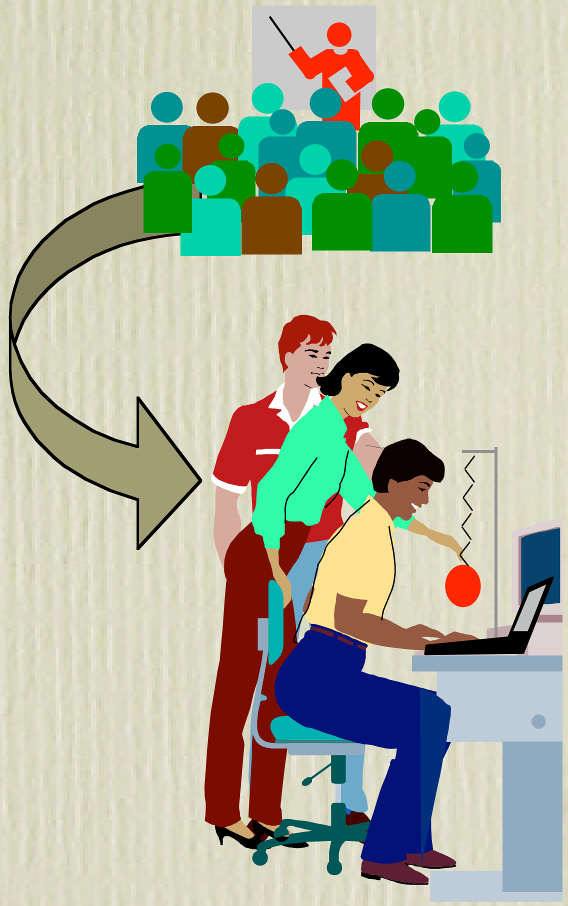
NC STATE UNIVERSITY
Physics Education R & D Group

SCALE-UP

Student-Centered Activities for Large Enrollment Undergraduate Programs

Robert J. Beichner



Conference on Reform
Alexandria, VA - November 2003

NC STATE UNIVERSITY
Physics Education R & D Group

Faculty

Robert Beichner
Ruth Chabay
John Risley
Bruce Sherwood

+ David Haase
+ John Hubisz
+ John Park (Science Education)

Graduate Students

Lin Ding
Sejung Kim
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Jeanne Morse

S-UP "Alumni"

David Abbott
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Avi Marcheweka
Jeff Saul

SCALE-UP: Student-Centered Activities for Large Enrollment Undergraduate Programs

- Actively **engage** students in their learning
- Design an **environment** to support learning
- Develop/modify instructional **activities**
- **Assess** impact on learning
- **Encourage** others to adopt what works

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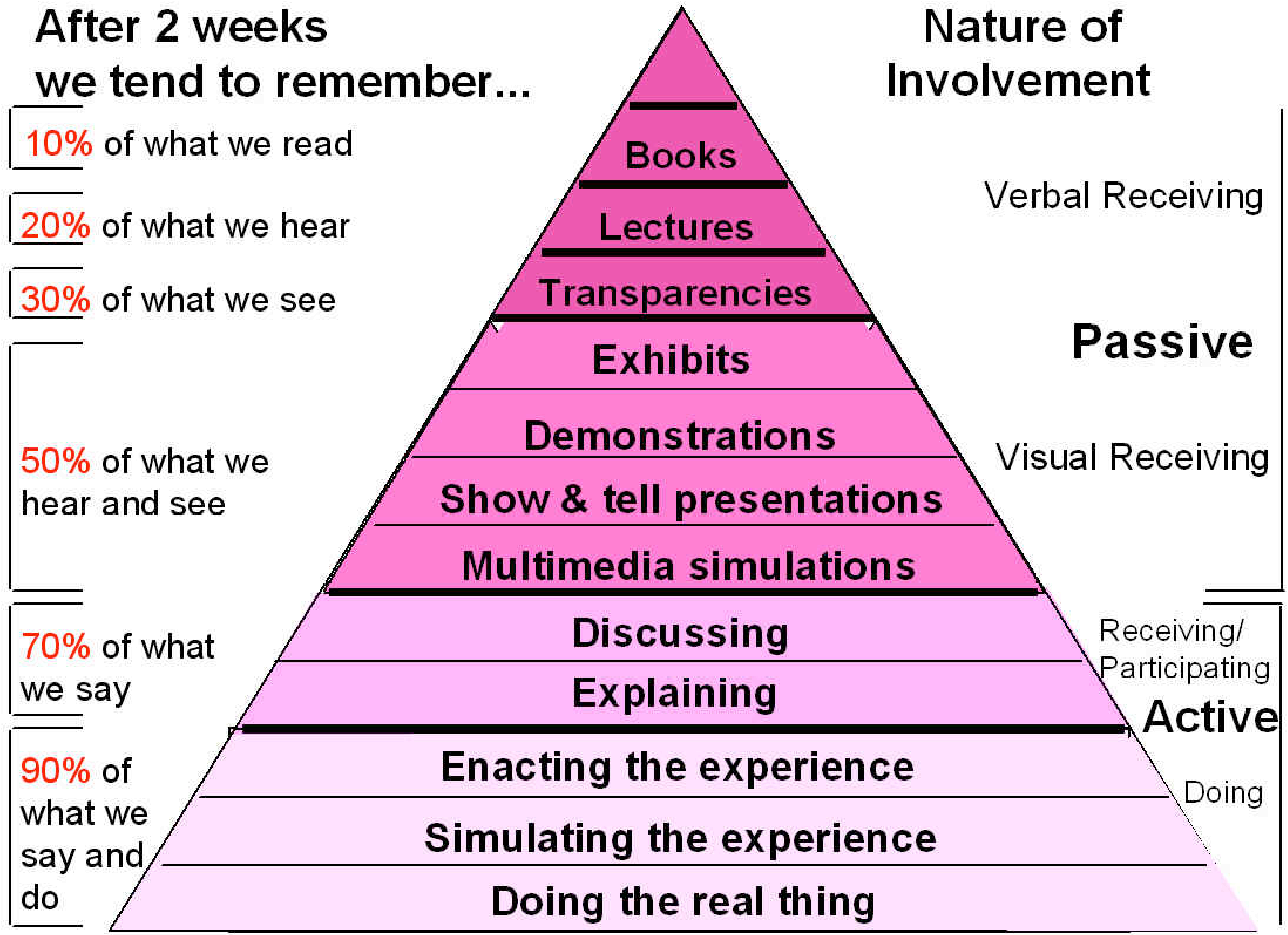


Adapted from Edgar Dale, *Audio-Visual Methods in Teaching* (3rd Edn.), Holt, Rinehart, and Winston (1969).

Cooperative Learning Benefits

- Active/interactive learning (at upper Bloom levels)
- Individuals get stuck & give up. Groups share resources
- Students see alternative strategies.
- More and better questions are asked.
- Cognitive Rehearsal: students learn more when they teach others (just like us)

Cooperative Learning “Secrets”

- Individual **accountability**. Each member is responsible for doing their own fair share of the work and for mastering all the material.
- Positive **interdependence**. Team members have to rely upon one another.
- Face-to-face **interaction**. Some or all of the group effort must be spent with members working together.
- Appropriate use of **interpersonal** skills. Members must receive instruction and then practice leadership, decision-making, communication, and conflict management.
- Regular **self-assessment** of group functioning. Groups need to evaluate how well their team is functioning, where they could improve, and what they should do differently in the future.

Active Learning

Compare:
Body Language
Initiative
Sound Levels
Involvement w/ Material

Group “Engineering”

- Top students often motivated by grades
  - Give teamsmanship bonus if exam average >80
- Bottom students try to avoid work
  - Groups can “fire” lazy members

NOT minimum

Group Contracts

GROUP A1

Group Contract

Instructions: Please initial all clauses of this contract you are committed to following. An initial implies that you are committing yourself to abide by the clause next to it.

A. I agree to come to class on a regular basis.
B. In the result that I am unable to attend class, I will make it my personal responsibility to get any and all notes from my group.
C. Under any and all circumstances, I will get what work I am allotted to do, done and turned in on time.
D. If I am sick and unable to make it to class on the date a group assignment is due, I will call my group members to make other arrangements to get my work turned in on time.
E. The time and place of group meetings shall be agreed upon unanimously within our group.
F. I will be in attendance and prompt for each and every group meeting.
G. Should an emergency arise that prevents me from attending a group meeting, I will notify my fellow group members immediately.
H. I will do my share of the group work, there will never be an occasion where one group member
time when a group membe
I. Each member will agree
before it is turned in. In
automatic, each member
particular solution until a
can be reached, a vote will
J. I will do everything in m
members understand each
K. If I do not understand a co
ask my fellow group memb

obey each and every clause I have initialed and understand that breach of contract will result in a maximum of two verbal reprimands and on third offense, dismissal from the group.

name date

Forming Groups

Start with your spreadsheet of students...

Robert Baker
John Baylor
David Carr
Mary Edwards
John Jacobson
Deborah James
Jim Johnson
Susan Johnson
William Jones
Steve Macon
Sarah Oswald
Peter Patterson
Julie Sasson
Sally Smith
Paul Taylor
Jason Titus
Paula Tyler
Joe Williams

Forming Groups

Note women (!) and minorities (*)

Robert Baker
John Baylor
David Carr
Mary Edwards!
John Jacobson*
Deborah James!
Jim Johnson
Susan Johnson!*
William Jones
Steve Macon*
Sarah Oswald!
Peter Patterson*
Julie Sasson!*
Sally Smith!*
Paul Taylor
Jason Titus
Paula Tyler!
Joe Williams

Contact your registrar.

Forming Groups

Rank and divide into thirds

Top 1/3

- Sally Smith!*
- William Jones
- Joe Williams
- David Carr
- Julie Sasson!*
- Mary Edwards!

Middle 1/3

- Robert Baker
- Susan Johnson!*
- Paul Taylor
- Steve Macon*
- Sarah Oswald!
- Paula Tyler!

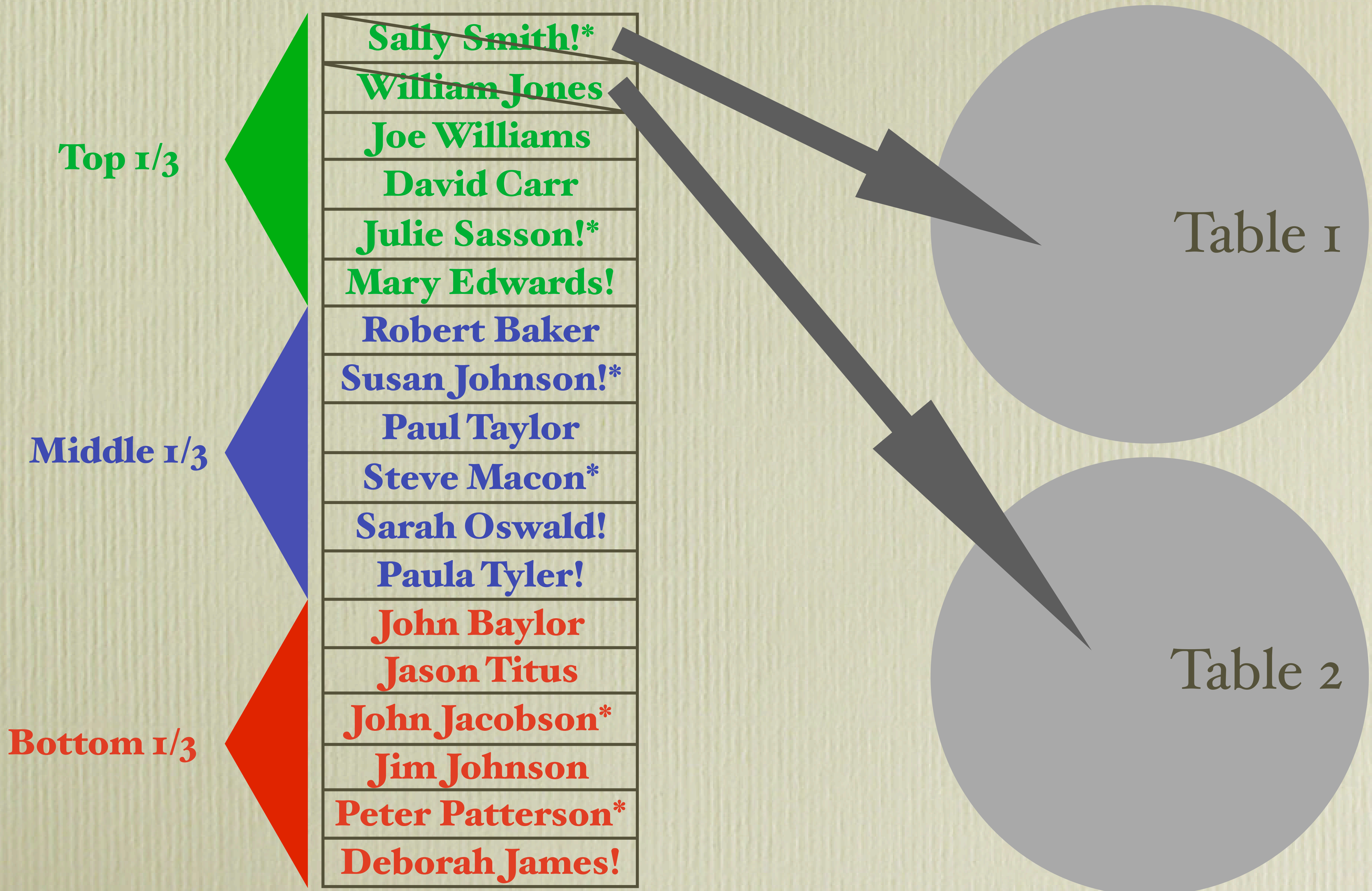
Bottom 1/3

- John Baylor
- Jason Titus
- John Jacobson*
- Jim Johnson
- Peter Patterson*
- Deborah James!

FCI, GPA, former physics/math grade, etc.

Forming Groups

Distribute the very top people, one to each table.



Forming Groups

There will be three groups of three students at each table.

Top 1/3	~~Sally Smith!*~~	Sally Smith!*	A1	Table 1
	~~William Jones~~		A1	
	Joe Williams		A1	
	David Carr		B1	
	Julie Sasson!*		B1	
	Mary Edwards!		B1	
Middle 1/3	Robert Baker		C1	
	Susan Johnson!*		C1	
	Paul Taylor		C1	
	Steve Macon*	William Jones	A2	Table 2
	Sarah Oswald!		A2	
	Paula Tyler!		A2	
Bottom 1/3	John Baylor		B2	
	Jason Titus		B2	
	John Jacobson*		B2	
	Jim Johnson		C2	
	Peter Patterson*		C2	
	Deborah James!		C2	

Forming Groups

Fill in A groups heterogeneously. Women and minorities should not be alone.

Top 1/3	~~Sally Smith!*~~	Sally Smith!*	A1	Table 1
	~~William Jones~~	Susan Johnson!*	A1	
	Joe Williams	John Baylor	A1	
	David Carr		B1	
	Julie Sasson!*		B1	
	Mary Edwards		B1	
Middle 1/3	Robert Baker		C1	
	~~Susan Johnson!*~~		C1	
	Paul Taylor		C1	
	~~Steve Macon*~~	William Jones	A2	Table 2
	Sarah Oswald!	Steve Macon*	A2	
	Paula Tyler!	John Jacobson*	A2	
Bottom 1/3	~~John Baylor~~		B2	
	Jason Titus		B2	
	~~John Jacobson*~~		B2	
	Jim Johnson		C2	
	Peter Patterson*		C2	
	Deborah James!		C2	

Forming Groups

Fill in B groups the same way.

Top 1/3	~~Sally Smith!*~~	Sally Smith!*	A1	Table 1
Top 1/3	~~William Jones~~	Susan Johnson!*	A1	Table 1
Top 1/3	~~Joe Williams~~	John Baylor	A1	Table 1
Top 1/3	David Carr	Joe Williams	B1	Table 1
Top 1/3	~~Julie Sasson!*~~	Robert Baker	B1	Table 1
Top 1/3	Mary Edwards!	Jason Titus	B1	Table 1
Middle 1/3	~~Robert Baker~~		C1	Table 1
Middle 1/3	~~Susan Johnson!*~~		C1	Table 1
Middle 1/3	Paul Taylor		C1	Table 1
Middle 1/3	~~Steve Macon*~~	William Jones	A2	Table 2
Middle 1/3	~~Sarah Oswald!~~	Steve Macon*	A2	Table 2
Middle 1/3	Paula Tyler!	John Jacobson*	A2	Table 2
Bottom 1/3	~~John Baylor~~	Julie Sasson!*	B2	Table 2
Bottom 1/3	~~Jason Titus~~	Sarah Oswald!	B2	Table 2
Bottom 1/3	~~John Jacobson*~~	Peter Patterson*	B2	Table 2
Bottom 1/3	Jim Johnson		C2	Table 2
Bottom 1/3	~~Peter Patterson*~~		C2	Table 2
Bottom 1/3	Deborah James!		C2	Table 2

Forming Groups

Finish with the C groups.

Third	Ranked list	Student	Group	Table
Top 1/3	~~Sally Smith!*~~	Sally Smith!*	A1	Table 1
Top 1/3	~~William Jones~~	Susan Johnson!*	A1	Table 1
Top 1/3	~~Joe Williams~~	John Baylor	A1	Table 1
Top 1/3	~~David Carr~~	Joe Williams	B1	Table 1
Top 1/3	~~Julie Sasson!*~~	Robert Baker	B1	Table 1
Top 1/3	~~Mary Edwards!~~	Jason Titus	B1	Table 1
Middle 1/3	~~Robert Baker~~	Mary Edwards!	C1	Table 1
Middle 1/3	~~Susan Johnson!*~~	Paula Tyler!	C1	Table 1
Middle 1/3	~~Paul Taylor~~	Deborah James!	C1	Table 1
Middle 1/3	~~Steve Macon*~~	William Jones	A2	Table 2
Middle 1/3	~~Sarah Oswald!~~	Steve Macon*	A2	Table 2
Middle 1/3	~~Paula Tyler!~~	John Jacobson*	A2	Table 2
Bottom 1/3	~~John Baylor~~	Julie Sasson!*	B2	Table 2
Bottom 1/3	~~Jason Titus~~	Sarah Oswald!	B2	Table 2
Bottom 1/3	~~John Jacobson*~~	Peter Patterson*	B2	Table 2
Bottom 1/3	~~Jim Johnson~~	David Carr	C2	Table 2
Bottom 1/3	~~Peter Patterson*~~	Paul Taylor	C2	Table 2
Bottom 1/3	~~Deborah James!~~	Jim Johnson	C2	Table 2

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Lessons from the Greeks...

τεχνολόγια

Random House *Dictionary of the English Language*, Unabridged Edition
C.A.E. Luschnig's *An Introduction to Ancient Greek*, Scribner

Lessons from the Greeks...

τεχνολόγια

- τέχνη: art or skill

technique: the body of specialized procedures and methods used in any specific field; method of performance; **method of accomplishing**

Random House *Dictionary of the English Language*, Unabridged Edition
C.A.E. Luschnig's *An Introduction to Ancient Greek*, Scribner

Lessons from the Greeks...

τεχνολόγια

- λόγος: understanding or reasoning
  logical: reasonable, **carefully considered**

Random House *Dictionary of the English Language*, Unabridged Edition
C.A.E. Luschnig's *An Introduction to Ancient Greek*, Scribner

What are we talking about ?

technology

a carefully considered
means of achieving a goal

R.J. Beichner's *Dictionary of My Language*, Greatly Abridged Edition.

The Ancient Greeks

&

Instructional Technology

Grecian Auditorium

Special area designed to facilitate hearing by a large group called the “audience”

Theater of Dionysus, Athens

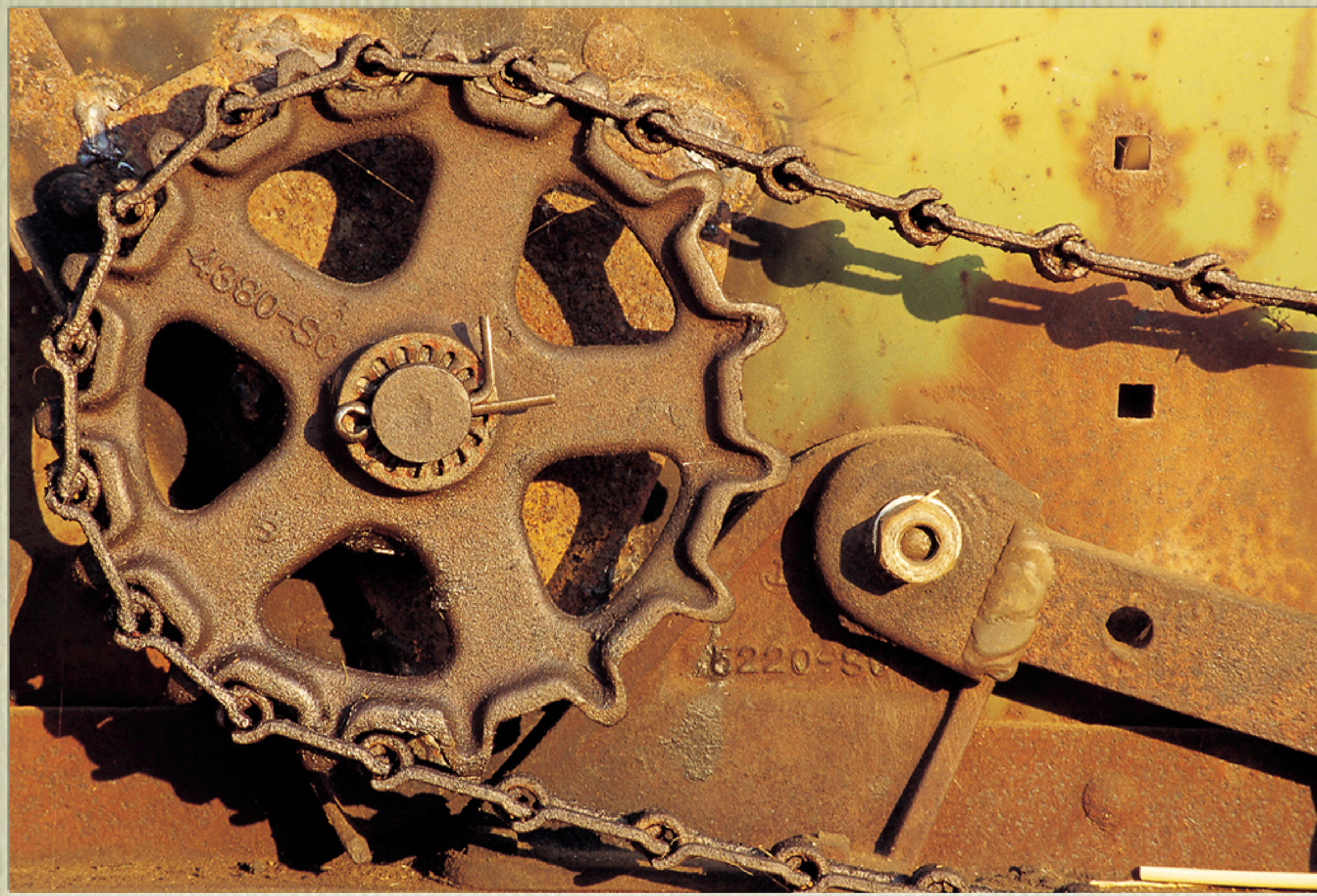
c. 500 BCE

Kalimera Kriti Hotel, Crete

c. 2000 CE

Progress ?

Auditorium = Old Technology



Entertainment is fine in an auditorium.

Education is too important and has different goals.

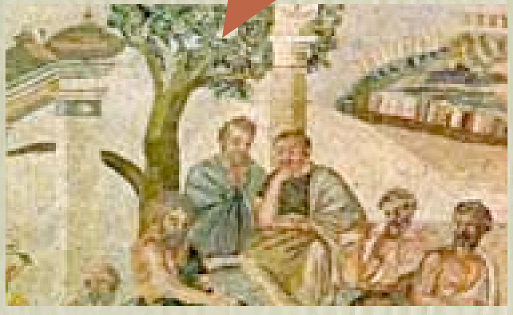
Education in Ancient Greece

- Pythagoras (Samos & Croton, 580-500 BCE)

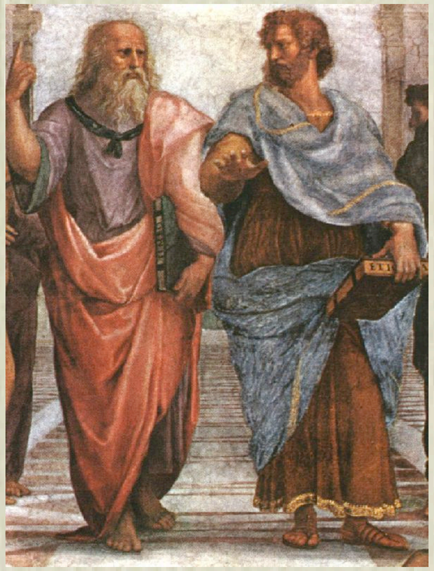
- Socrates (Athens, 469-399 BCE)

τεχνολογία
!

- Plato's Academy (Athens, 427-347 BCE)



- Aristotle's Lyceum (Athens, 384-322 BCE)



The Lecture Hall

- Pope Gregory VII called for clergy education in 1079
  - Lecturers or "readers" stood in the front of an auditorium, dictating from their personally hand-written books.
  - Students listened and made their own books.

Gutenberg's *Bible* not till 1455

(Xerographic Method of Instruction)

"dry"

Different *Technology* for a Different Purpose

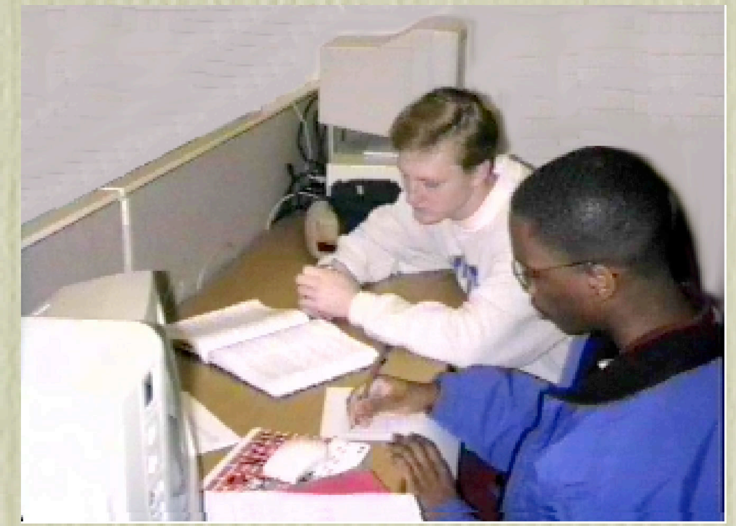
New *Technology*

Student-**C**entered **A**ctivities for
Large **E**nrollment **U**ndergraduate **P**rograms
(SCALE-UP)

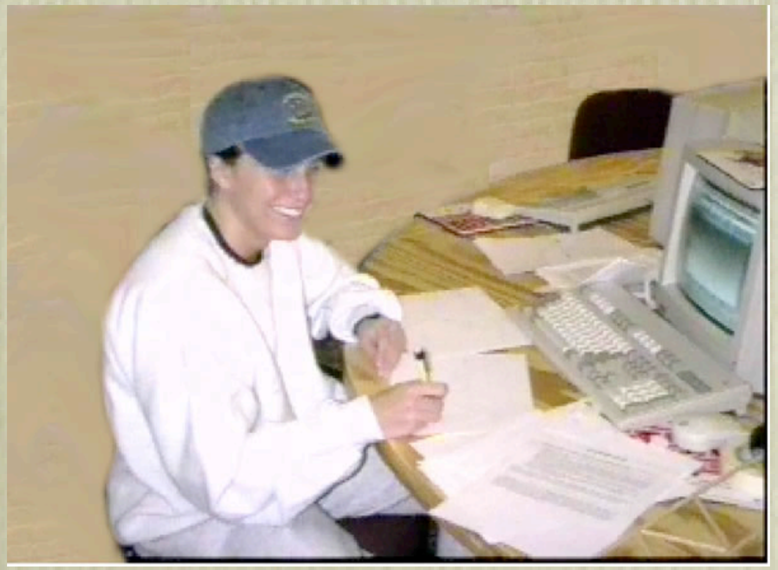
- Round Tables & Whiteboards
- Less Lecturing
- More "Doing"

Table Trials

- Lecture hall modifications



- Rectangular tables
- Round tables (6, 7, 9, 10 foot)

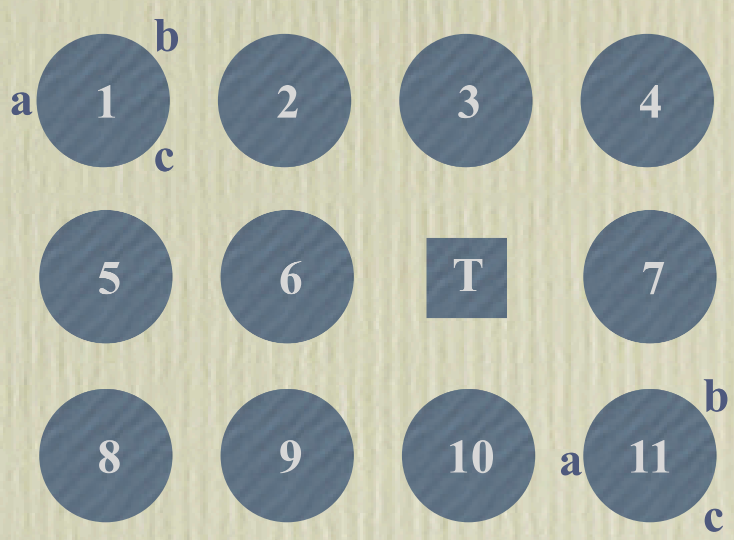



John
Chris
Mark


SCALE-UP
Student-Centered Activities for Large Enrollment
University Physics
DELL

Classroom Management

- Tables for organization

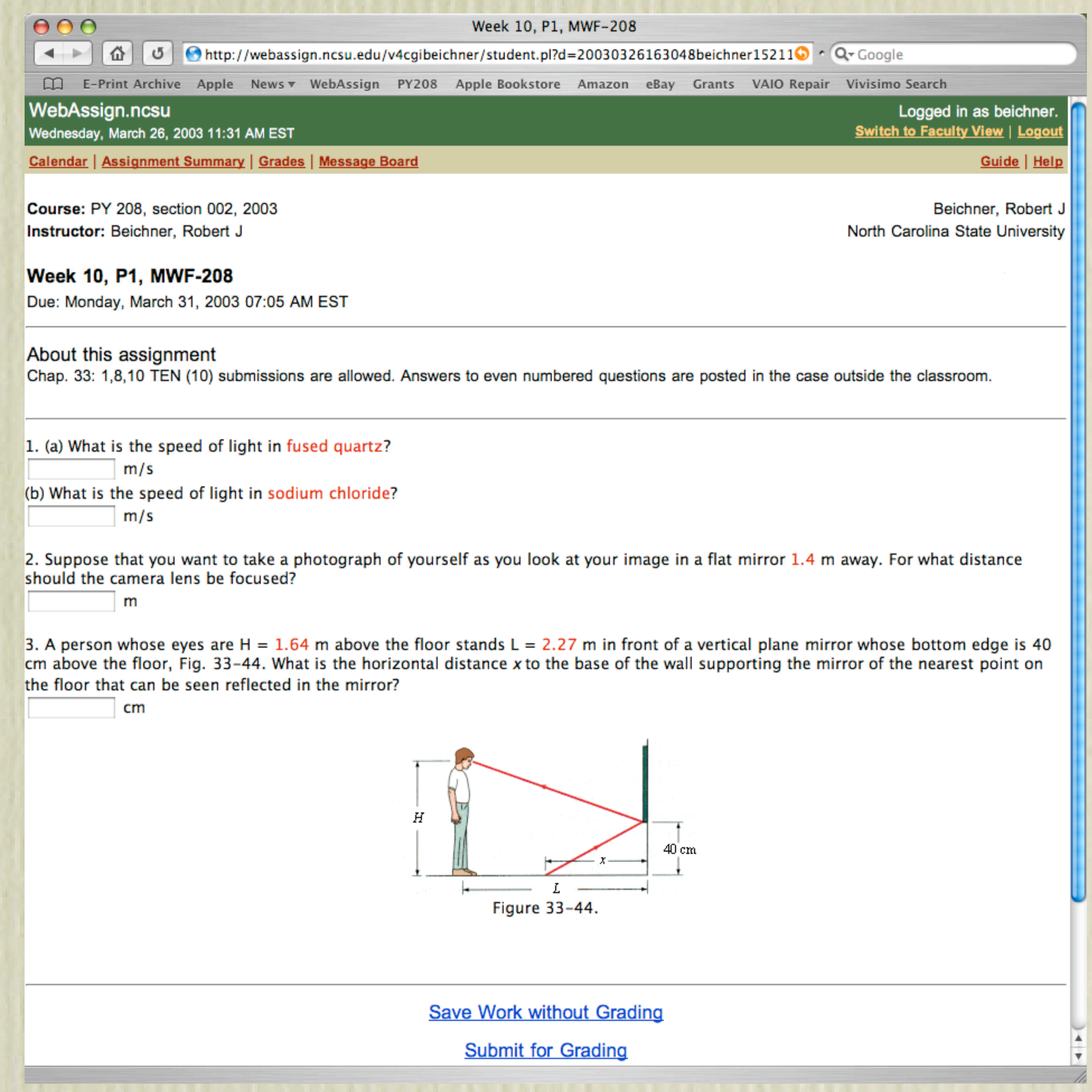


- Name Tags

- Computer Support

Grading

- Rapid Grading Scheme √− √ √+
  - Every minute/paper = 1.5 hours
- Group assignments
- Random “sampling” 
  - WebAssign
  - GOAL protocol



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Activities

- Tangibles
- Ponderables
- Simulations
- Labs
- Problem Solving

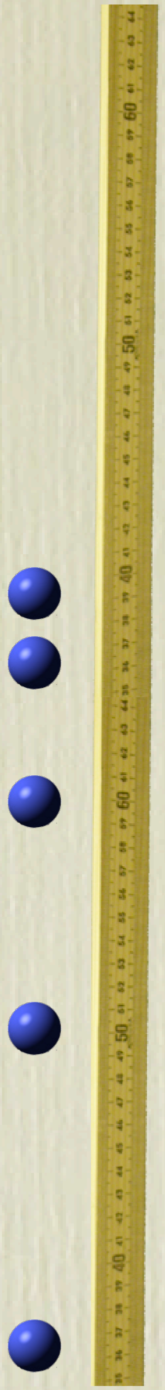
Tangibles

- How thick is one page of your text?

- How many extra electrons are on a piece of tape?

- How do you make the ball follow an arc?

- What impulse is experienced by a bouncing ball?



Activities

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Ponderables

- How far does a bowling ball skid? 
- What fraction of a candy bar is burned while walking past the snack isle?

- How many electrons can you fit on a foil-covered racquetball?

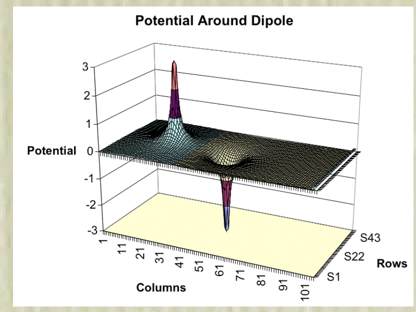
- How many two-step paces does it take to walk from NYC to LA?

Activities

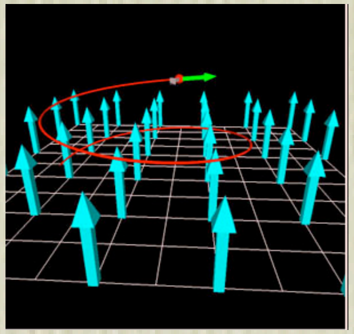
- Tangibles
- Ponderables
- Simulations
- Labs
- Problem Solving

Simulations

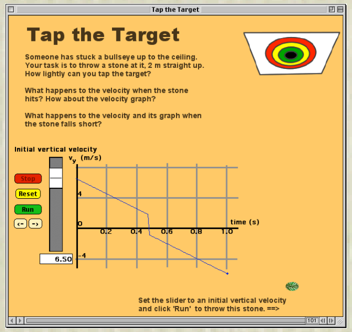
- *Excel* graph of 3-D potential well

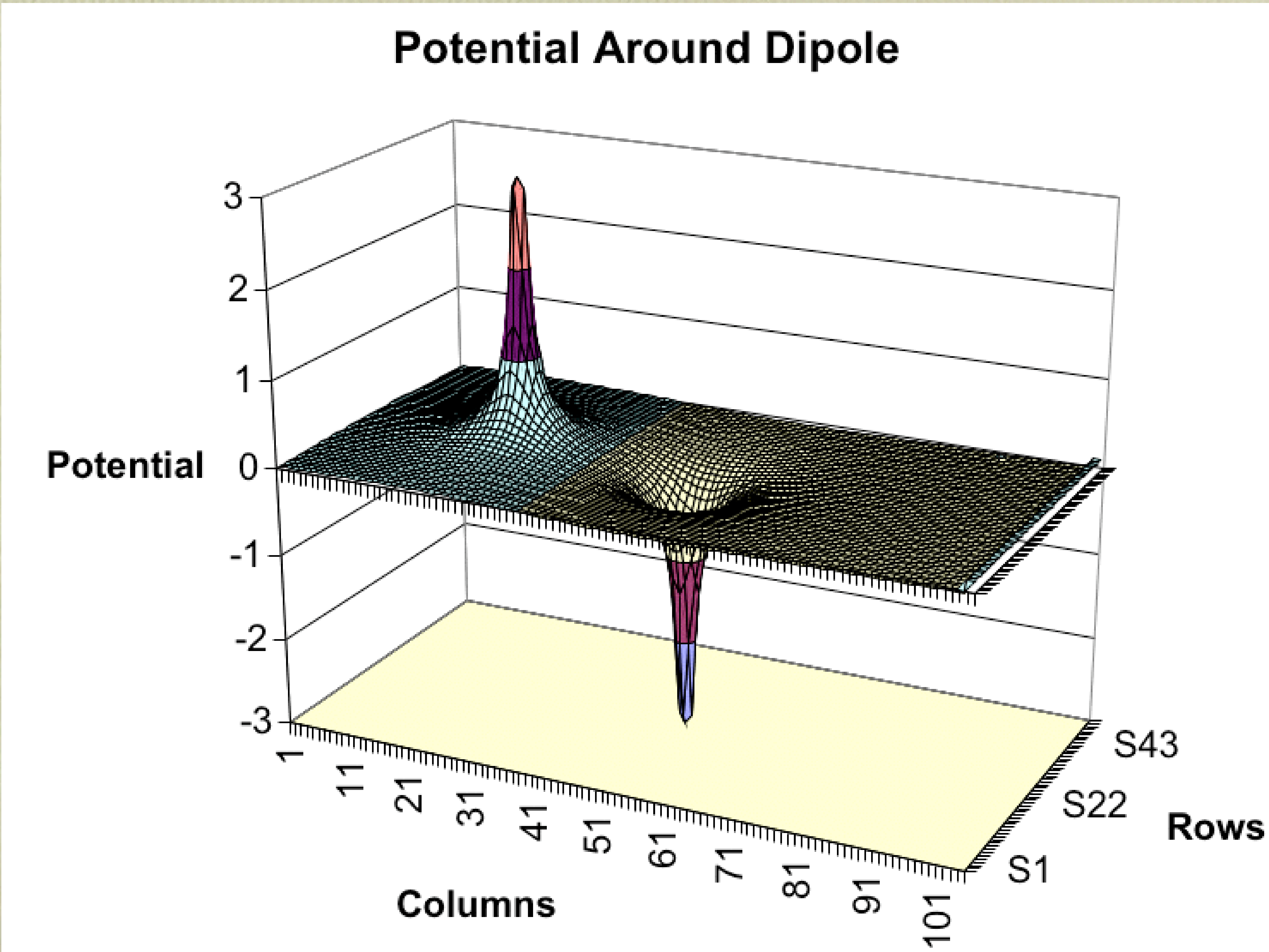


- *VPython* programming



- *Interactive Physics* vertical velocity





Potential Around Dipole
3
2
1
0
-1
-2
-3
Potential
1
11
21
31
41
51
61
71
81
91
101
Columns
S43
S22
S1
Rows

Simulations

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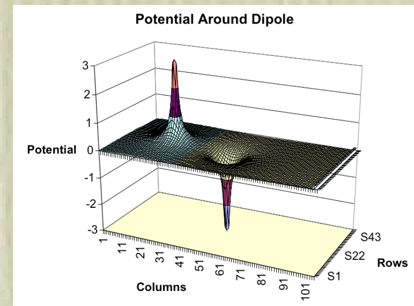

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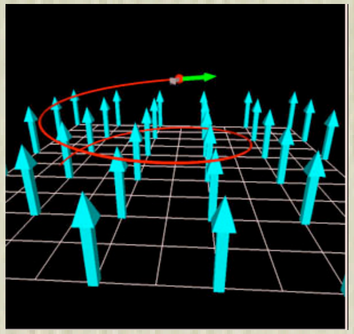

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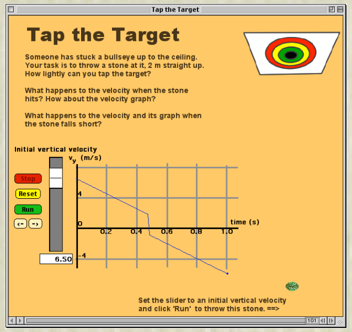
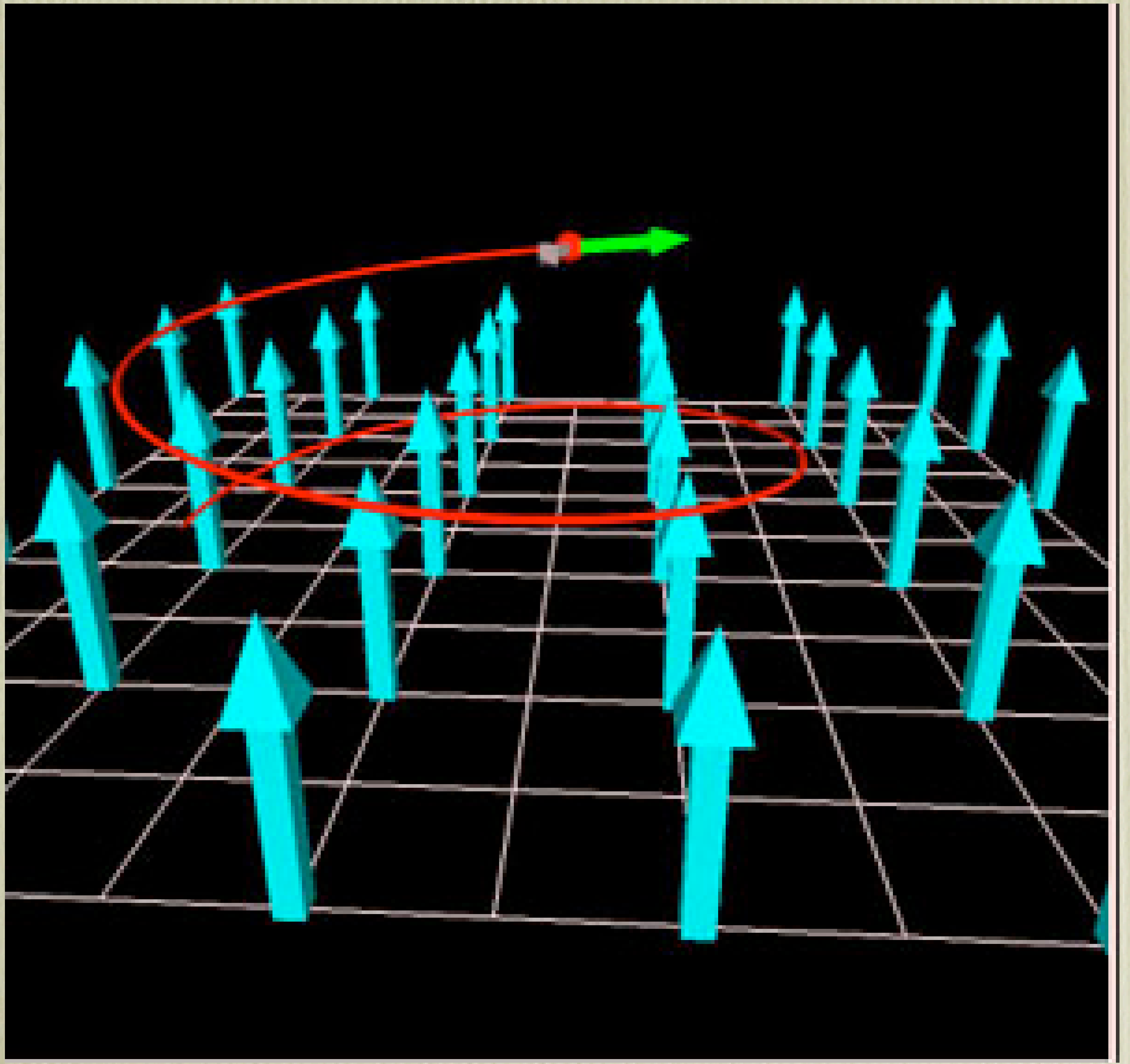
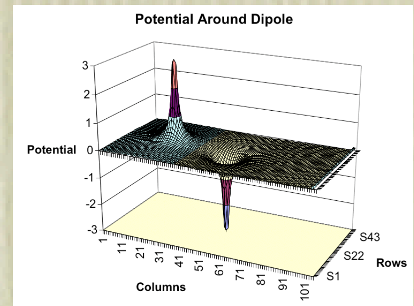




Simulations

- *Excel* graph of 3-D potential well



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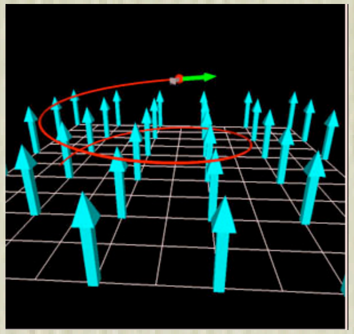

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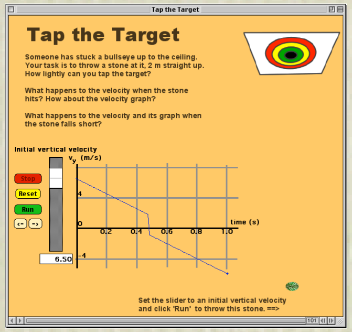
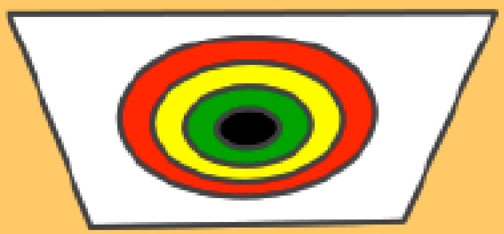


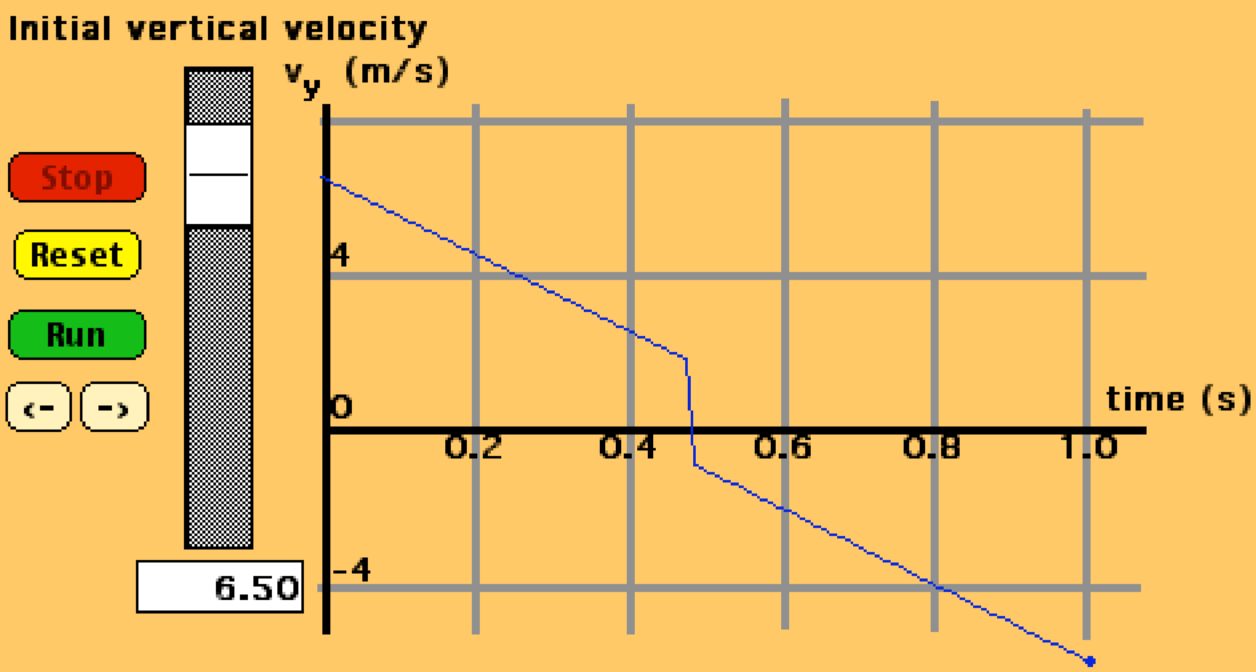
Tap the Target



Someone has stuck a bullseye up to the ceiling.
Your task is to throw a stone at it, 2 m straight up.
How lightly can you tap the target?

What happens to the velocity when the stone hits? How about the velocity graph?

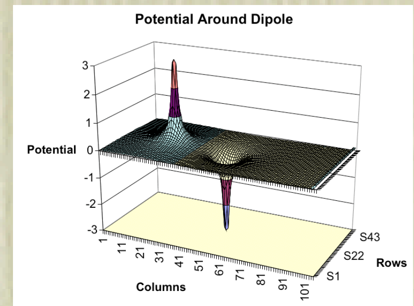
What happens to the velocity and its graph when the stone falls short?



Set the slider to an initial vertical velocity and click 'Run' to throw this stone. ==>

Simulations

- *Excel* graph of 3-D potential well



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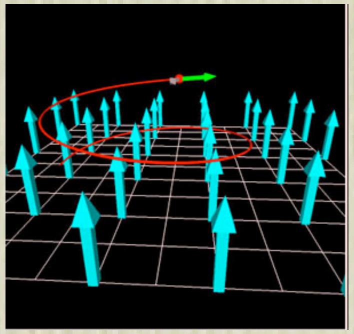

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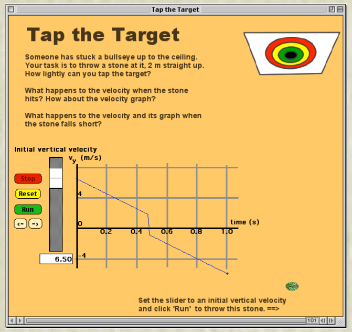
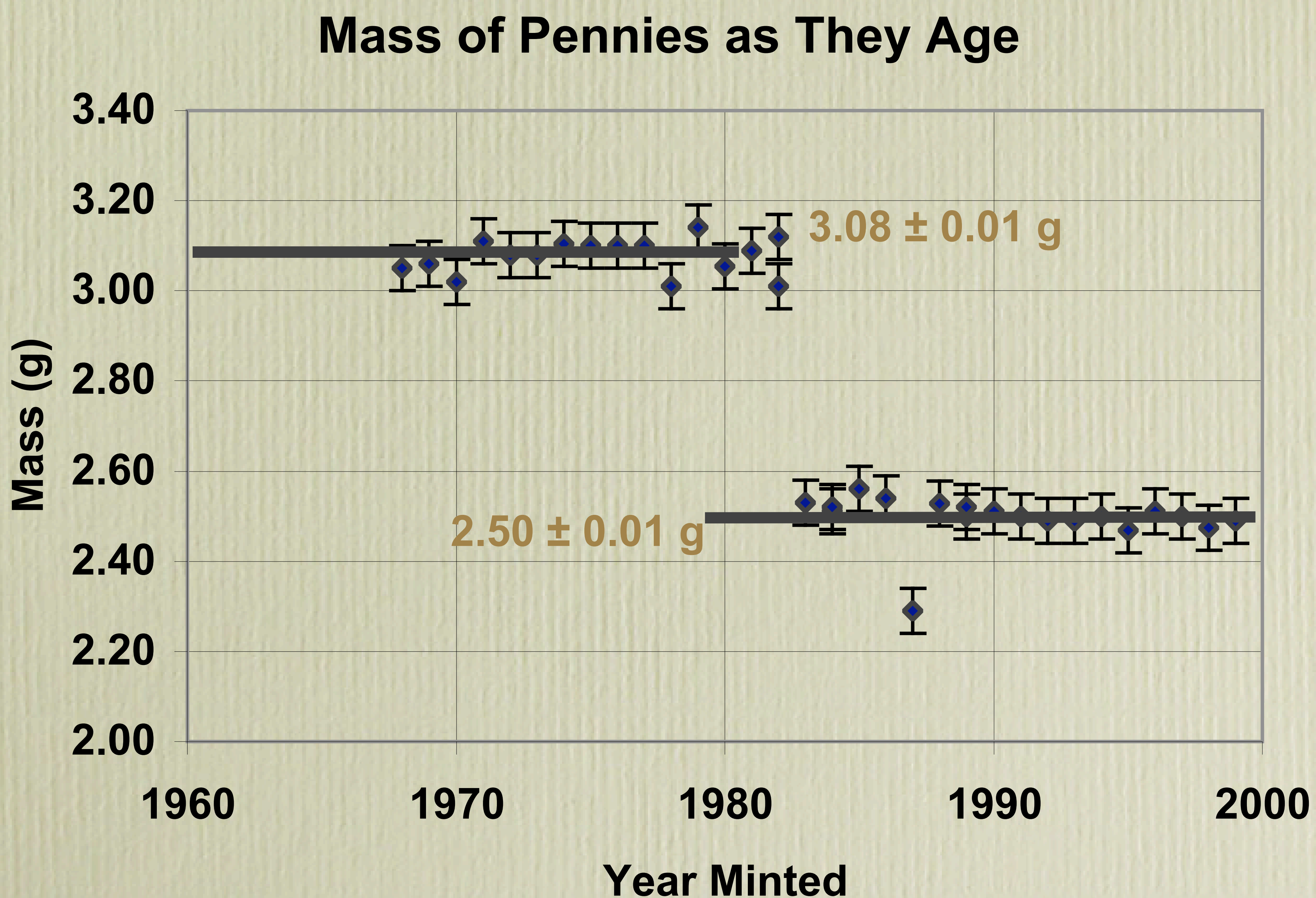


Activities

- Tangibles
- Ponderables
- Simulations
- **Labs**
- Problem Solving

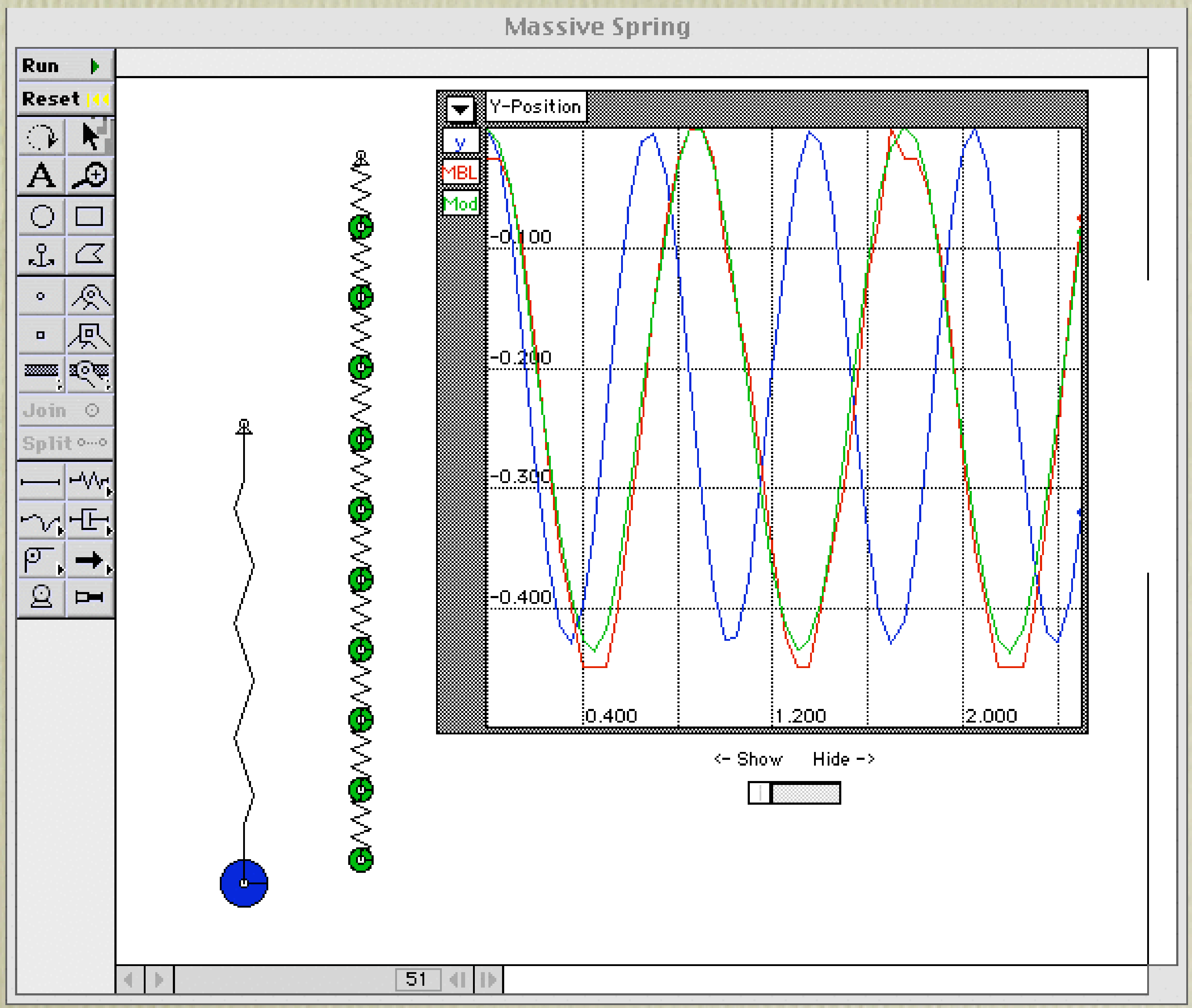
Labs

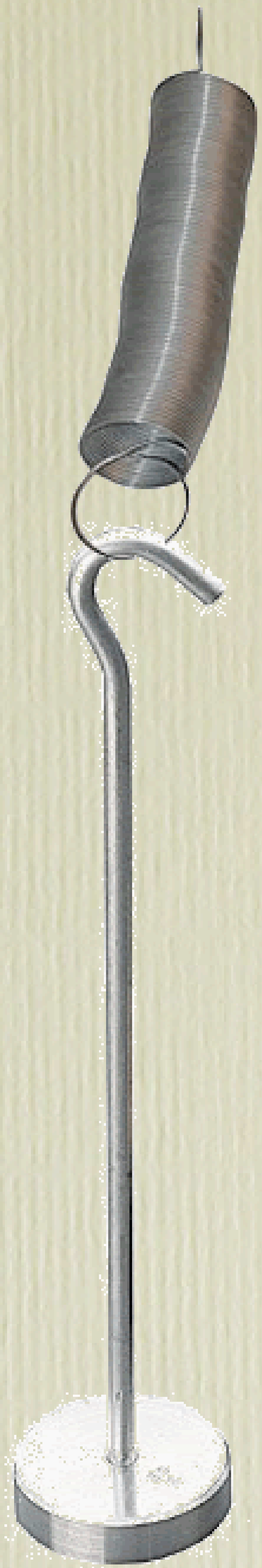
- Does the mass of a penny change as it ages?



Labs

- Model an oscillating mass on a spring






GO

Lab Details

- Purpose
- Grading (rubric for students and instructors)
- Clear expectations with guidance
- Pre/post lab activities, reports, teamsmanship

Activities

- Tangibles
- Ponderables
- Simulations
- Labs
- **Problem Solving**

Problem Solving Protocol

Explicitly Taught & Required

- Gather
- Organize
- Analyze
- Learn

Design a child's spring-loaded toy gun that will safely launch a ping-pong ball. Make sure you explicitly state the relevant specifications of your design. You'll need to convince the legal team that your toy is safe, so be sure to note any important design considerations.

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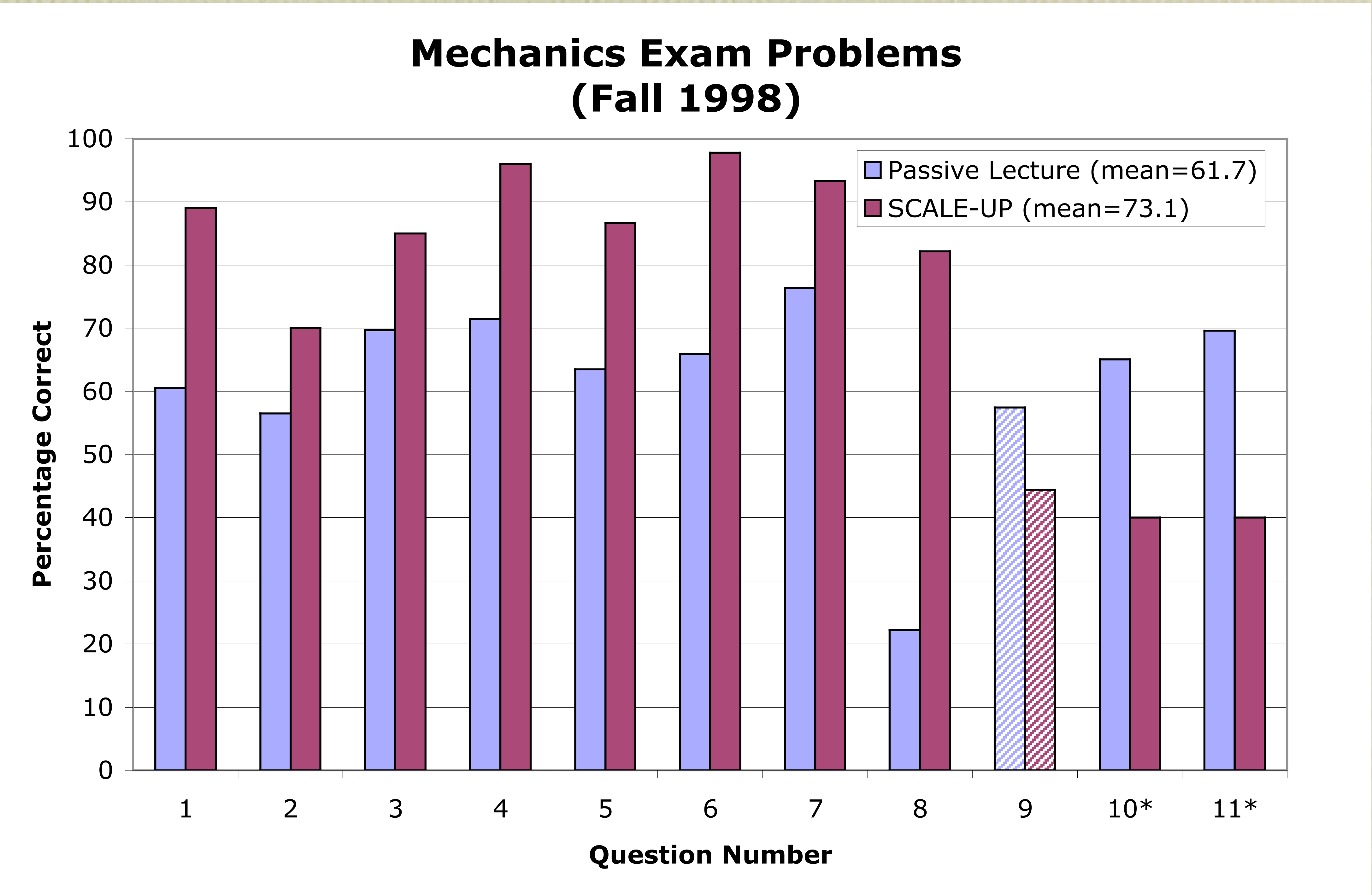
Does it Work ?

- Problem Solving
- Pass/Fail Rates
- Conceptual Learning
- Attitudes
- Performance in Later Classes

Can they solve problems ?



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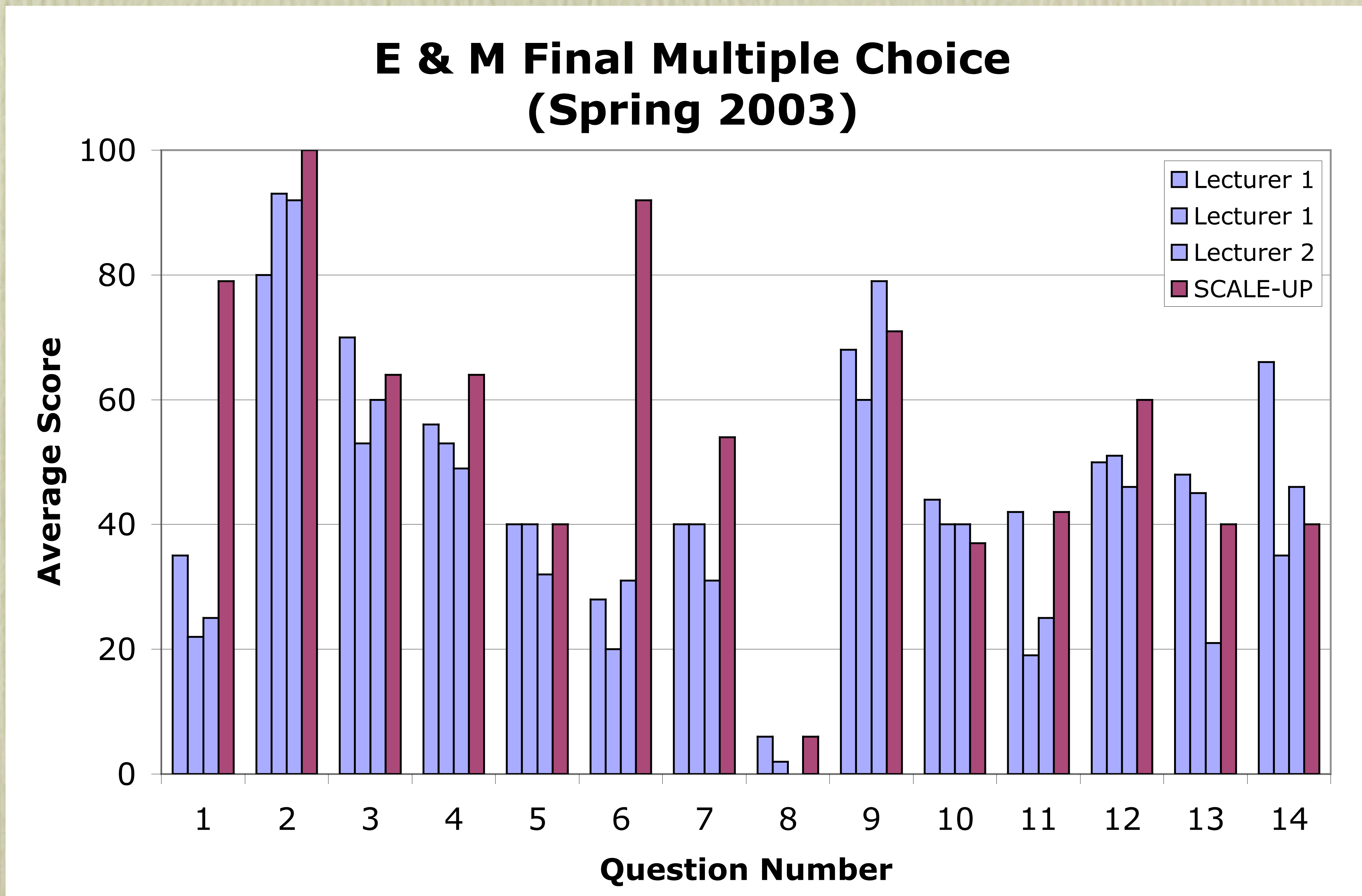

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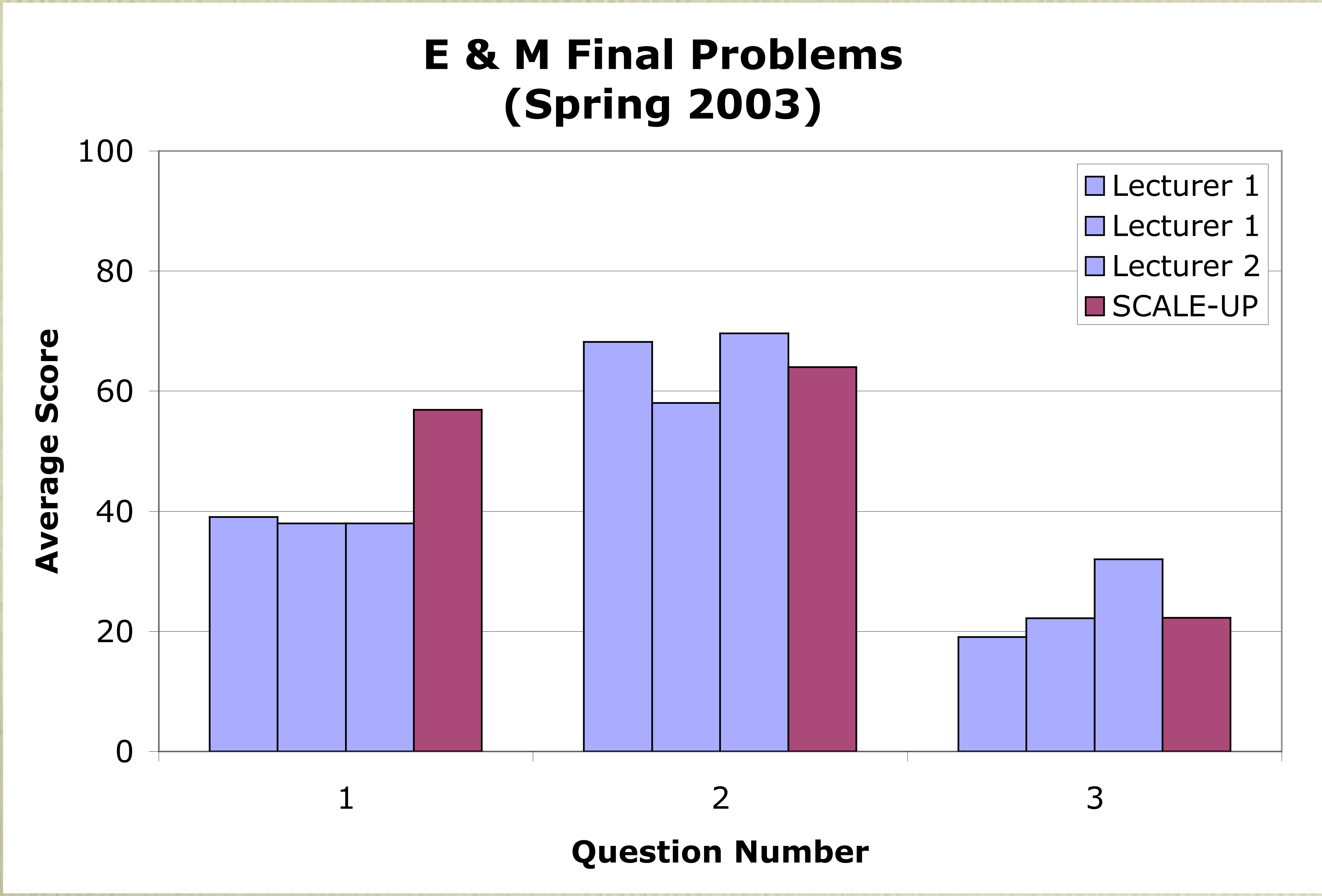

Does it Work ?

- Problem Solving
- Pass/Fail Rates
- Conceptual Learning
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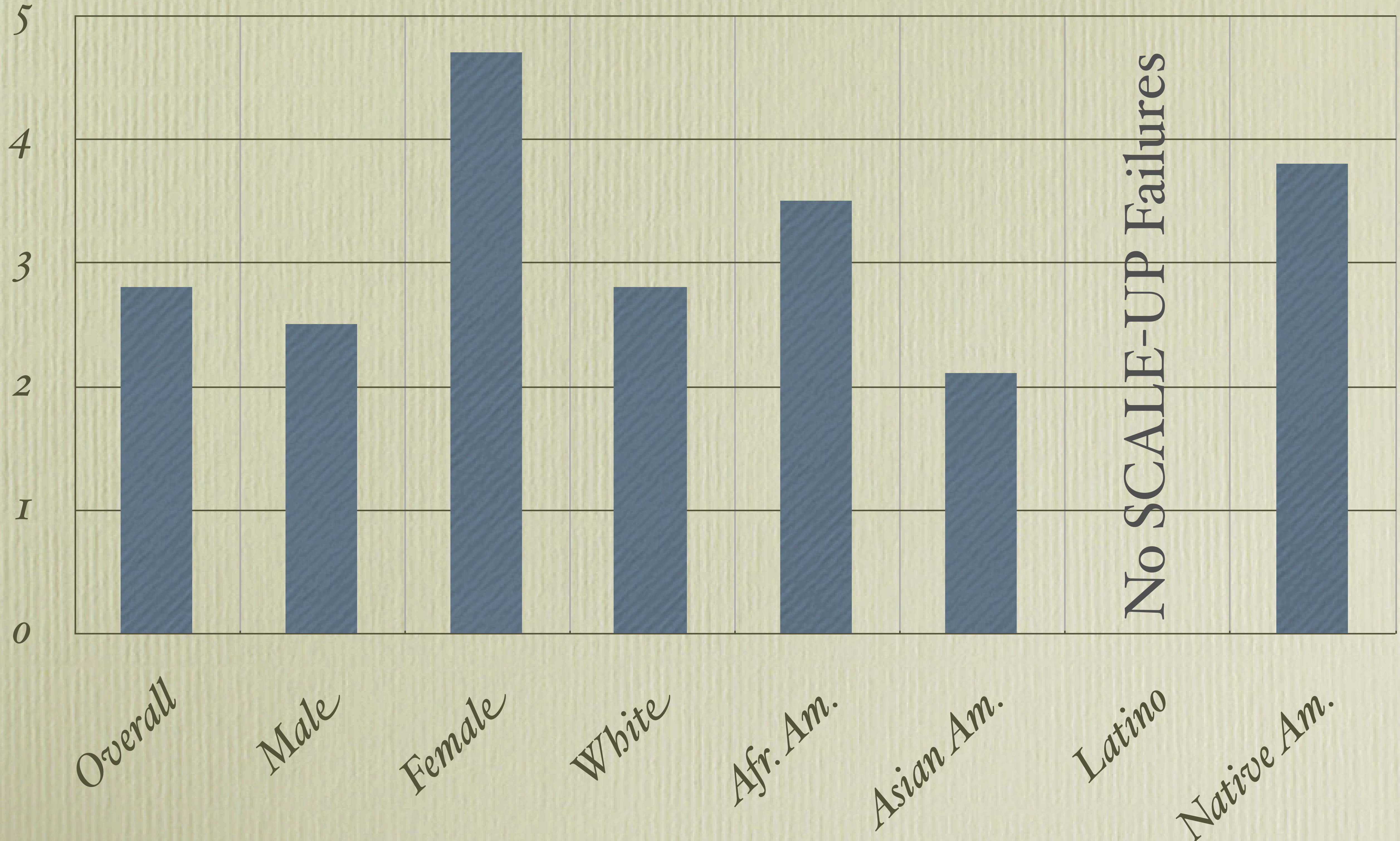
Pass/Fail Rate Ratios

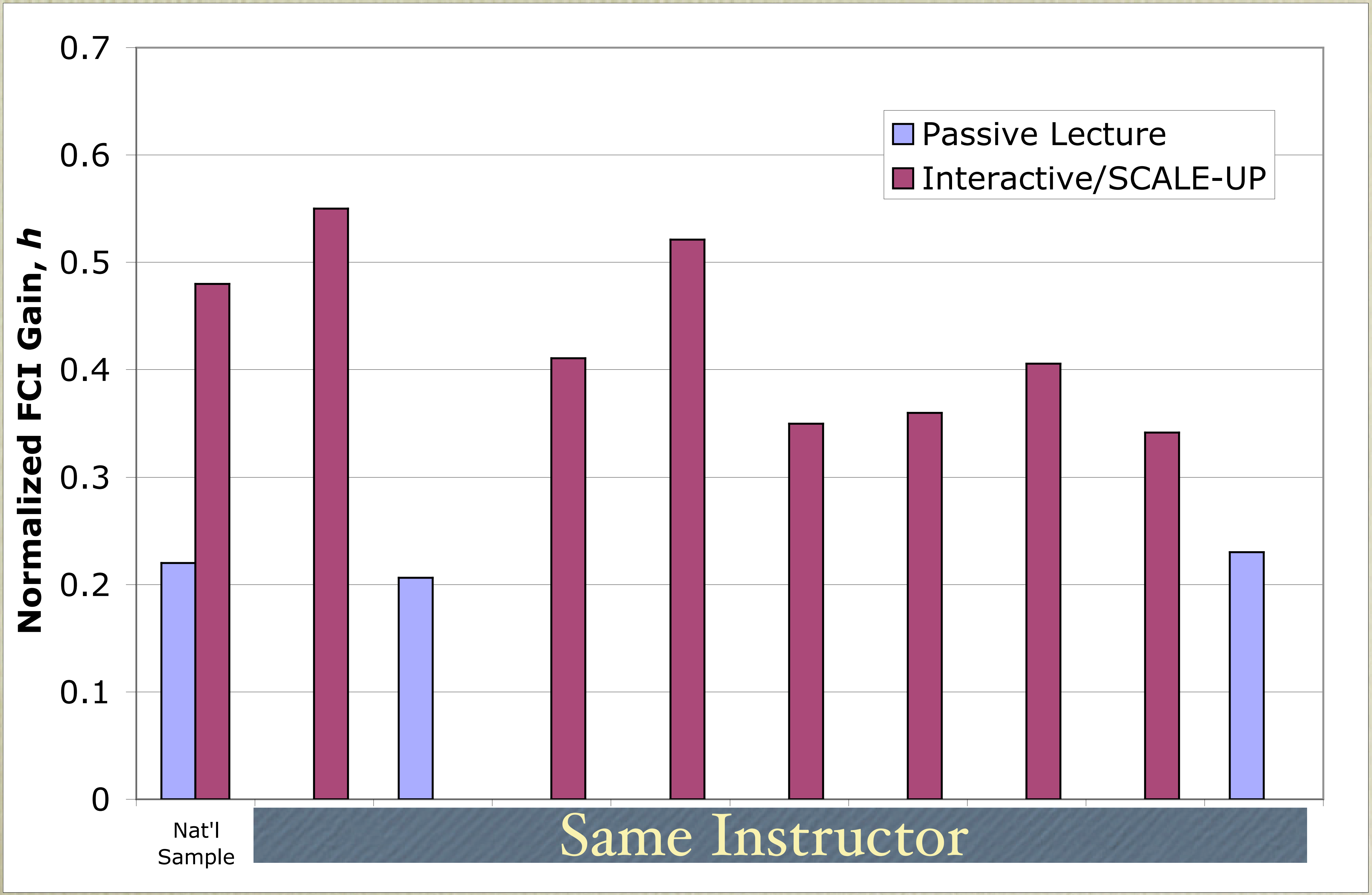
Fall 1997 through Spring 2002 (N > 16,000)



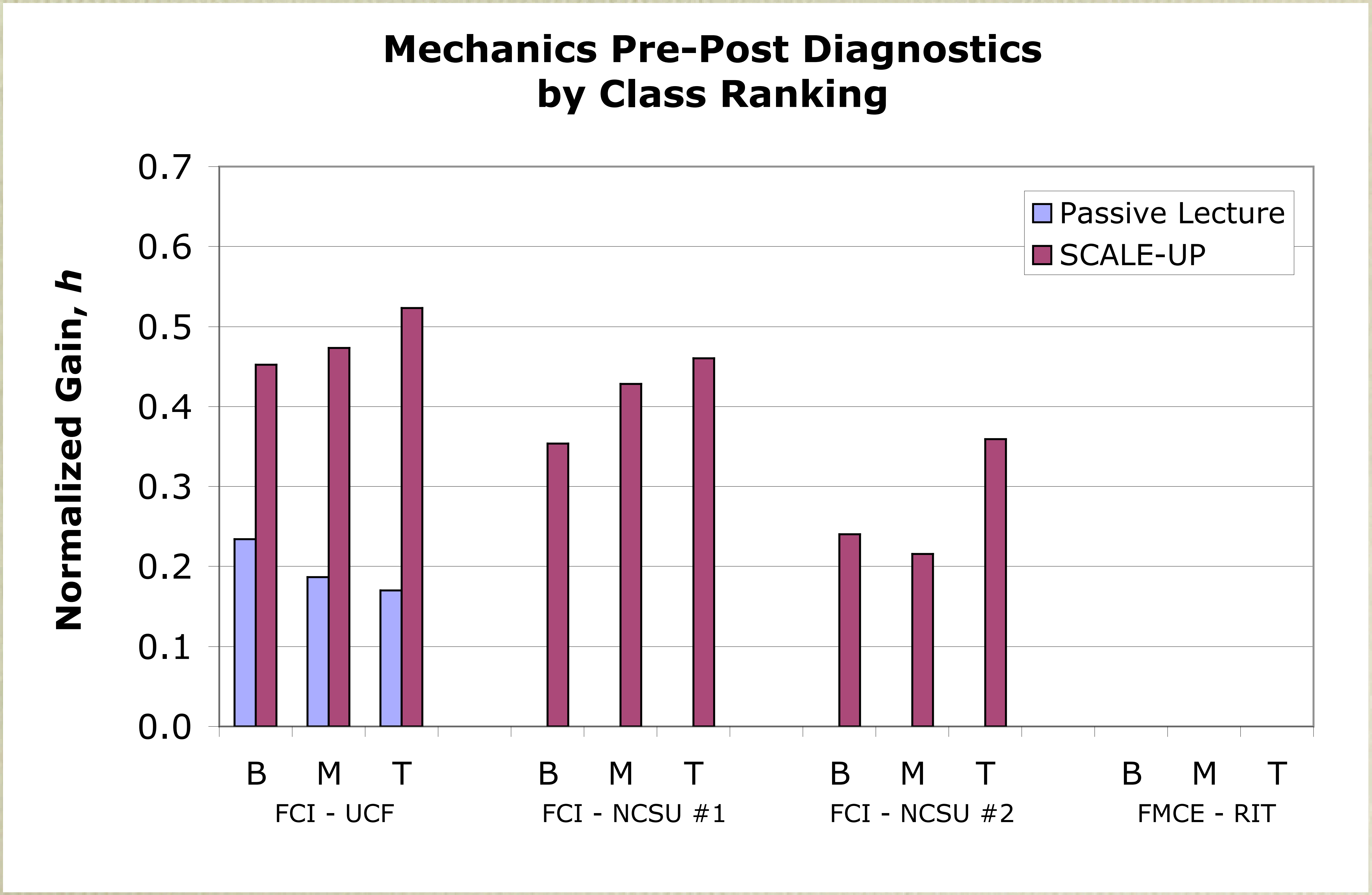
Does it Work ?

- Problem Solving
- Pass/Fail Rates
- Conceptual Learning
- Attitudes
- Performance in Later Classes

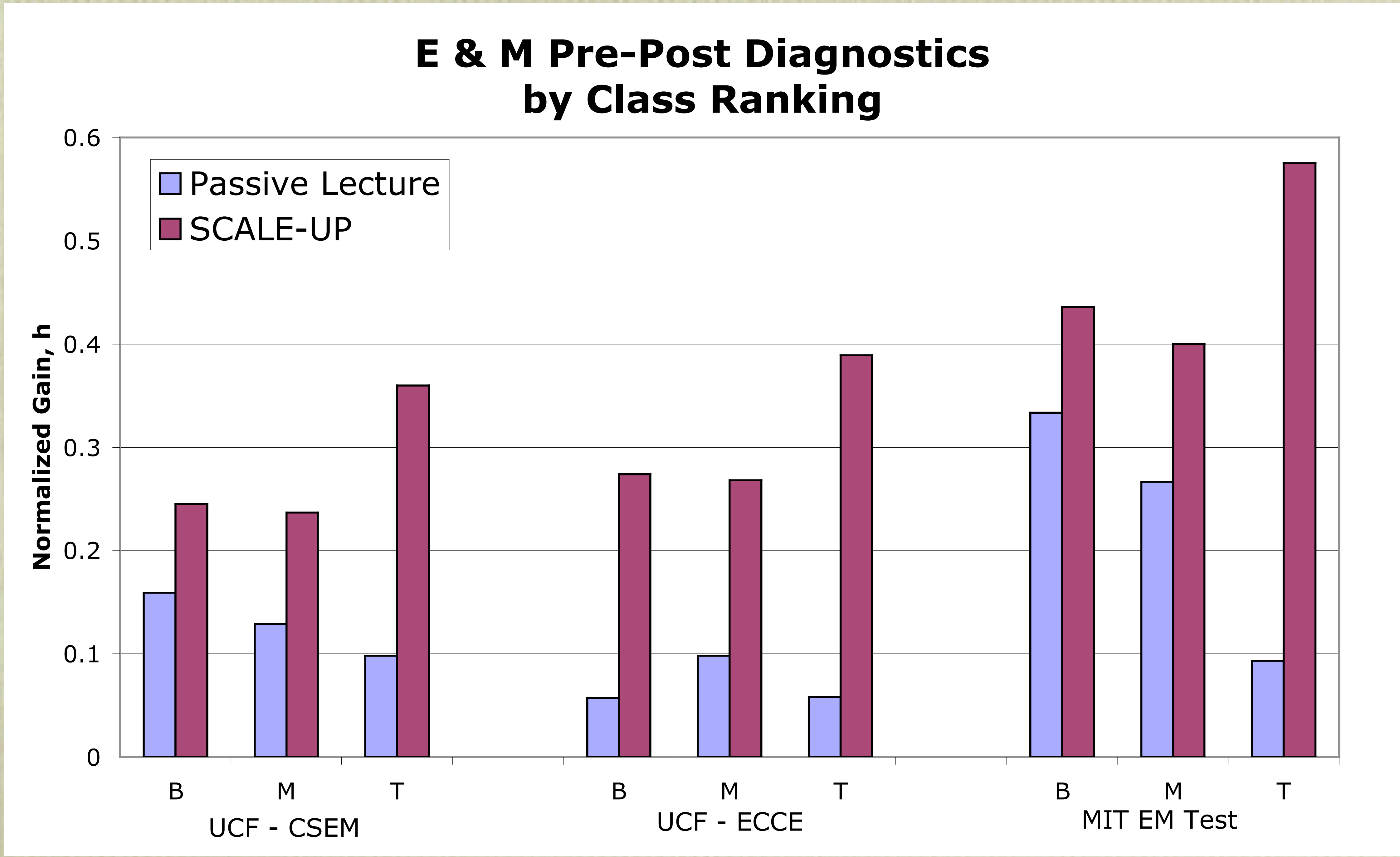
Conceptual Learning



Conceptual Learning



Conceptual Learning



Does it Work ?

- Problem Solving
- Pass/Fail Rates
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- Attitudes
- Performance in Later Classes

Attitudes

(Same Instructor)	Lecture/Lab	SCALE-UP
# Classes	3	6
# Students	263	342
% Attendance	75.2	90.3
Std. Dev.	24.0	11.6

Attitudes

- "I can deal with the lecture class, it's just that I enjoy more...getting more into the interactive projects. It's more hands on. If you don't understand something, you just ask the guy next to you. Nobody yells at you for talking."

- "...you have a professor right in the middle and...a couple of guys spread out and you can flag them down...In the lecture, you are sitting...25 rows back. You really don't have anyone but the two people next to you and they don't know. You really don't have anyone with some knowledge to help you out."

Does it Work ?

- Problem Solving
- Pass/Fail Rates
- Conceptual Learning
- Attitudes
- Performance in Later Classes

Later Performance

- S-UP Mechanics students do significantly better in later E & M course (whether traditional or S-UP)
- S-UP students do a little worse than traditional students in later Engineering Statics course
  - But much larger fraction pass SCALE-UP
  - No difference in passing rates for SAT > 500
  - Of students with SAT Math < 500, 83% of S-UP pass Statics vs. 69% of traditionally taught students.

Thanks to Dr. Joni Spurlin

SCALE-UP: Student-Centered Activities for Large Enrollment Undergraduate Programs

- Actively **engage** students in their learning
- Design an **environment** to support learning
- Develop/modify instructional **activities**
- **Assess** impact on learning
- **Encourage** others to adopt what works

Adopting Schools

- SCALE-UP approach is being tried at many schools; in physics, chemistry, and soon engineering and mathematics.

Adopters

American University

Adopters

University of Central Florida

Adopters

Coastal Carolina University

Adopters

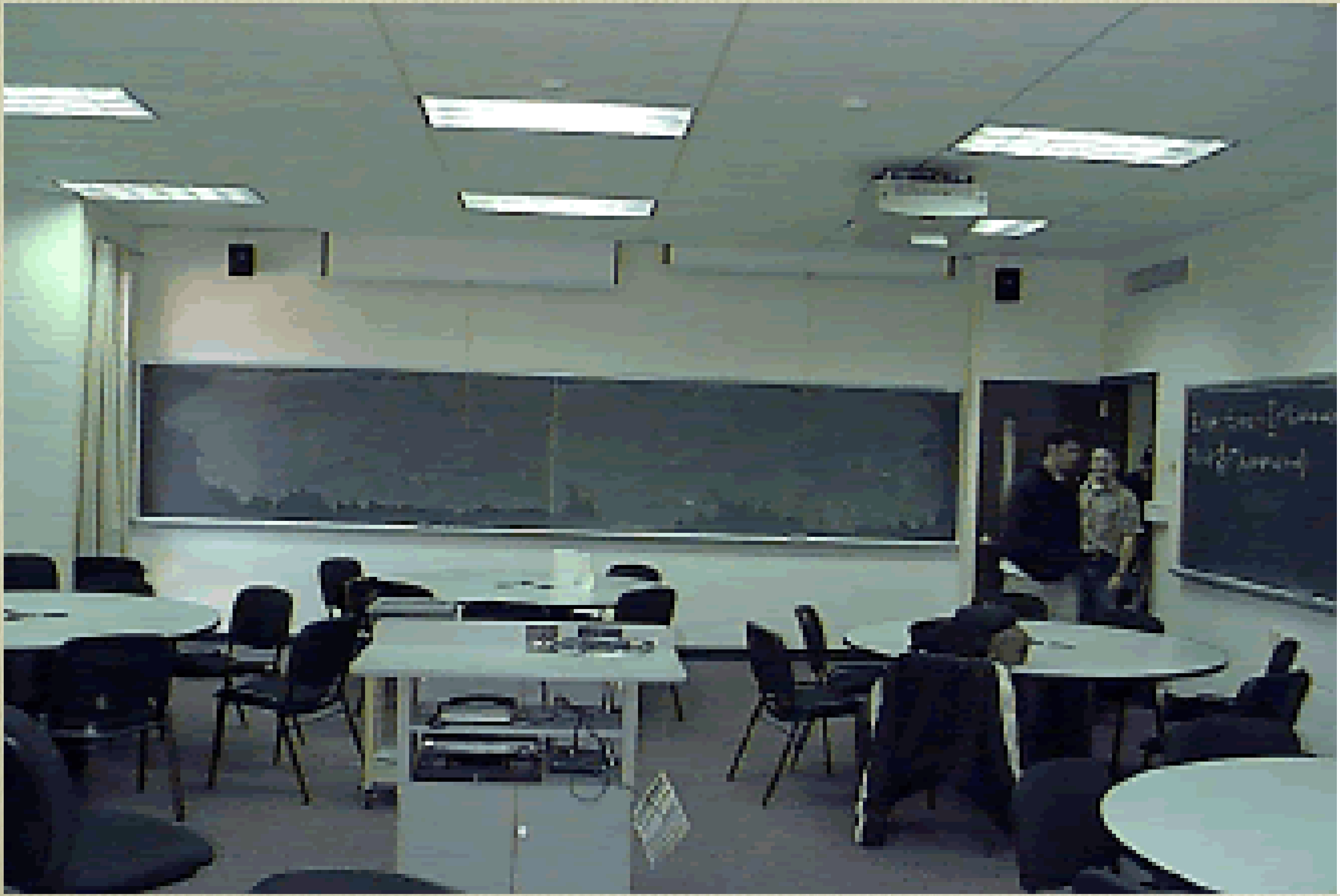
MIT

Adopters

University of New Hampshire

Adopters

RIT



Adopters

Photos not available for:

University of Alabama
Bradley University
Raleigh Charter High School
Wake Technical Community College

also under consideration at:
Clemson, Colorado, SUNY Oswego,
Iowa State, Florida State

“Products”

- Lesson Plans
- Handouts, Web pages, Supporting files
- Classroom design specifications & help
- Teacher enhancement guides
- Travel assistance
- “Mainstreaming” in Textbooks

Bouncing Ball plan for 1/2 hour

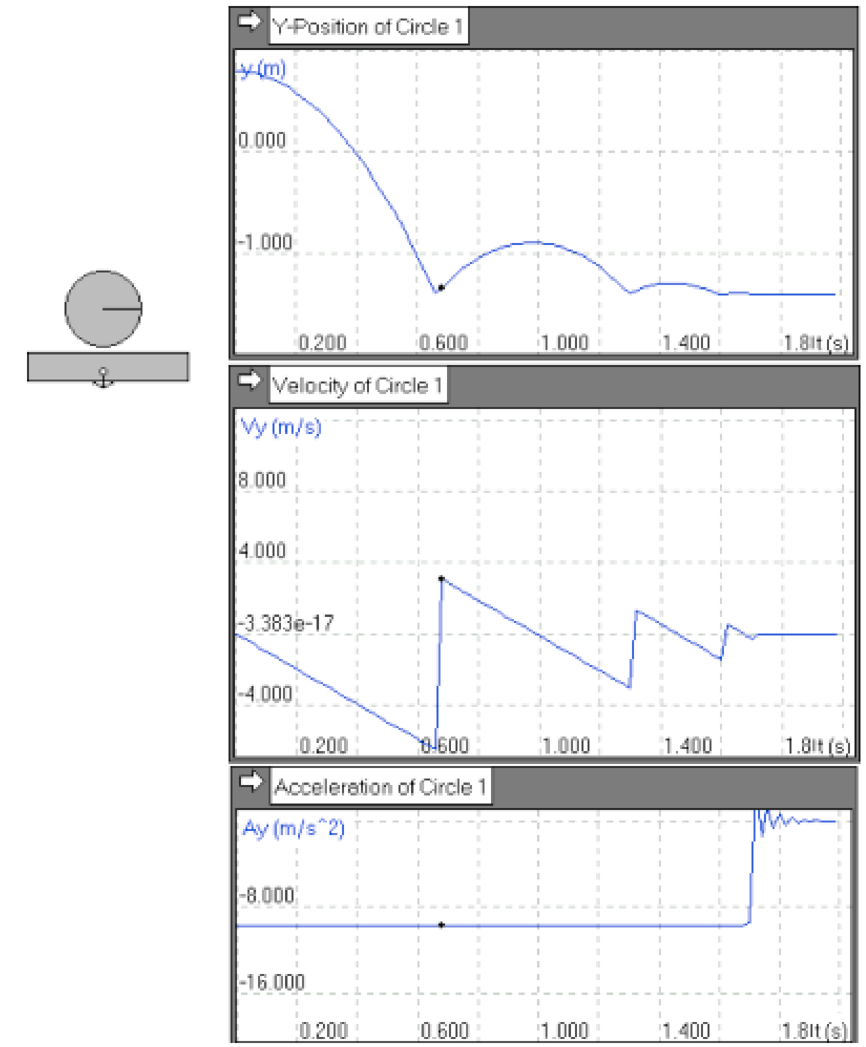
Students have a great deal of difficulty making the connection betwe
events and the graphs representing that motion. The purpose of this
to help students make that connection and see an example of the str
shortcomings of *Interactive Physics* simulation software.

Objectives:

After completing this exercise, students should be able to sketch gra
position, velocity, and acceleration versus time when they are presen
simple motion event. They will recognize the relationships between
graphs and be able to produce either of the other two graphs when g
the them. They will also be able to create simple simulations using *I*
Physics.

Misconceptions:

Students have a great deal of difficulty interpreting kinematics graph
often construct graphs from data points, but don't really know what
graphs represent. The most common mistake is called the "graph as
error. They expect graphs to be similar to a photographic representa
motion event. Basically, they believe all kinematics graphs will look l
of *y* vs. *x*. Making the transition from an abscissa of *x* to one of *t* is a
point we often skip over.



Related activities:

Graphs and Tracks exercises and group challenges.
Use of Sonic Ranger to get kinesthetic experience and relate to graphs.
Excel curve fitting and model making from position & time data.
VideoGraph or *VideoPoint* analysis of freefall or coffee filter drop.

Task	Reason	Notes
1. **Drop a racquetball** from rest, let it bounce three times, and catch it. Have each individual write down as thorough a description of the motion as they can, using works.	Eventually we want them to see how compact, yet complete graphs can be. They allow trends to be seen without obscuring the details.	Warn students that "gravity" and "force" are not allowed words since they haven't been covered yet.
2. Have a few **people read** what they wrote. Discuss the motion as a large group.	We want them to thoroughly examine the motion situation.	Make sure everyone hears what is said. You will probably have to repeat it.

Spring Force Constant Determination as a Learning Tool for Graphing and Modeling

Newton, I.[1*], Galilei, G.[1†], & Einstein, A.[1‡]
*(1. PY205_011 Group 4C; * Manager, † Skeptic, ‡ Reporter)*

One of the goals of science is the development of physical and mathematical models to describe physical systems by using observational and experimental data. We then use these models to either explain previously observed data or to predict results that have not actually been observed where the quality of the model determines its predictive value. In this experiment, we focused on developing a mathematical model relating the applied force on a spring and the resulting change in length (or stretching). We suspended weights of known masses (ranging from 0 g up to 270 g) from a randomly chosen spring and measured the changes in length of the spring. We then plotted the change in length (m) against the force (N) exerted by the mass on the spring for all our data points. From our data, we saw a clear linear relationship between force and displacement. Using linear regression, we determined our spring force constant, F_s, to be 21.3 N/m and the initial tension, T_{init}, of our spring to be approximately 0.5 N. Our results correlated nicely with Hooke's Law, which provides a general mathematical model for springs under compression and extension, but we further refined the prevailing mathematical model by incorporating T_{init}.

I. INTRODUCTION

This lab focuses on generating a model relating the force applied to a spring and the distance the spring stretches from its original length, or *rest length*. This relationship is well understood as Hooke's Law and states 1) extension of a spring is proportional to the applied force and 2) a spring will return to its rest length when the force is removed so long as the *elastic limit* has not been exceeded. Beyond the *elastic limit*, springs exhibit *plastic behavior* where additional force causes deformation of the spring such that the original or rest length is altered. Hooke's Law is illustrated in Fig. 1[(1)].

Mathematically, Hooke's Law can be described in Eqn. 1[(2)] where F_{s_w} is equal in magnitude to both N_{w_s} and W_{e_w} (the applied force), k is the spring's force constant, which is unique for any given spring and is a measure of the spring's stiffness, and d is the displacement change in length of the spring from its rest position.

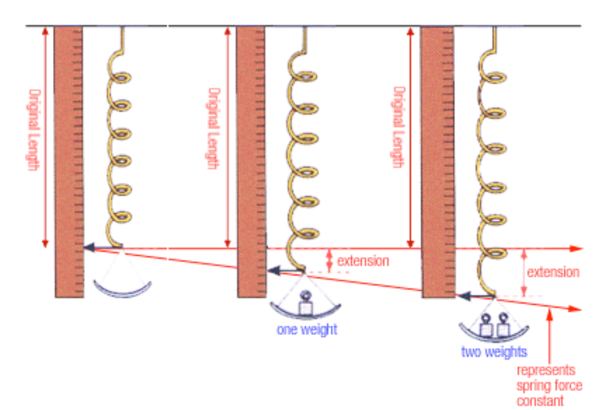


Fig. 1. Illustration of Hooke's Law. As additional weights are added, there is a linear increase in the length of the spring.

$$\left|F_{s\to w}\right| = \left|W_{e\to w}\right| = (k * d) = (m_{weights} * g) \qquad (1)$$

The free body diagrams describing the elements in this system are in seen Fig. 2. Notice that F_{s_w} and N_{w_s} are Newton 3rd law pairs.

We are specifically interested in experimentally determining the spring constant, k, for our given spring. This spring constant arises from various physical

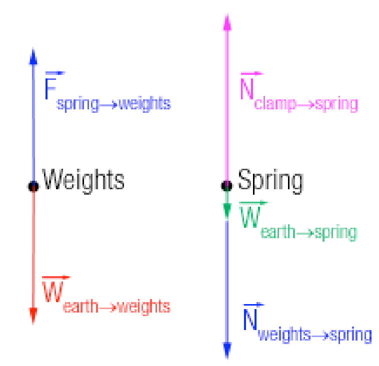


Fig. 2. Simple free body diagrams illustrating relationship between forces present in our model.

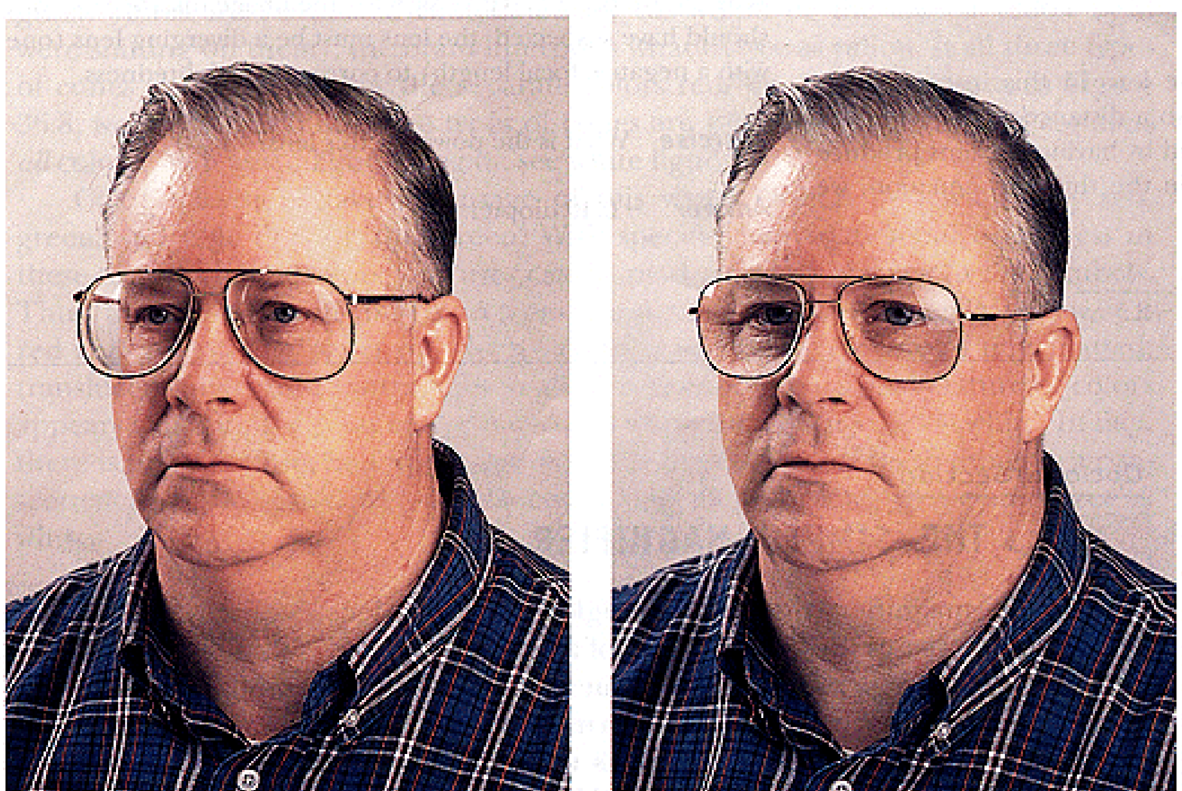
"Mainstreaming"

QuickLab

Determine the thickness of a page from this book. (Note that numbers that have no measurement errors—like the count of a number of pages—do not affect the significant figures in a calculation.) In terms of significant figures, why is it better to measure the thickness of as many pages as possible and then divide by the number of sheets?

Quick Quiz 36.5

Which glasses in Figure 36.38 correct near-sightedness and which correct farsightedness?



(a) (b)

Besides what you might expect to learn about physics concepts, a very valuable skill you should hope to take away from your physics course is the ability to solve complicated problems. The way physicists approach complex situations and break them down into manageable pieces is extremely useful. We have developed a memory aid to help you easily recall the steps required for successful problem solving. When working on problems, the secret is to keep your GOAL in mind!

GOAL Problem-Solving Steps

Gather information

The first thing to do when approaching a problem is to understand the situation. Carefully read the problem statement, looking for key phrases like "at rest" or "freely falls." What information is given? Exactly what is the question asking? Don't forget to gather information from your own experiences and common sense. What should a reasonable answer look like? You wouldn't expect to calculate the speed of an automobile to be 5×10^6 m/s. Do you know what units to expect? Are there any limiting cases you can consider? What happens when an angle approaches 0° or 90° or when a mass becomes huge or goes to zero? Also make sure you carefully study any drawings that accompany the problem.

Organize your approach

Once you have a really good idea of what the problem is about, you need to think about what to do next. Have you seen this type of question before? Being able to classify a problem can make it much easier to lay out a plan to solve it. You should almost always make a quick drawing of the situation. Label important events with circled letters. Indicate any known values, perhaps in a table or directly on your sketch.

Analyze the problem

Because you have already categorized the problem, it should not be too difficult to select relevant equations that apply to this type of situation. Use algebra (and calculus, if necessary) to solve for the unknown variable in terms of what is given. Substitute in the appropriate numbers, calculate the result, and round it to the proper number of significant figures.

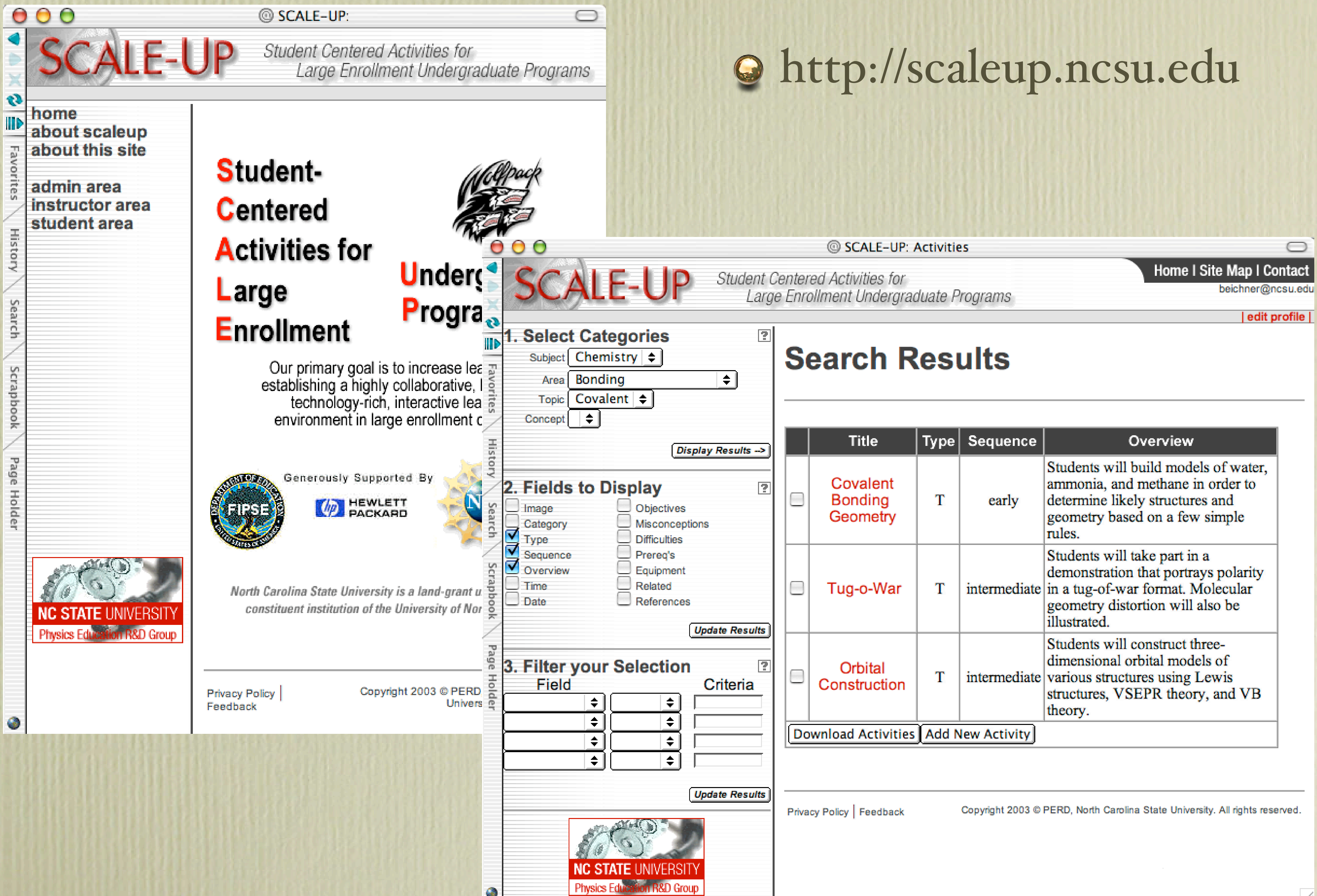
Learn from your efforts

This is the most important part. Examine your numerical answer. Does it meet your expectations from the first step? What about the algebraic form of the result—before you plugged in numbers? Does it make sense? (Try looking at the variables in it to see whether the answer would change in a physically meaningful way if they were drastically increased or decreased or even became zero.) Think about how this problem compares with others you have done. How was it similar? In what critical ways did it differ? Why was this problem assigned? You should have learned something by doing it. Can you figure out what?

When solving complex problems, you may need to identify a series of subproblems and apply the GOAL process to each. For very simple problems, you probably don't need GOAL at all. But when you are looking at a problem and you don't know what to do next, remember what the letters in GOAL stand for and use that as a guide.

For more information:

- http://scaleup.ncsu.edu



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What’s Next ?

- New curriculum: *Matter & Interactions*
- Chemistry, Engineering, and Math (NCSU)
- Biology (Puerto Rico, Colorado?)
- Algebra-based Physics (WKy)
- Physical Science for K-12 Teachers (UCF)
- Physical Oceanography (Coastal Carolina)
- New Textbook