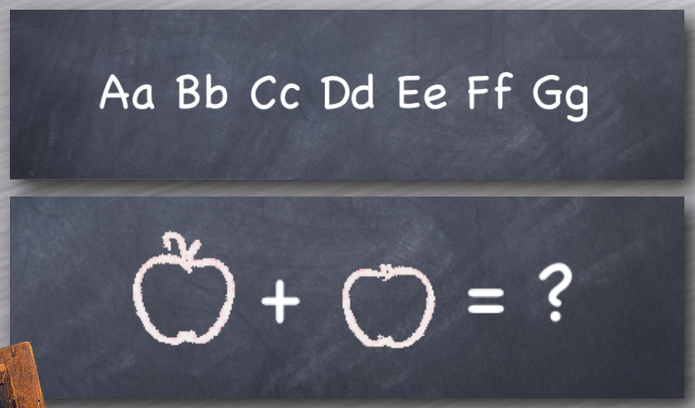
Monks were great at copying

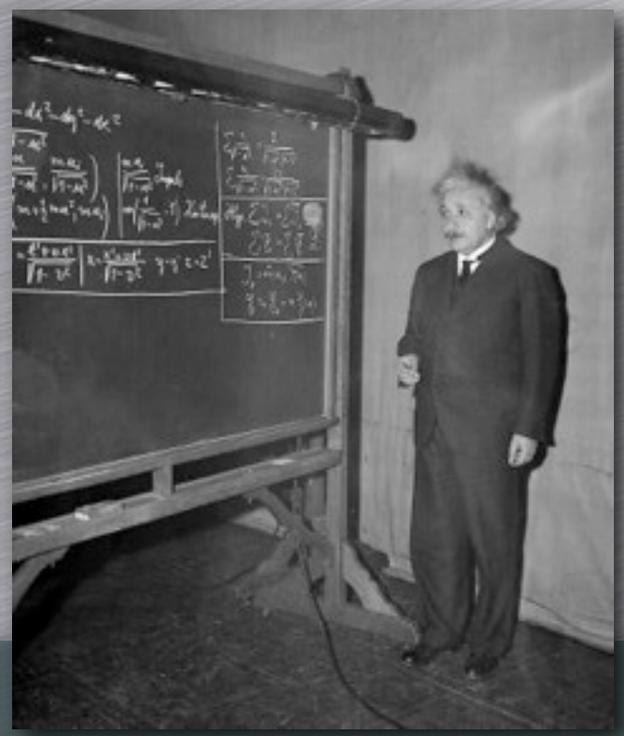
+

Monasteries had auditorium spaces

Auditorium turned into Lecture Hall

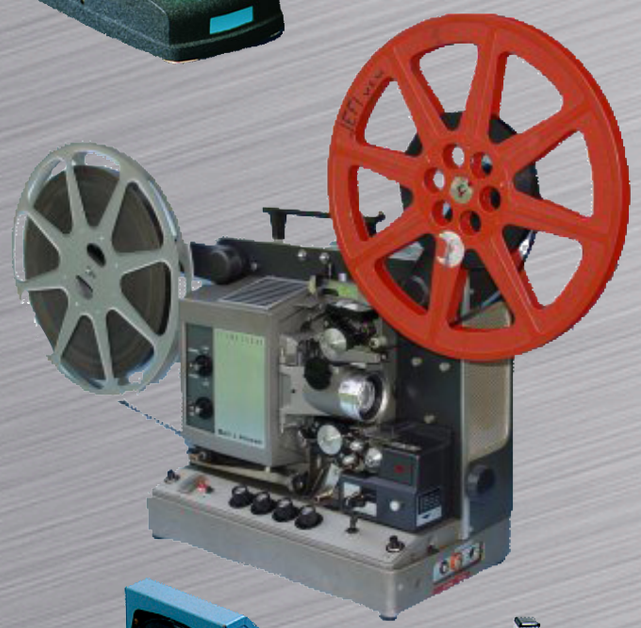
How did we get here ?





Blackboard

How did we get here ?



Various Projectors

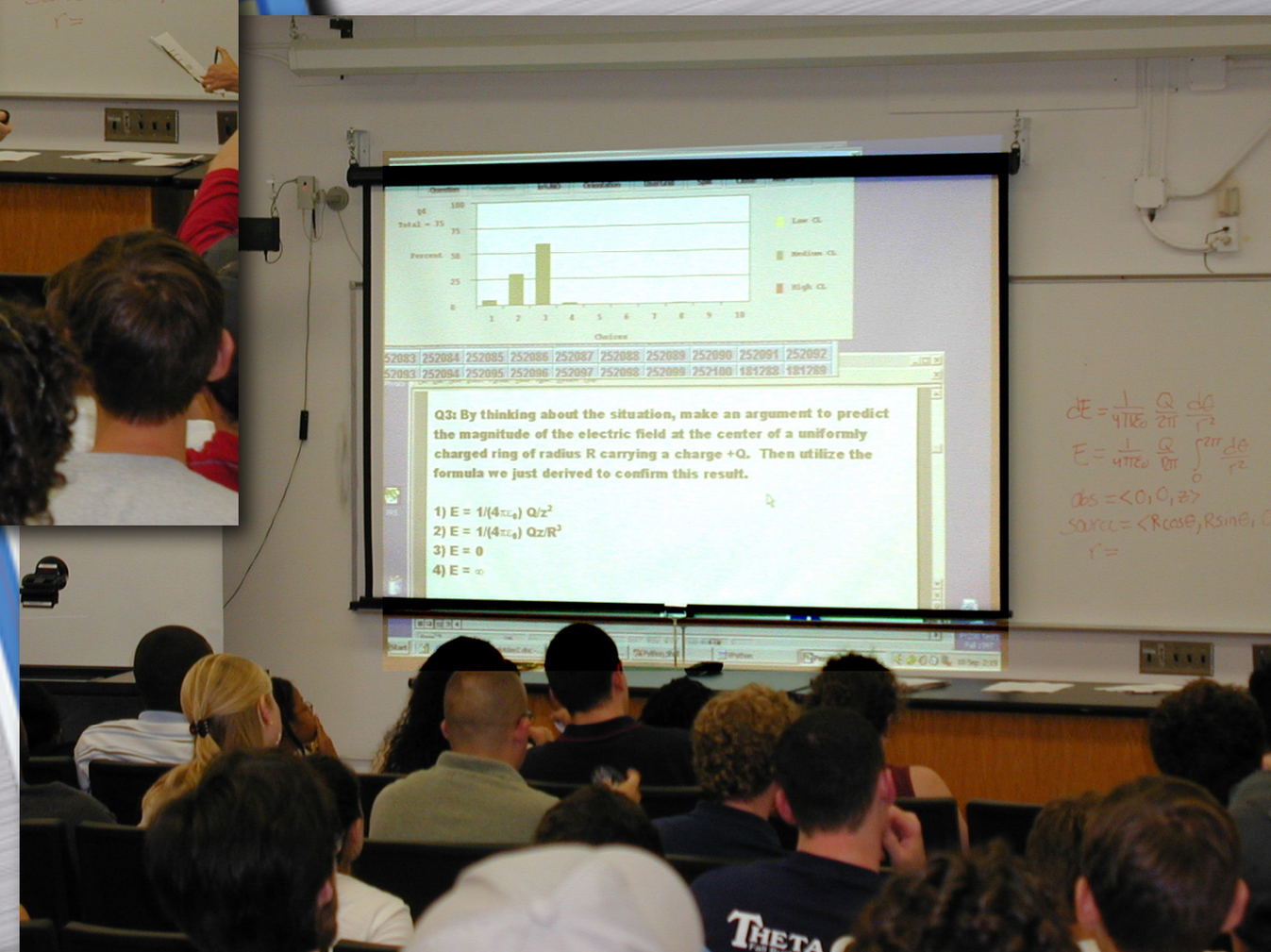
How did we get here ?

Broadcast and recorded television

How did we get here ?

Microcomputers

How did we get here ?



Student Response Systems "Clickers"

How did we get here ?

MIT OpenCourseWare, Intro to Bioengineering, BE.010J
Prof. Douglas Lauffenburger, Head of Biological Engineering

Personal Electronics

How did we get here ?

Teachers have been concerned about student use of technology in the classroom for a long time.

...if one sees written treatises...these are not...the things of most worth...

Plato, Seventh Letter, 353 BCE


Adapting to new technology is difficult
(Used by permission of NRK)

Sorry, video not available

Search YouTube for “Monastery Helpdesk”

Overview

- What are the problems ?
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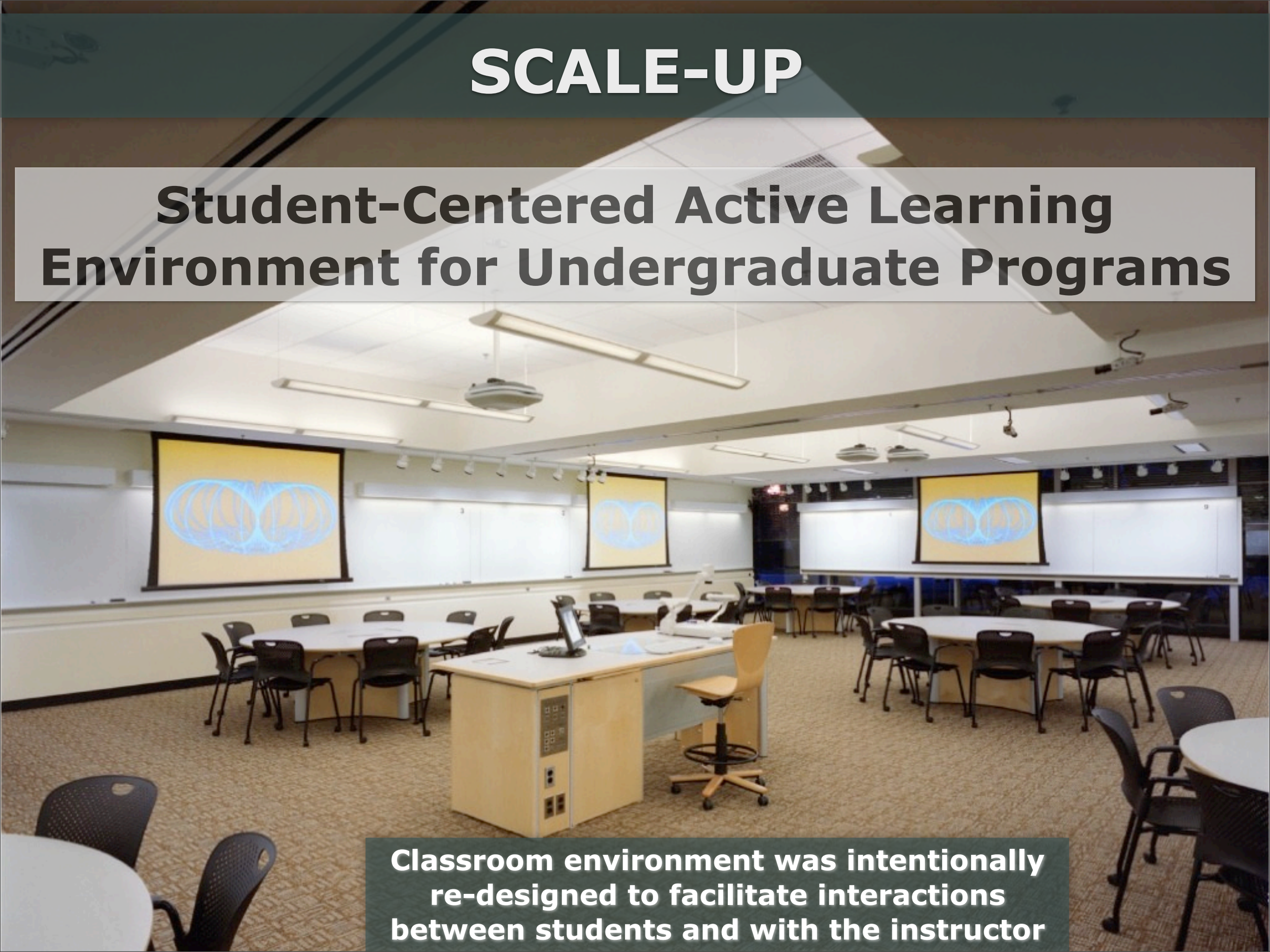
Technology

Technology (tekˈnäləjē) noun - the application of scientific knowledge for practical purposes...a designed solution to a particular problem

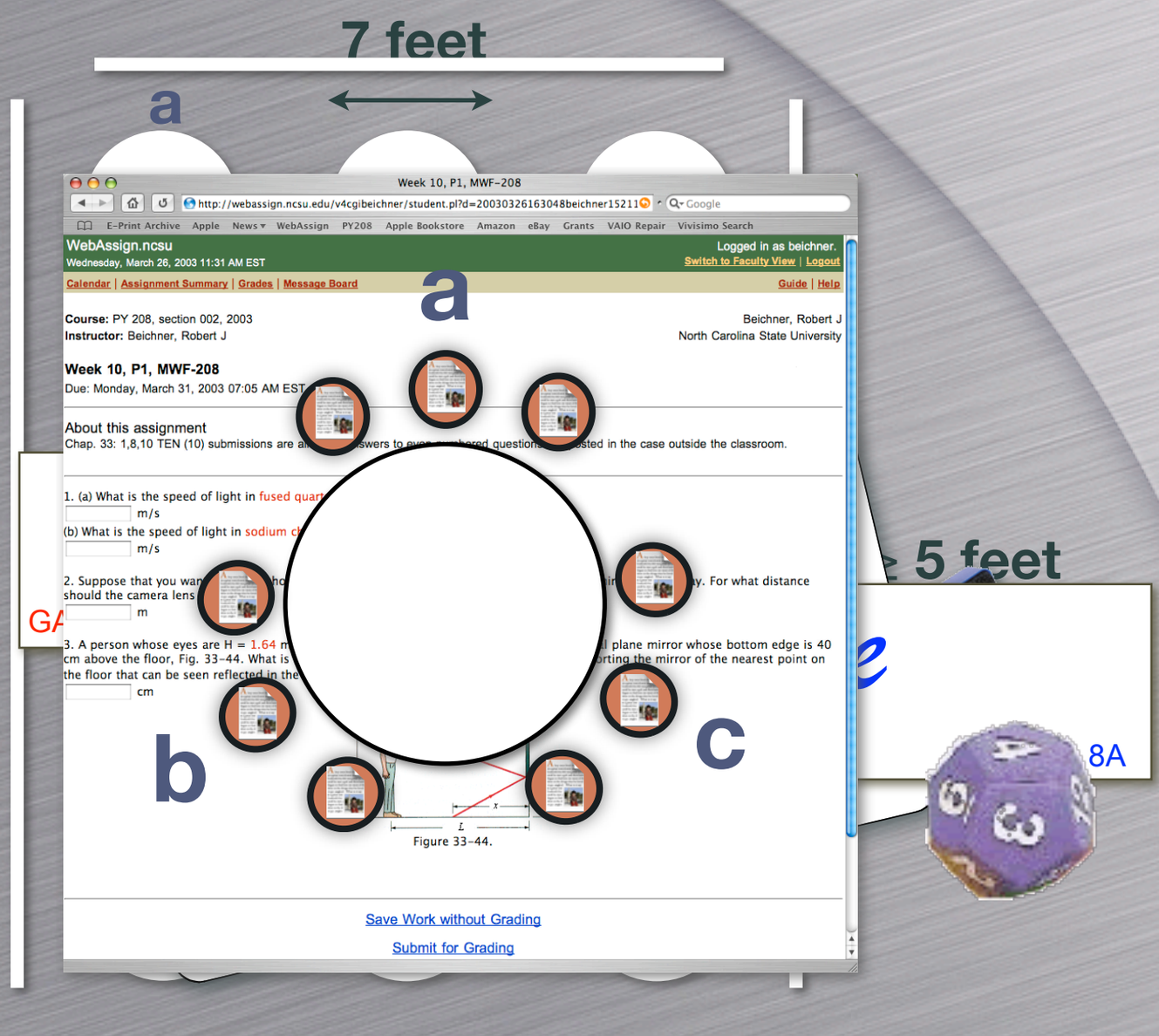
SCALE-UP

Student-Centered Active Learning Environment for Undergraduate Programs



Classroom environment was intentionally re-designed to facilitate interactions between students and with the instructor

SCALE-UP



- Round Tables
- 3 Teams of 3 per Table
- alls
- s
- us
- ork,
- Homework lottery
- Pass and Reflect

the instructor walks around the room, listening and asking questions

SCALE-UP

5 hours/week* (MW 2 hrs, F 1 hr)

10 minute lecture (Organization & Motivation)

Activities (Tangibles, Ponderables, Visibles)

Followup discussion

5 minute lecture summary

* for NC State Physics

"Typical" Classtime

SCALE-UP

How thick is one page from your textbook ?

Figure out how to read Universal Product Codes

How many extra electrons are on a piece of tape ?

Why does the definition of flux include a dot product ?

Tangibles **Simple (or complex) observations**

SCALE-UP

How far does a bowling ball skid ?

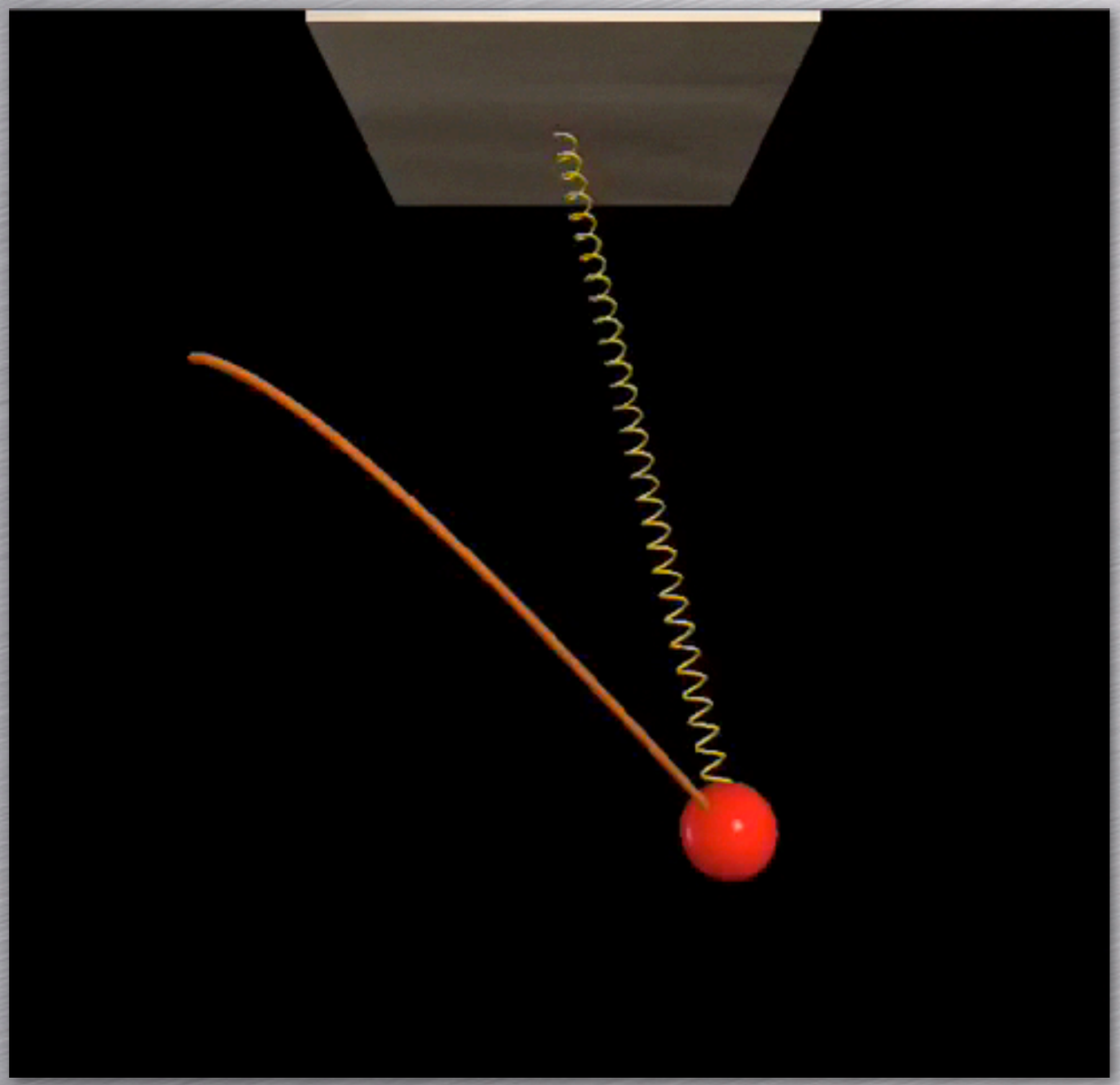
What fraction of a candy bar is used in the store ?

How many electrons fit on a foil-covered ball ?

How many steps is it from NYC to LA ?

Ponderables **Ill-defined problems**

SCALE-UP



*vertical_spring_3D.py – /Users/beichner/Desktop/M & I/For Bob/Pgms/vertical_s...

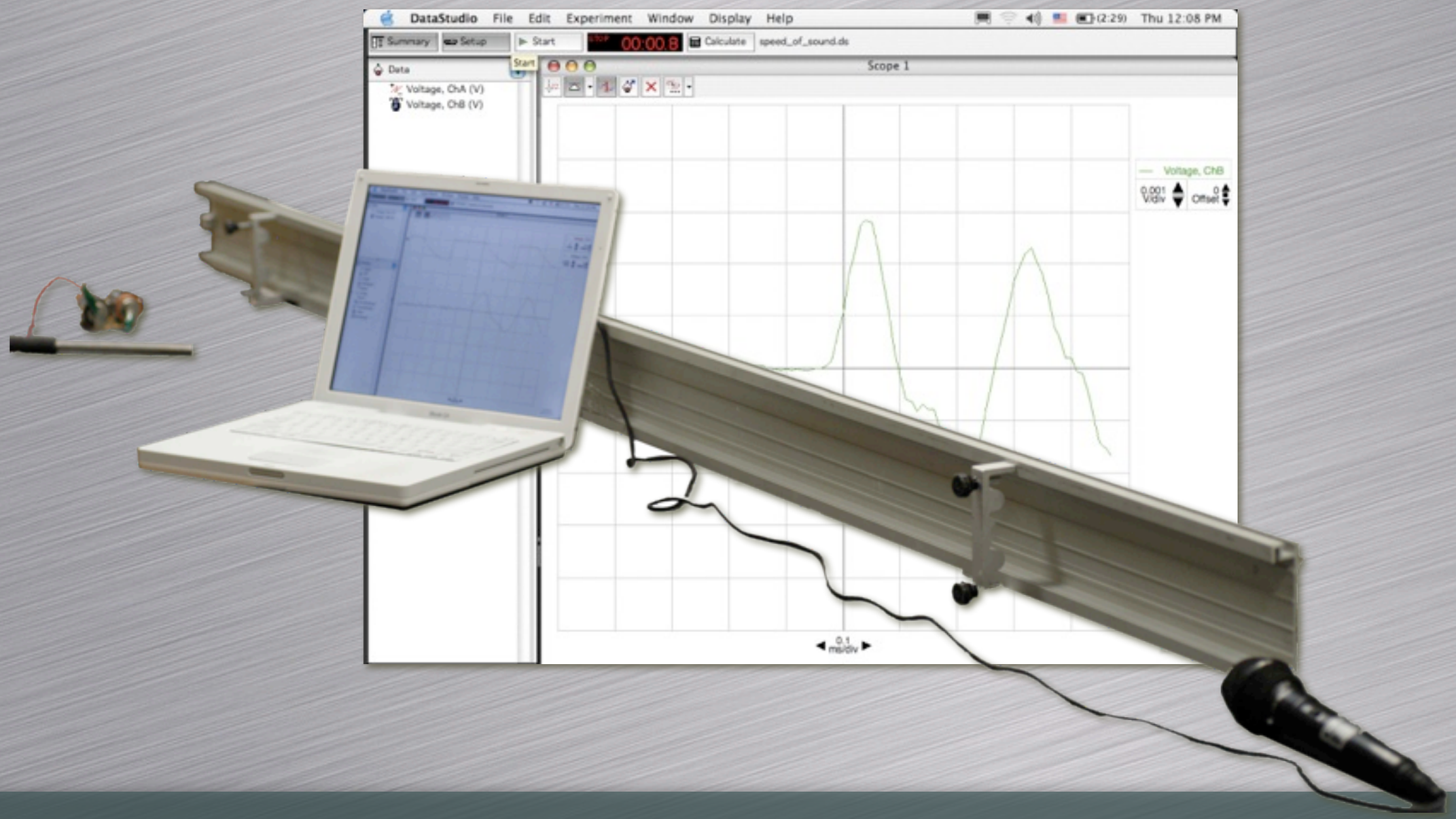
```
from visual import *

a=display(y=0, width=800, height=900)
##a.stereo='crosseyed'

ball=sphere(pos=(0,0,0), radius=0.03, color=color.red,
            display=a,material=materials.plastic)
ball.mass=0.020
ball.p=vector(0,0,0)
ball.trail = curve(color=color.green, radius=0.003)
ball.trail.color=(.8,.3,0)

L0=0.20
spring = helix(pos=(0,L0,0), axis=(0,-L0,0), radius=0.008,
               thickness=.003, color=(1,.7,0), coils=30)
spring.k = 0.9

h=.01
ceiling=box(pos=(0,L0+h,0), size=(1.5*L0,h,1.5*L0),
            material=materials.wood)

dt=0.01
t=0.
Fgrav = vector (0,-ball.mass*9.8,0)
a.center=(0,-L0/2.,0)

ball.pos=vector(-0.2,0,0.2)
spring.axis=ball.pos-spring.pos
ball.p = vector(.01,0,.01)

a.autoscale=0
while 1:
    if a.mouse.clicked > 0:
        break
    rate(40)
    sdir = ball.pos - spring.pos
    smag = sdir.mag - L0
    s = smag*norm(sdir)
    Fspring = -spring.k*s
    Fnet = Fspring + Fgrav
    ball.p = ball.p + Fnet*dt
    ball.pos = ball.pos + (ball.p/ball.mass)*dt
    spring.axis = ball.pos - spring.pos
    ball.trail.append(pos=ball.pos)

    t=t+dt
```

Ln: 24 Col: 0

Visibles Student-generated models of reality

SCALE-UP

Stretch wires, measure speed of sound, predict thermal properties



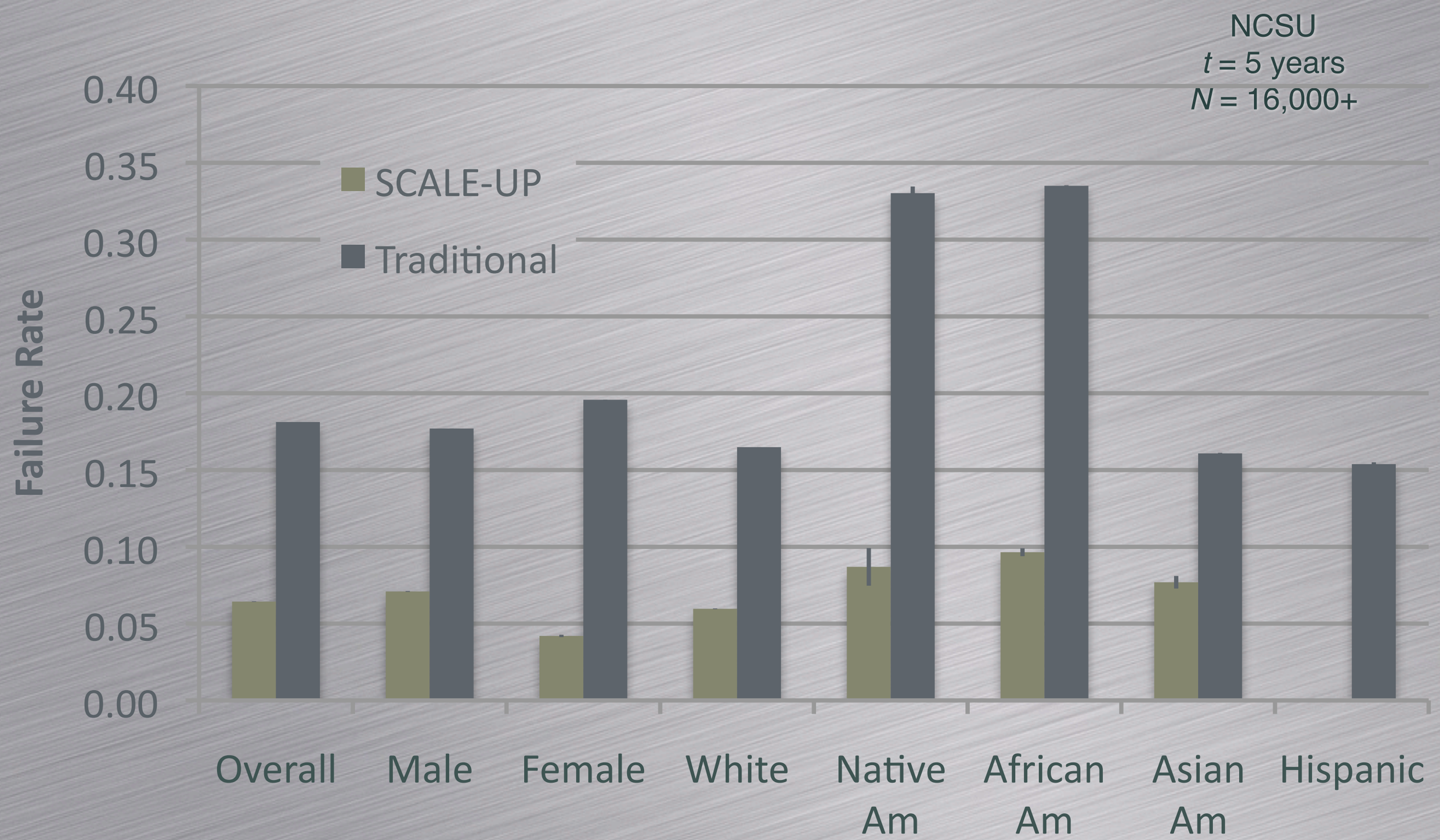
Semester-Long Linkages

Did It Work ?

- Problem solving skills developed
- Conceptual learning increased
- Retention much higher
- Top students benefit most
- Performance in later classes enhanced
- Student attitudes better

Did It Work ?

Retention Rates



Where Are We Now ?

Wisconsin-Platteville

Virginia Med School

Minnesota

Florida Gulf Coast

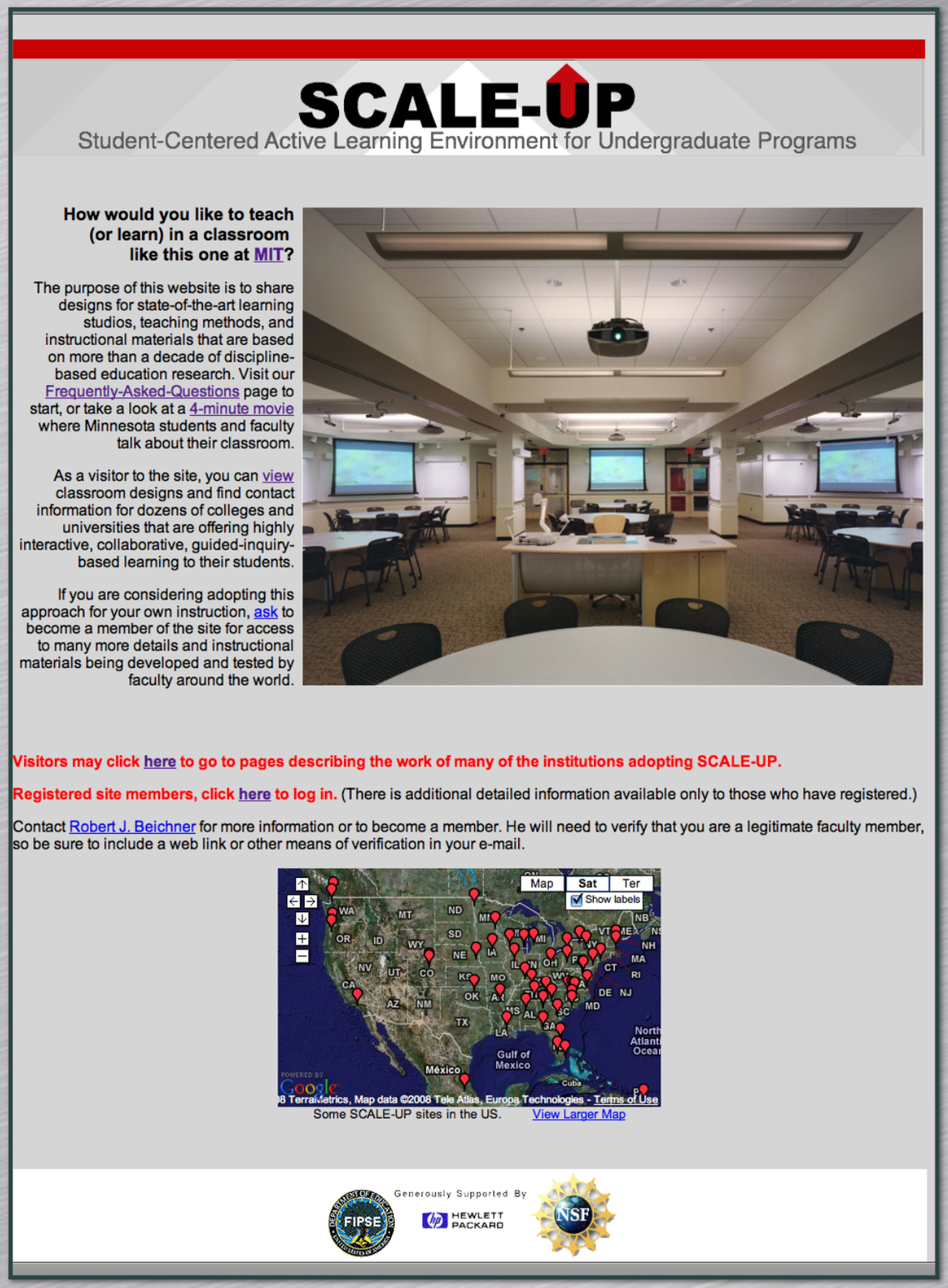
UT Dallas

Where Are We Now ?

For more info...

beichner@ncsu.edu

SCALE-UP website (http://scaleup.ncsu.edu) is now a wiki.



SCALE-UP

Student-Centered Active Learning Environment for Undergraduate Programs

How would you like to teach (or learn) in a classroom like this one at MIT?

The purpose of this website is to share designs for state-of-the-art learning studios, teaching methods, and instructional materials that are based on more than a decade of discipline-based education research. Visit our Frequently-Asked-Questions page to start, or take a look at a 4-minute movie where Minnesota students and faculty talk about their classroom.

As a visitor to the site, you can view classroom designs and find contact information for dozens of colleges and universities that are offering highly interactive, collaborative, guided-inquiry-based learning to their students.

If you are considering adopting this approach for your own instruction, ask to become a member of the site for access to many more details and instructional materials being developed and tested by faculty around the world.

Visitors may click here to go to pages describing the work of many of the institutions adopting SCALE-UP.

Registered site members, click here to log in. (There is additional detailed information available only to those who have registered.)

Contact Robert J. Beichner for more information or to become a member. He will need to verify that you are a legitimate faculty member, so be sure to include a web link or other means of verification in your e-mail.

Some SCALE-UP sites in the US. View Larger Map

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