

# Assessment: Shifting the focus from teaching to learning



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# Overview

- Some context-My background
- What do I mean by “assessment”
- **Why** do assessment?
- **What** should one assess?
- Some example assessments
- Some example findings
- **How** to do assessment with efficiency in mind



# My Background

- Trained as an experimental CM physicist.
- My husband is also a physicist. As a result, I have worked at various places:
  - ✓ community college,
  - ✓ small liberal arts college,
  - ✓ top 25 national university with a focus on engineering,
  - ✓ state university in an urban setting.



# My Background

- I don't develop instructional materials or approaches.
- I use research based materials and approaches and have done so in many different types of classrooms with different types of students.
- I understand the importance of assessment and I do it.



## A bit of history...

- 15 or more years ago, I came across a magazine article on re-inventing undergraduate education.
- A highlighted box said  
**“We are shifting the emphasis on teaching to an emphasis on learning”**
- I had no idea what this meant. I realized that and it bothered me.

## Some more history...

- I went to a meeting like this one. Bob Hilborn gave a talk on assessing student conceptual learning.
- Then I understood the quote.
- All the other speakers talked about how to do a better job teaching.
- Bob talked about how I might know if my students actually learned.





## My Definition of Assessment

**A** measure of some student characteristic  
(e.g. knowledge, skill, attitude)

often used to evaluate the curriculum  
and/or pedagogy

**ALWAYS** used in attempts to improve  
learning or other course outcomes.

**The role of assessment is not to grade the  
students, nor is it to grade instructors.**



# Why Engage in Assessment?

- I want to do my part to help improve science education by doing the best I can for my students.
- To do so, I need to figure out what MY students are (and are not) learning as I try to improve my courses.



# What to Assess?

- In order to care about assessment outcomes, you first need to establish course goals.
- What do you want to accomplish? What are your top two or three goals for your course?



# Assessments should match your course goals

Existing assessment instruments:

- Conceptual Knowledge
- Textbook Problem Solving Ability
- Students attitudes and expectations about learning science
- Scientific Reasoning Ability
- Laboratory Skills

You can develop your own if needed.



# Examples of Conceptual Assessments

- **Force Concept Inventory (FCI)**
- **Force/Motion Conceptual Evaluation (FMCE)**
- Real Time Physics Electric Circuits
- Diagnostic Evaluation of Electricity and Magnetism (DEEM or Marx Exam)
- **Conceptual Survey on Magnetism (CSM)**
- Conservation of Energy/Momentum
- Waves
- Thermodynamics



# The Pre-/Post- Instruction Assessment Model

- An assessment is given at the start of the course. The same assessment is given at the end of the course.
- Thereby measure LEARNING that has occurred during the same time period as the teaching.
- Typically, the assessment grade doesn't count toward the students course grade.
- Typically, the assessments are given unannounced. They are not returned.



# Advantages of the Pre/Post Assessment Model

- Is a measure of learning as opposed to existing knowledge.
- Unlike test scores or other grades, measures “off the top of the head” knowledge-not the ability to cram or effort.
- Typically quantitative and objective so one can compare semester to semester or to a national baseline.

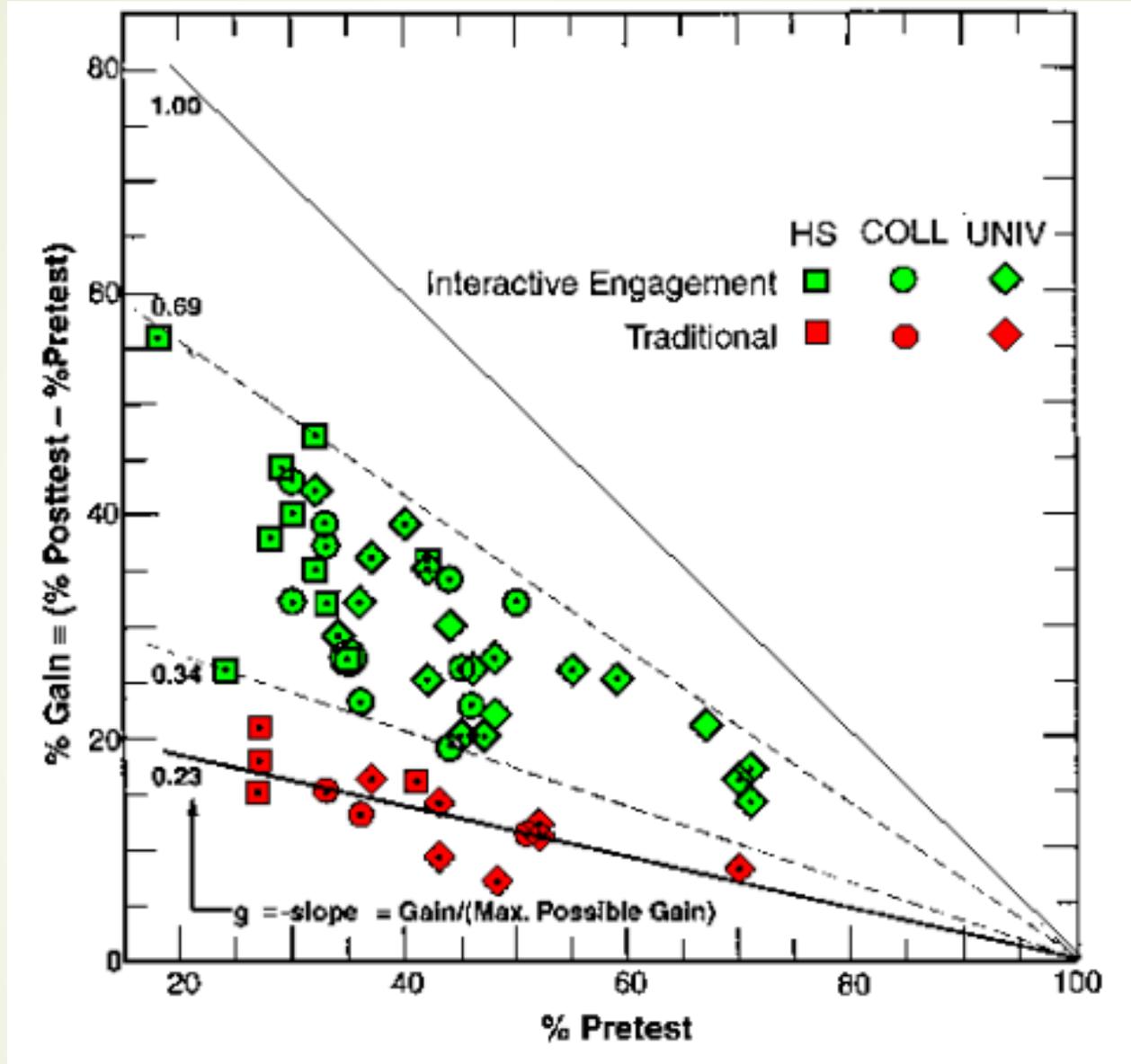


# The Force Concept Inventory (FCI)



# Some Example Results

- Evidence that we can do better than “teaching the way we were taught” or “doing what our colleagues did”.
- Traditional Instruction can be improved and you know of some of the approaches to doing so.





## Talking about FCI or FMCE Results: “Normalized Gain” in Understanding

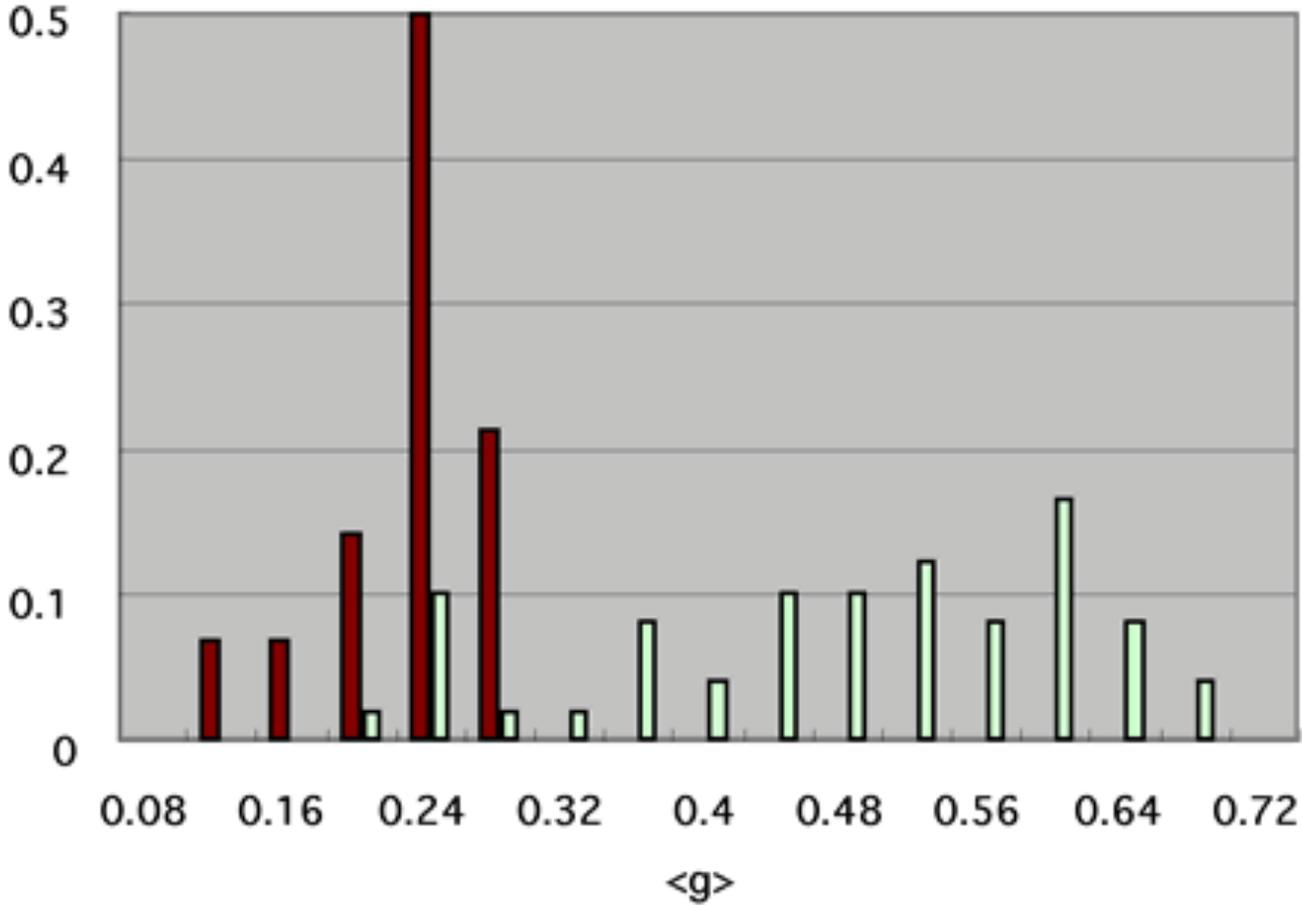
$$g = \frac{\text{Post} - \text{Pre}}{100 - \text{Pre}} = \frac{\text{How much they learned}}{\text{How much they didn't already know}}$$

$$g = \frac{90\% - 80\%}{100\% - 80\%} = 50\% \quad (\text{Pre} - 80\%, \text{Post } 90\%)$$

$$g = \frac{60\% - 20\%}{100\% - 20\%} = 50\% \quad (\text{Pre} - 20\%, \text{Post } 60\%)$$

■ T Courses    □ IE Courses

Fraction of Courses





# FMCE Questions





# Some Example Results

- ▶ The impact of “Studio” or “Scale-up” classrooms



# “Studio” or “Scale-UP Classrooms”

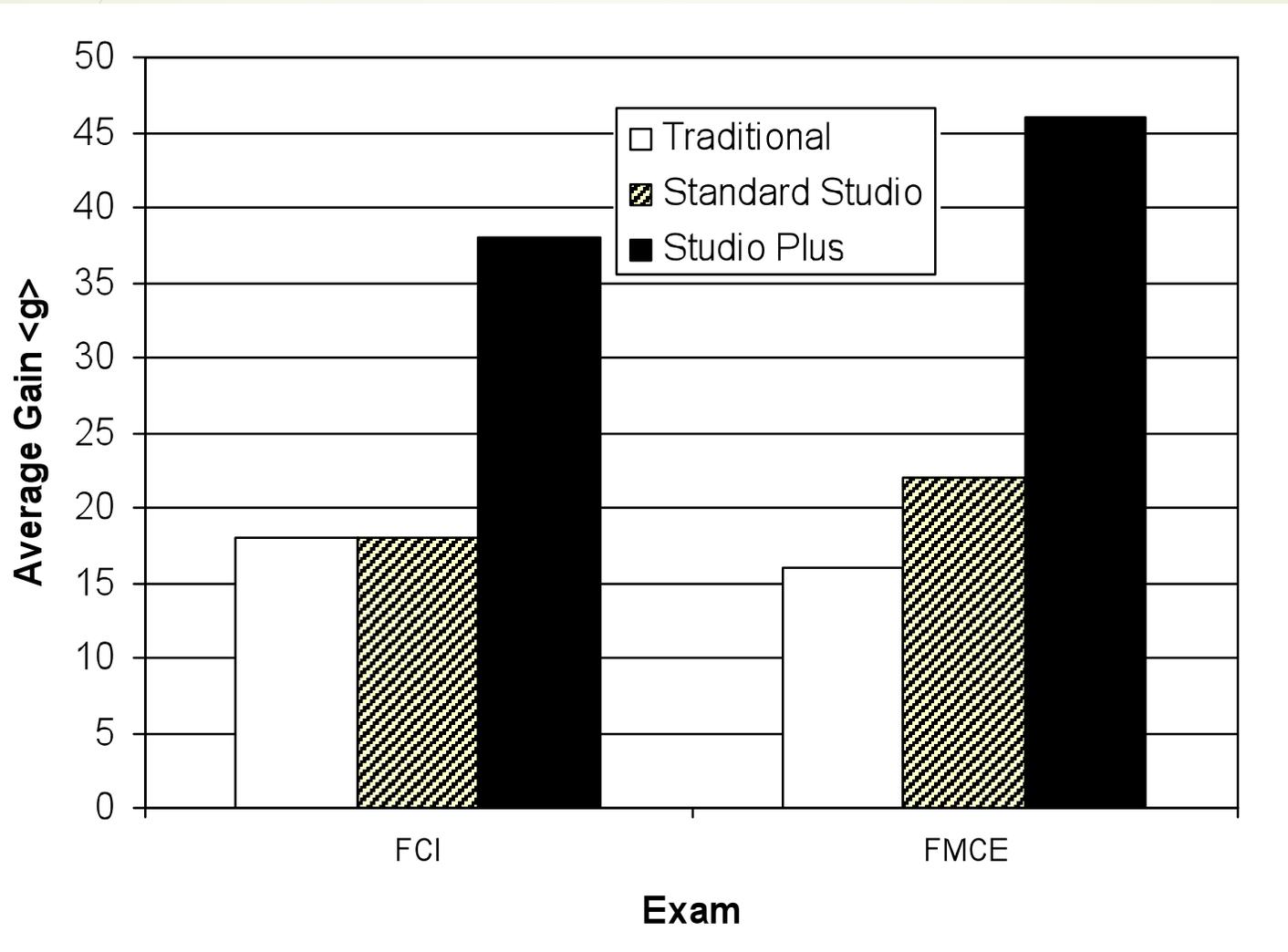
- ▶ Integrated lecture and laboratory instruction.
  - ▶ Specially designed classrooms.
  - ▶ Technology enhanced instruction.
  - ▶ Students are “doing things” during class time.
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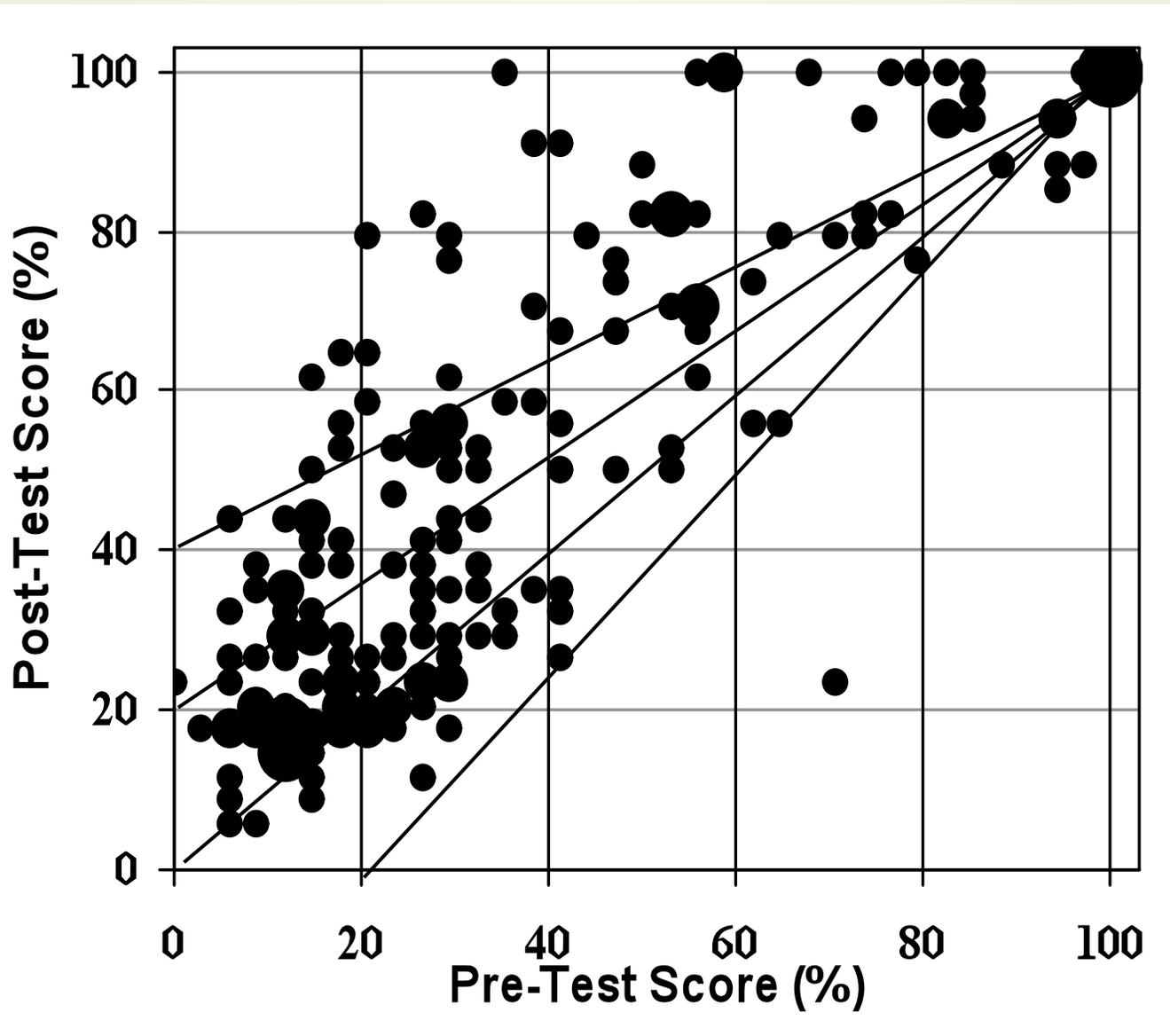


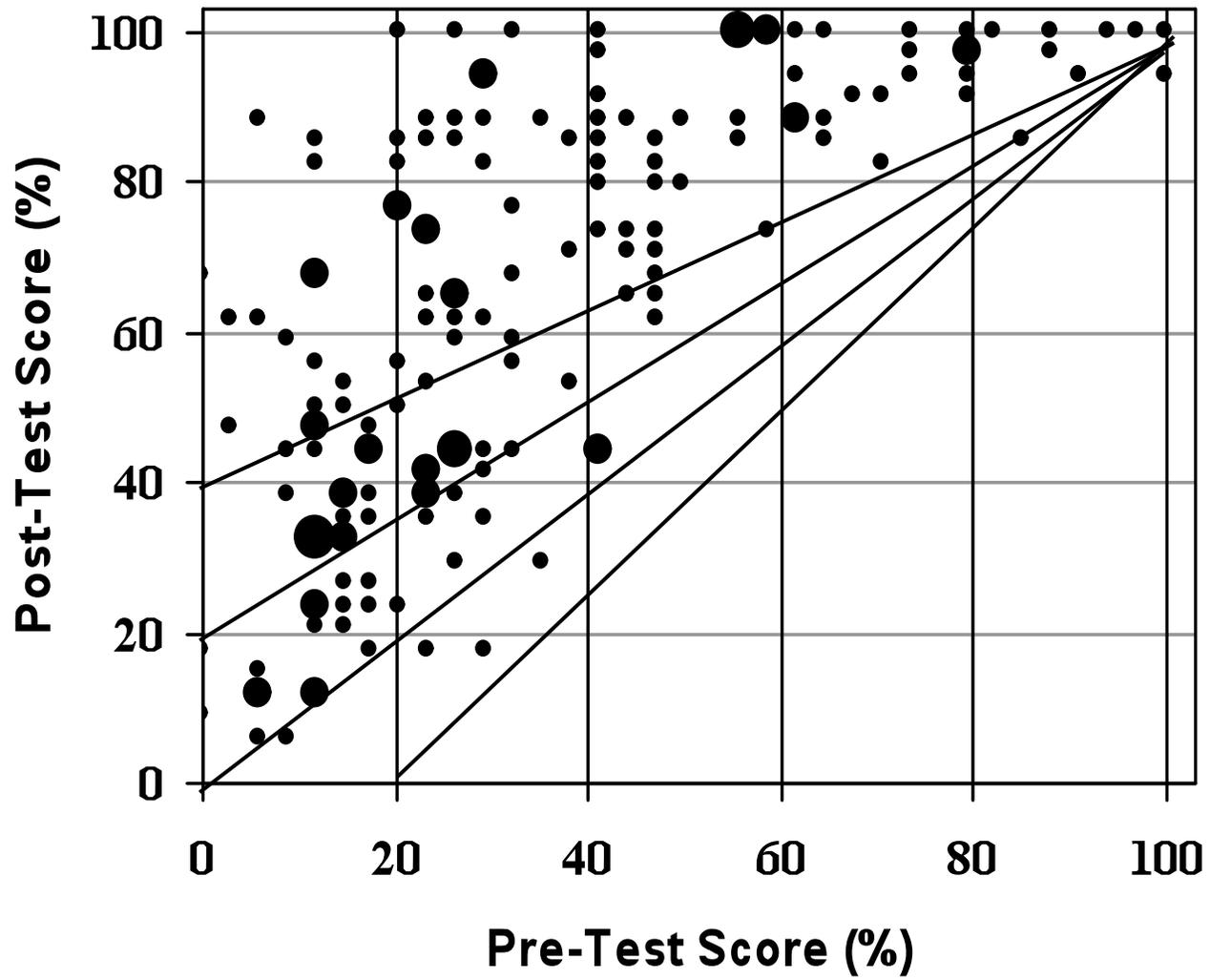
# The Experiment

- Experiment performed in the early days of the Studio Physics course at Rensselaer (Spring 1998).
- Divided 10 sections of about 50 students each into two broad categories – “Standard Studio” and “Studio Plus”. Both taught in the Studio model/scale-up model.
- Both groups used the same classrooms, did the same homework assignments, followed the same schedule, had the same lectures and took the same exams.
- The only difference between these two groups was that the standard classes did not incorporate Interactive Lecture Demonstrations or Cooperative Group Problem Solving.

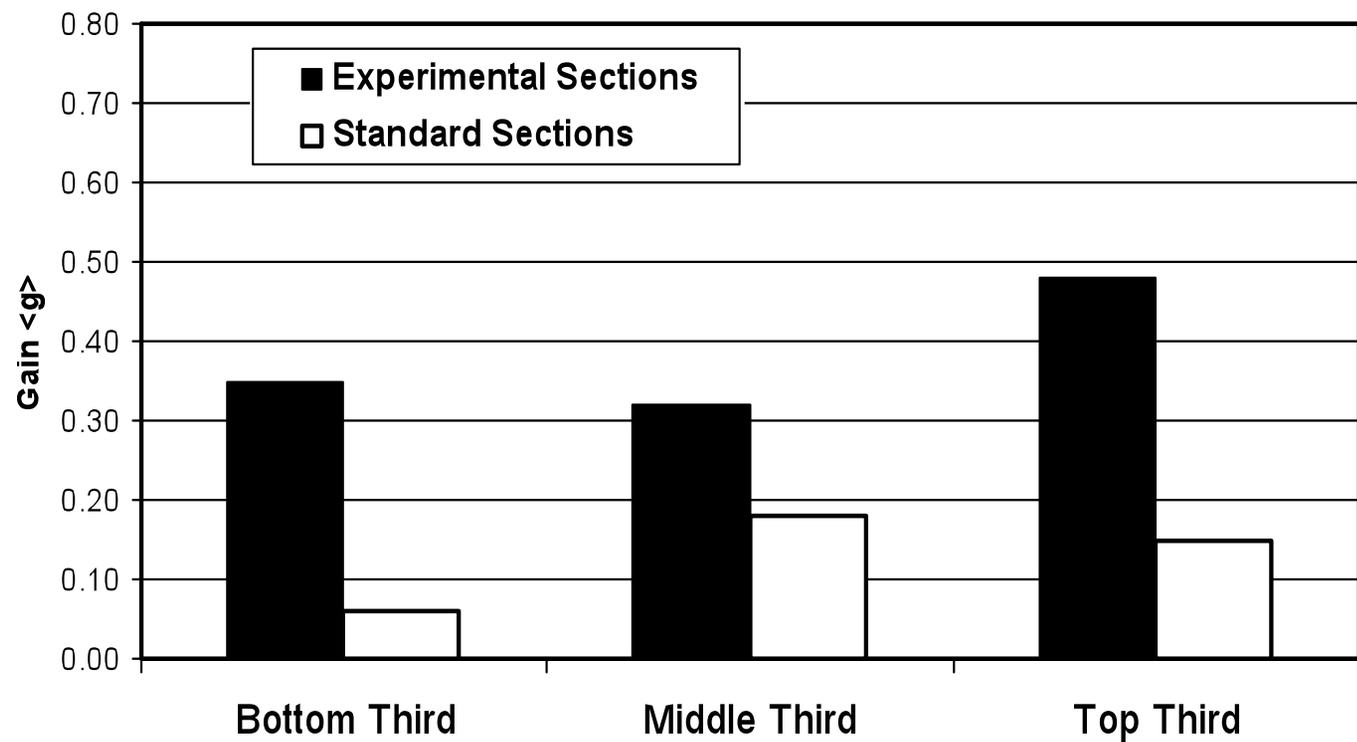
# The Curriculum is Critical







## Force and Motion Conceptual Evaluation

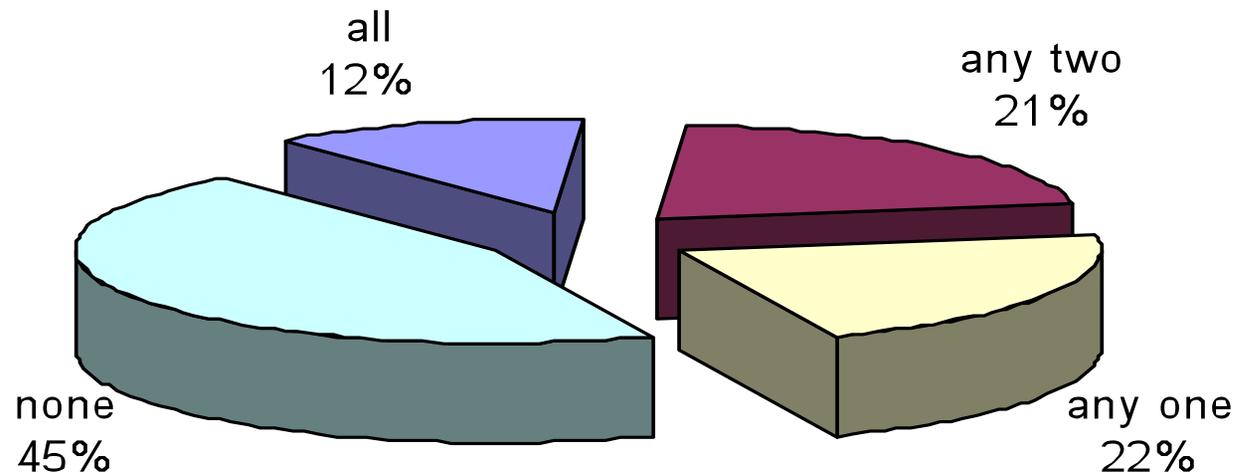




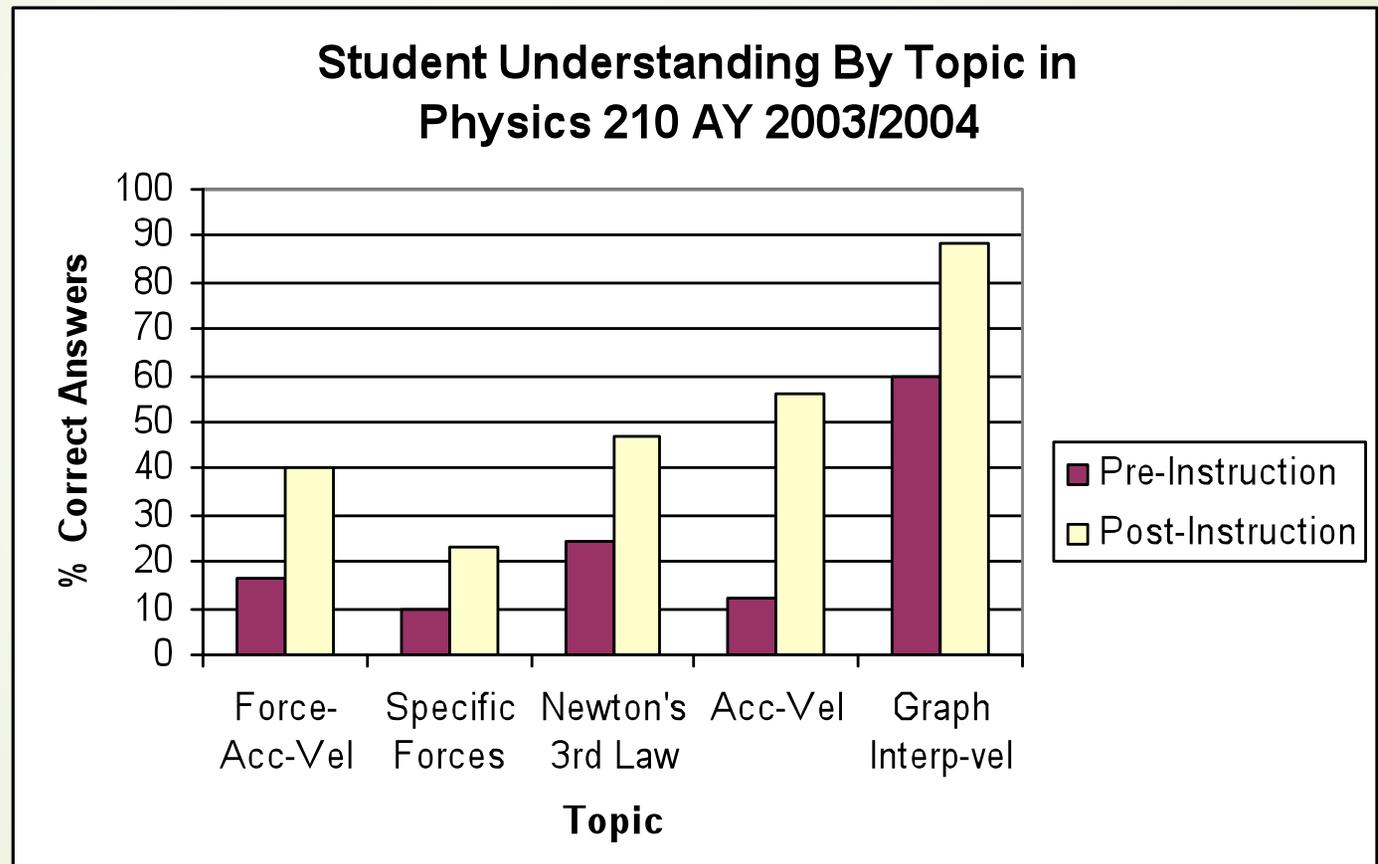
# What do students know coming in?

- Another important advantage of pre/post assessment.
- Suppose that your students
  - must have a high school physics class for admission
  - Many have take advance placement physics
  - All have taken a one semester statics course the previous semester
  - Avg SAT score about 1475
- What percentage understand Newton's 2<sup>nd</sup> Law? (**example questions**)

1. Velocity and Acceleration (Kin.)
2.  $F=ma$  (N2)
3. Newton's Third Law (N3)



# Beyond Gain



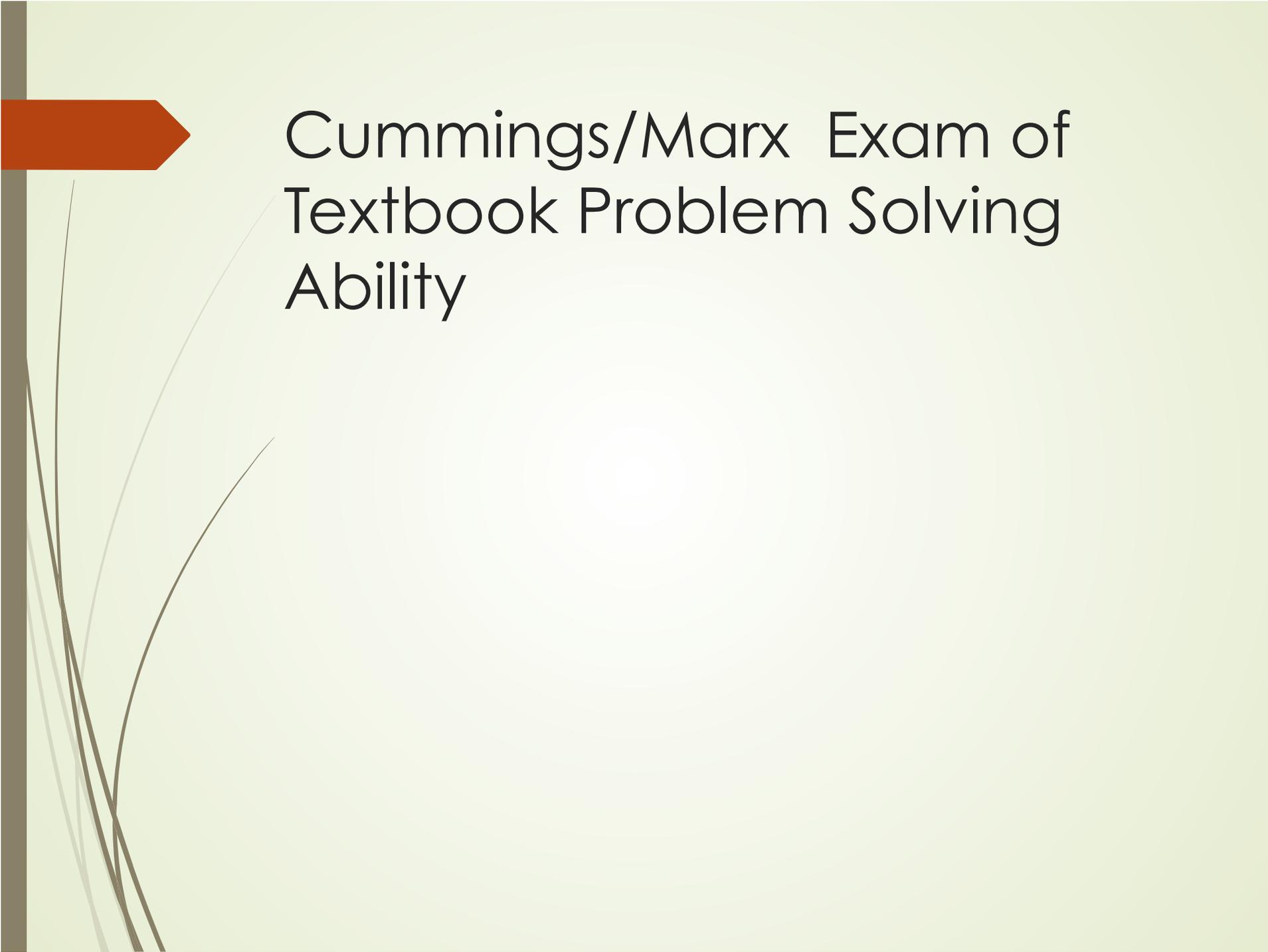
# Categories of Assessments and examples

- Assessment of Conceptual Understanding**
- Assessment of Problem Solving Ability**
  - Mechanics Baseline Exam
  - Our exam



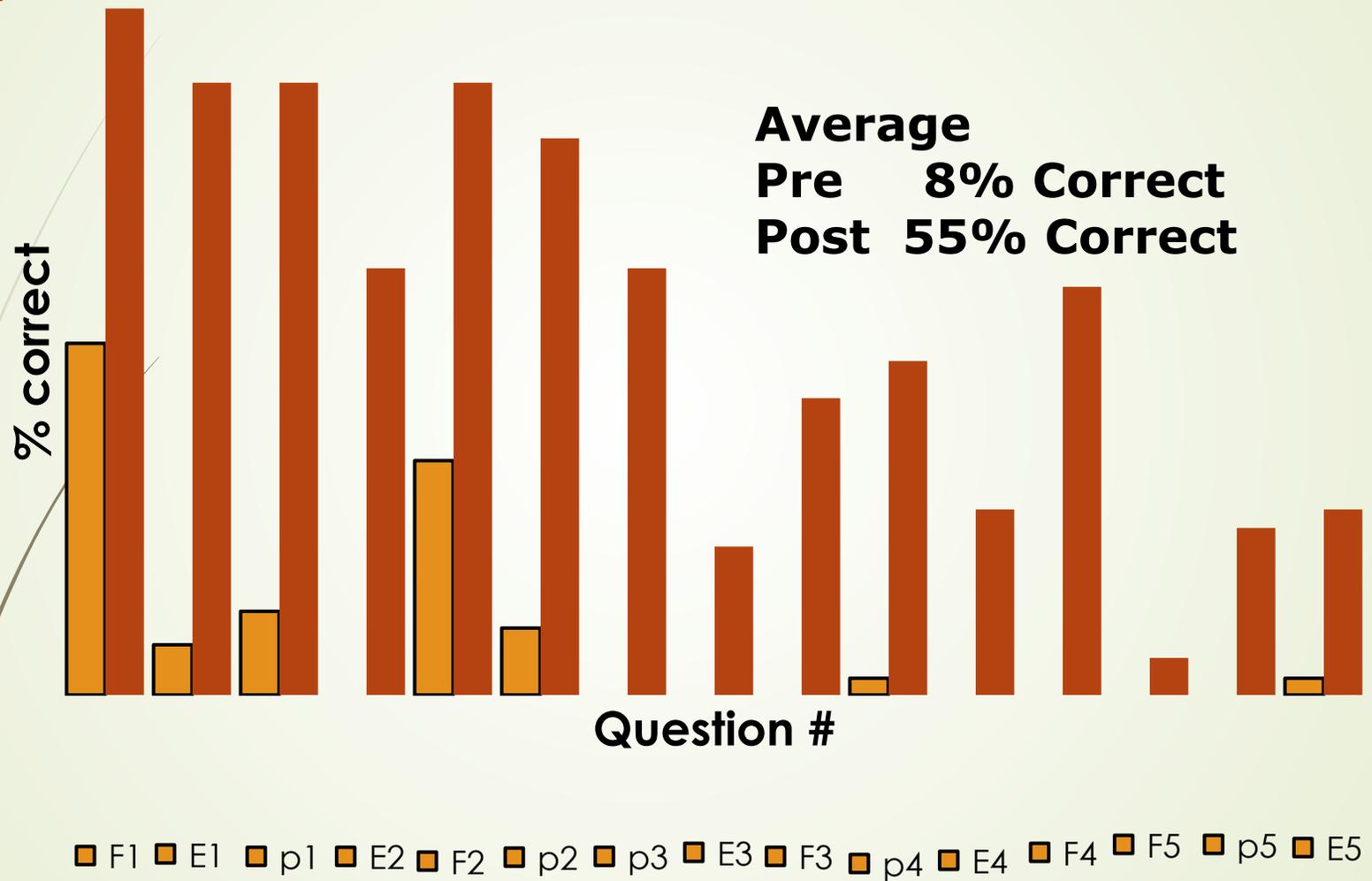
# Mechanics Baseline Exam





# Cummings/Marx Exam of Textbook Problem Solving Ability

# SCSU Physics I Pre/Post N=41/37



# Categories of Assessments and examples

**-Assessment of Conceptual Understanding**

**-Assessment of Problem Solving Ability**

**-Assessments of Student Attitudes and Expectations**

- Maryland Physics Expectation Survey (MPEX)
- Colorado Learning about Science (C-LASS)

# CLASS Categories

1. Personal Interest
2. Real World Connection
3. Problem Solving General
4. Problem Solving Confidence
5. Problem Solving Sophistication
6. SensesMaking/Effort
7. Conceptual understanding
8. Applied Conceptual understanding
9. Other questions with consistent Expert Views



# Example Questions

- ▶ Knowledge in physics consists of many unrelated pieces of information that each pertain to specific situations
  - ▶ Problem solving in physics is basically matching equations to the situations and plugging in numbers to get a result.
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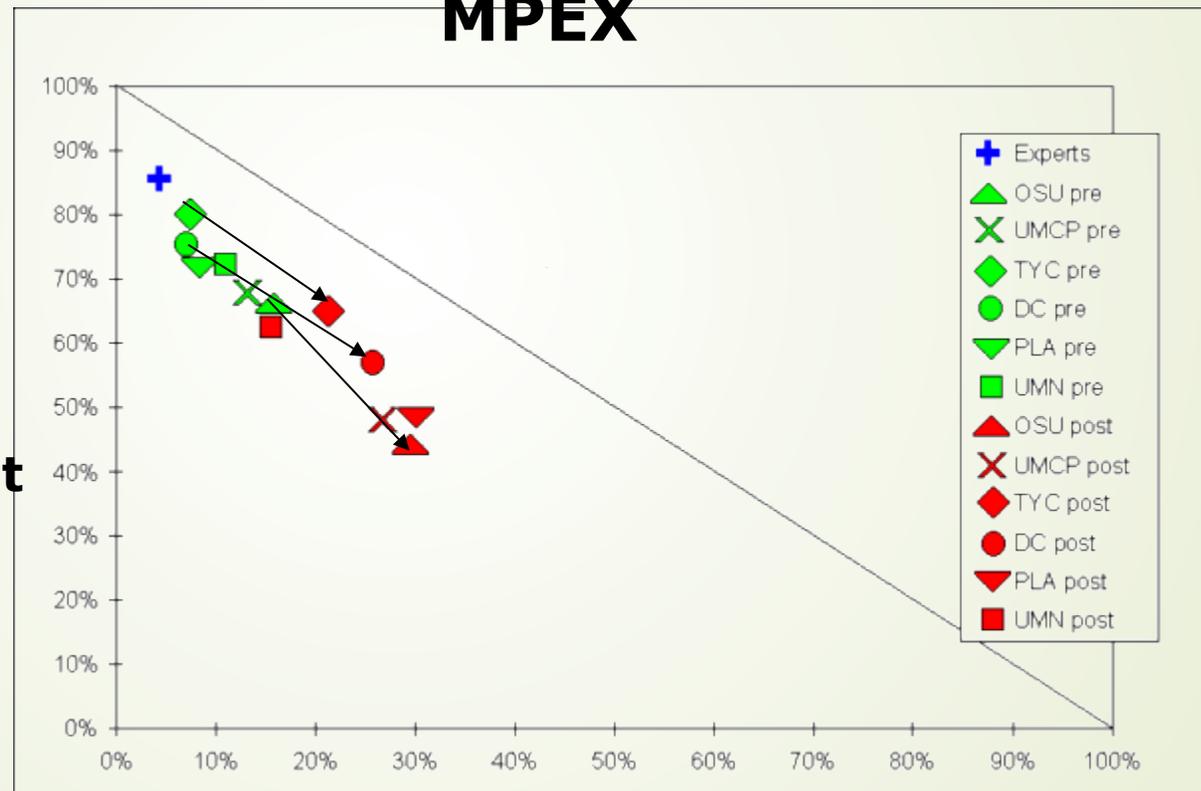
# Example Questions

- Knowledge in physics consists of many unrelated pieces of information that each pertain to specific situations **(Disagree)**
- Problem solving in physics is basically matching equations to the situations and plugging in numbers to get a result. **(Disagree)**

# Example Result from Previous Studies

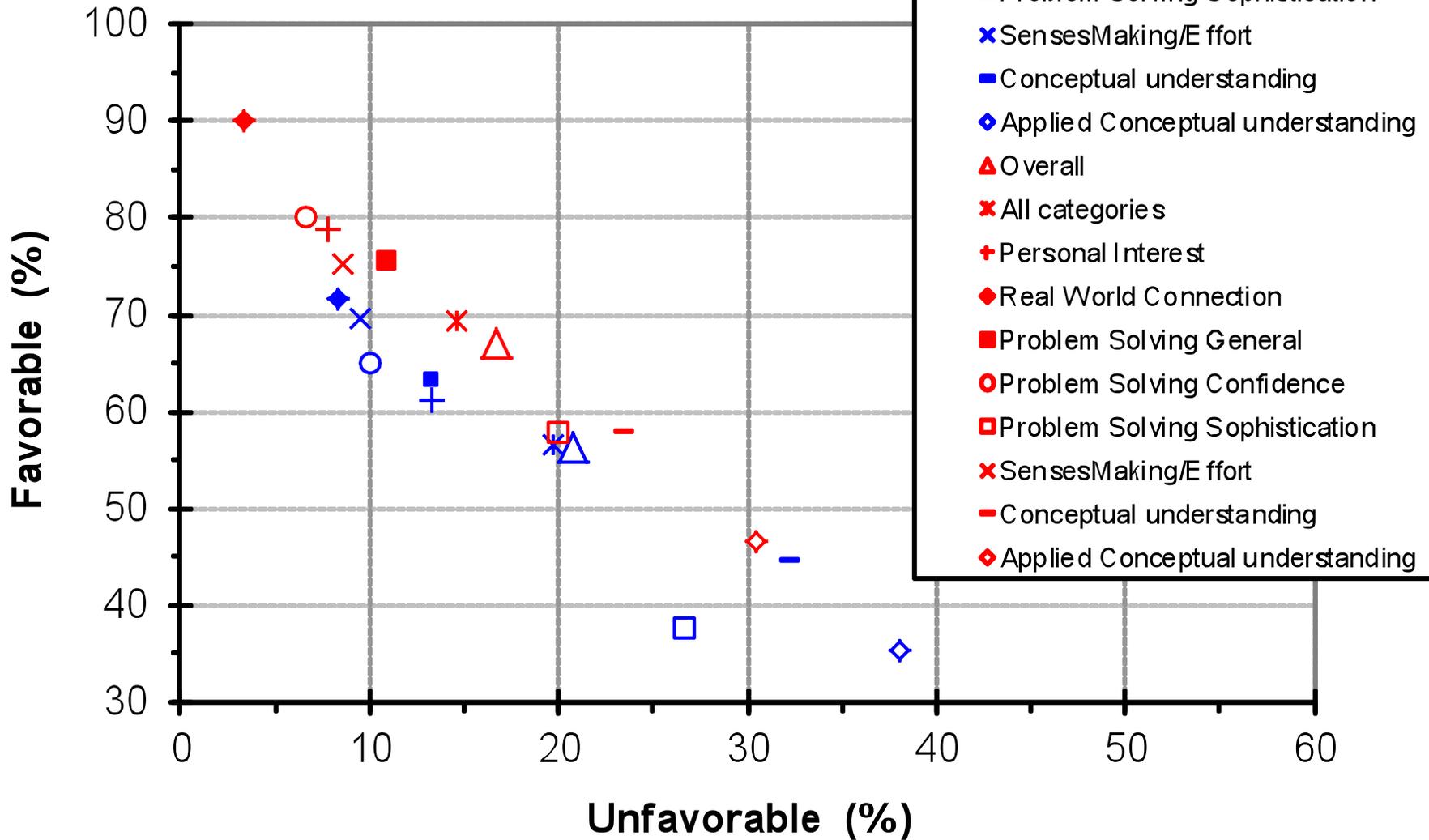
## Maryland Physics Expectation Survey MPEX

**% Agreement with Expert**



**% Disagreement with Expert**

**CLASS pre/post:  
SCSU Students  
(course for elem. ed. majors)  
PRE and POST**



Unfortunately, previous work has indicated that physics courses tend to be largely unsuccessful in these regard to improving students' attitudes.





# How to get started with new teaching methods and assessment.

- Pick one (or two) of the techniques or materials that have been shown to lead to improved learning.
- Pick an assessment that aligns with the goals of the technique and your goals for the course.

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- Give the pre-instruction assessment (make use of “wasted” days like lab the first week).
  - Assessment should be unannounced, ungraded and not returned.
  - Do your best with the course and new technique/materials.
  - Give the post-test. Make use of “wasted” days or prep for the final.
  - **Learn from your pre-post comparison and repeat.**



# Why do assessment?

- Verify that these techniques work (or don't) **NO**
- For the administrators-maybe
- Because it is really interesting applied science-It is, so be careful.
- **Because if you are going to teach, you may as well be a good teacher. If you are going to be a good teacher, your students will need to LEARN (not memorize) SOMETHING.**

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# Problem Solving and Conceptual Learning

- Eric Mazur's study
  - The Cal Poly study
  - My RPI work
  - A UT Austin Study
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