SCALE-UP

Student-Centered Active Learning Environment with Upside-down Pedagogies
Problem solving skills developed

Conceptual learning increased

Retention much higher

Top students benefit most

Performance in later classes enhanced

Student attitudes better

“Peek” at final results ...
Overview

**CONTEXT**
- What is the problem?
- What is the best way to respond?
- How did we get into this situation?

**STATUS**
- What did SCALE-UP do?
- Did it work?
- Where are we now?
36% of students showed no significant improvement in critical thinking, complex reasoning, or writing after four years of college.

What is the problem?

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

Normalized gain is the percentage of possible progress on a concept test.

\[ \langle g \rangle = \frac{\text{PostTest Score} - \text{PreTest Score}}{\text{Possible Gain}} \]

Average gain for traditionally taught classes is 22%.

Students Have Changed

New Demographics

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

2009: 70% ...and it is still rising.

What do we do with these folks?

“They aren’t as good as they used to be.”
What is the problem?

Education Should Place More Emphasis On:

- Effective Communication: 89%
- Critical Thinking: 81%
- Problem Solving: 75%
- Teamwork Skills: 71%
- Locating & Evaluating Info: 68%

“We don’t provide what they need.”

“Percentage of Employers Saying...” from Raising the Bar, Hart Research Associates, Washington DC, January 2010 for LEAP (Liberal Education and America’s Promise initiative of the Assoc. of Am. Colleges and Universities)
What is the problem?

Students are digital natives. We aren’t.

Kids these days...

75% (4 and under) use computers

8–18 year olds average 7.5 hours/day (with nearly 11 hours of content) using entertainment media

Kaiser Family Foundation, 2010

Students are digital natives. We aren’t.
What is the problem?

They think differently with technology!

Students are digital natives. We aren’t.
Hebb’s Rule: Neurons that fire together, wire together.

The brain is plastic!


Students are digital natives. We aren’t.
What is the problem?

Information scarcity to abundance
What is the problem?

The Internet has become a form of external memory, where information is stored collectively outside ourselves.

People recall where to find information more than the actual facts.

“Human memory is adapting to new communications technology.”


Information access changes everything
What is the problem?

Nearly $\frac{1}{3}$ of all 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.
What is the problem?

Students have options. And this isn’t the best one.
What is the problem?

...and neither is this.
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STATUS
How can we respond?

Data ≠ Wisdom

Data ➔ Information ➔ Knowledge ➔ Wisdom

(Discrete) Linked Organized Applied

Recognize that Data ≠ Wisdom

Quality of RELATIONSHIPS (faculty to student and student to student) is

Find out what works
How can we respond?

Don’t waste peoples’ talents

Network Routers

Computers
How can we respond?

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

Don’t waste peoples’ talents
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What happened?

θέατρον
auditorium

Greeks invented viewing/listening places
Auditoriums weren’t designed for education

What happened?
What happened?

"What Matters" is Social Interaction

Greeks did education differently
So what’s wrong with lecturing?

- Treats all students as if they are the same as the professor
- Hard to engage students
- Inadequate individual assistance
- Poor attendance and “success” rates
- Students fail to retain knowledge

What happened?

But...it worked for me!
So what’s wrong with lecturing?

“Experts...are familiar not only with the concepts but also with the jargon and vocabulary...[and] have a rich context from which to draw inferences about what is covered in a lecture. Students, on the other hand, are encountering the topic typically for the first time...”


We are not our students!
Overview

- **What is the problem?**
- **What is the best way to respond?**
- **How did we get into this situation?**
- **What did SCALE-UP do?**
- **Did it work?**
- **Where are we now?**
Evaluate design in terms of purpose
Classroom environment was intentionally re-designed to facilitate interactions between students and with the instructor
SCALE-UP

Studios are not a new idea
Teacher is free from the tyranny of content delivery

- Round Tables
- 3 Teams of 3 per Table
- White Boards on Walls
- Group White Boards
- No one is anonymous
- Homework lottery
- Pass and Reflect

While the students work, the instructor walks around the room, listening and asking questions.
D-Shaped Tables
2 Teams of 3 per Table
LCD Screen for Table
White Boards on Walls
Group White Boards
“Assigned” Seats

SCALE-UP

42” Screen

5 feet

5 feet
Backward design in flipped classroom

Performance Outcomes

Assessment

Students

Instruction

Teachers


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
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?

What is the power output of your hand?

Tangibles

Simple (or complex) observations
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?

Is residential solar electricity feasible in Raleigh?
from visual import *

ball = sphere(pos=(-0.2, 0, 0.2), radius=0.03, color=color.red, mass=0.020, material=materials.plastic, make_trail=True)

L0 = 0.20
spring = helix(pos=(0, L0, 0), axis=(0, -L0, 0), radius=0.008, thickness=0.003, color=(1, 1, 0), coils=30)
spring.k = 0.9

h = 0.01
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)
spring.axis = ball.pos - spring.pos
ball.p = vector(0.01, 0, 0.01)

while 1:
    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
t = t + dt
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Did It Work?

Concept Learning

Normalized Gain

FCI-NCSU  FCI-UCF  FMCE-RIT

First Semester - Mechanics

Passive Lecture
SCALE-UP
Did It Work?

Concept Learning

Normalized Gain

First Semester - Mechanics

Passive Lecture

SCALE-UP

FCI-NCSU  FCI-UCF  FMCE-RIT
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Concept Learning

Normalized Gain

<table>
<thead>
<tr>
<th></th>
<th>Passive Lecture</th>
<th>SCALE-UP</th>
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<td>E&amp;M-MIT</td>
<td>20</td>
<td>50</td>
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<tr>
<td>CSEM-UCF</td>
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<tr>
<td>ECCE-UCF</td>
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<td>30</td>
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</tbody>
</table>

Second Semester - E & M
Did It Work?

Concept Learning

Normalized Gain

Second Semester - E & M

E&M-MIT

CSEM-UCF

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Passive Lecture
SCALE-UP
Did It Work?

Concept Learning

Normalized Gain

FCI-NCSU  FCI-UCF  FMCE-RIT  E&M-MIT  CSEM-UCF  ECCE-UCF

Passive Lecture  SCALE-UP

Did It Work ?
Did It Work?

**Concept Learning**

Similar results at multiple schools in chemistry, engineering, biology, and computer science.

**Clemson** reports engineering content coverage is the same.

**Minnesota** thinks approach would work with 250 biology students in a large SCALE-UP classroom.

**Victoria** says database systems course “evaluation surpassed expectations.”
Did It Work?

Problem Solving

Score

Passive Lecture & Lab (mean=61.7)
SCALE-UP (mean=73.1)

Question Number

Did It Work?

Problem Solving

Score

Passive Lecture & Lab (mean=61.7)
SCALE-UP (mean=73.1)

Question Number

Did It Work?
Did It Work?

Retention Rates

NCSU

$t = 5$ years

$N = 16,000+$

Failure Rate

SCALE-UP

Traditional

Retention Rates for Overall, Male, Female, White, Native American, African American, Asian American, and Hispanic groups at NCSU over a 5-year period with a sample size of 16,000 or more.
“No change in the overall DFW rate for later engineering statics courses, even though the SCALE-UP physics failure rate is approximately 1/3 what it was with traditional classes. In fact, students defined as ‘at risk’ (based on SAT math scores < 500) fail statics courses 17% of the time if they took a SCALE-UP physics course, but 31% of the time if their background included only lecture-based physics courses.”
Did It Work?

Replications

Clemson

“Beginning in Fall 2006, all freshman Calculus I courses were taught using the SCALE-UP model, in order to address high DFW rates. Historically, the DFW percentage was 44%... The current DFW rate for all these courses, which includes nearly 800 freshmen, has dropped to approximately 22% in that program, which is encouraging our faculty to adopt the SCALE-UP approach permanently as part of our academic culture.”
Minnesota

“The instructors who were interviewed enjoyed teaching in the rooms so much that their only concern was a fear of not being able to continue to teach in these new learning spaces. Similarly, more than 85% of students overwhelmingly recommended the Active Learning Classrooms for other classes.”

Now more than 10,000 students per year take a course in an ALC.
"significantly better learning outcomes than the traditional lecture/recitation approach. This significant difference persisted even a year to 18 months after the end of the course...the gain of the experimental group was double that of the control...
250+ (x2?) Institutions

24 - 603 Students

Content Areas

Physics 37%
Biology/Health 17%
Chemistry 12%
Humanities 10%
Education 9%
Engineering 8%
Math/CS/Bus 7%
Where Are We Now?

- MIT
- Iowa
- UC-Berkeley
- Clemson
- Minnesota
- Ithaca College

250+ Adopters
Where Are We Now?

Bishop Moore HS

Wake-NC State Early College High School

Windward School
Where Are We Now?
Carefully structured collaborative teams share their work with the entire class

Tangibles-observations
Ponderables-intriguing questions
Visibles-computer simulations

Student Centered Active Learning Environment with Upside-down Pedagogies

Round tables each have 3 teams of 3 students
Whiteboards surround room
Technology support

Performance outcomes lead to assessment and instruction
Students become teachers
"Flipped classroom"—content delivery mostly outside class, freeing classtime for working on difficult aspects of material
For more info...

beichner@ncsu.edu

SCALE-UP website
(http://scaleup.ncsu.edu)