

## Physics 4810 / 7810 Week 3 - Rollin!

Day 5: Fa2008

Field Sites

quick feedback: any questions / comments

Feedback on your work

Structure of course (9/18, and assuming leadership on readings)

Designing Research-based materials:

Redish - methodology

Mazur - Peer Instruction

McDermott: student difficulty of X &

Creation of *Tutorials*



## Admin

- Returning work -- comment about feedback & expectations
- Fieldwork / Sites
- Preliminary project this week
- Signup for Topic to lead!

## Designing Materials

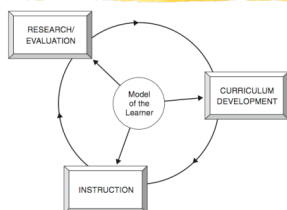


Figure 6.1 The Research and Redesign Wheel—the role of research in curriculum reform.

GOALS?

## Research Process

- Theory, Study / Evidence, Replication
- Is PER Physics?
- This question brings up a general theme I have noticed so far in the papers: the lack of evidence. I write all over the margins of the paper who says, how do you know, where is the evidence.
- There are so [few] citations and very small sample sizes. I am still not convinced that PER is physics
- I was also shocked by the lack of citations throughout the article. Many statements were made without any supporting evidence.
- How repeatable have these results been? (Both

## Goals: Problem Solving

I want to come out of physics 1110 better able to solve quantitative problems, think algorithmically and reason mathematically. I don't need to be an expert in the specifics of Newton's laws

How often do your teachers stress the problem solving components Redish lists on page 122: ability to find what physics will be useful for a problem, skill to take apart and solve complex problems, ability to evaluate the result of a solution and know whether it makes sense? How would you stress those things? Would you stress those components?

## MANY MANY Research-based techniques

- Peer Instruction
- Just in Time Teaching
- PhET, TEAL, Physlets, Robolab and SAM
- Tutorials
- Active Learning Problem Sets
- Interactive Lecture Demos
- Modeling Physics
- Physics of Everyday Thinking (PET, PSET)
- Workshop Physics
- Self-paced/ study ...

We WILL NOT COVER ALL THESE....

## Personal Response System



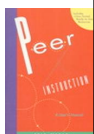
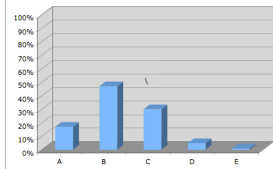
Consider *this* glass tube full of atoms, discharge lamp



Expect that on average

hand end of tube

1. Pose
2. Silent
3. Group
4. Class

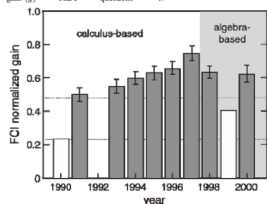


**by actively engaging students...**

## PI Results (2 slides)

Table 1. Force Concept Inventory (FCI) and Mechanics Baseline Test (MBT) results.\*

Year	Method	FCI pre	FCI post	Absolute gain (post-pre)	Normalized gain (g)	MBT quant. questions	N
<b>Calculus-based</b>							
1990	Traditional	70%	78%	8%			
1991	PI	71%	85%	14%			
1993	PI	70%	86%	16%			
1994	PI	70%	88%	18%			
1995	PI	67%	88%	21%			
1996	PI	67%	89%	22%			
1997	PI	67%	92%	25%			
<b>Algebra-based</b>							
1998	PI	50%	83%	33%			
1999	Traditional	48%	69%	21%			
2000	PI	47%	80%	33%			



Peer Instruction: Engaging Students One-on-One, All At Once  
 Catherine H. Crouch 1, Jessica Watkins 2, Adam P. Fagen 3, and Eric Mazur  
 Review of Physics Education Research Volume 1  
 Peer Instruction: Ten years of experience and results  
 Catherine H. Crouch and Eric Mazur, AJP, 69(9), 2001

## PI queries

- Why do PRS / computers instead of cards, hands?
- Why 5 answers instead of text etc?
- Do you have to have right answers to discuss?

## Peer Instruction

- I was worried when Mazur said he dropped some of the material from lecture (I hate when teachers rely on solely on the book to teach something)
- a) covering less material per topic or (b) reduce the number of topics taught, if Concept Tests are to be used during lecture. He opts for (a), I think I would choose (b).  
 Would you choose:
  - (a) Less (in class) per topic
  - (b) Fewer topics,
  - (c) Longer classes

If you were to significantly increase your teaching efforts, how would this affect your salary ?

- A) Positively
- B) Negatively
- C) No effect
- D) I don't know or I don't care
- E) I don't teach at all

How many gas stations are there in the USA?

- A: 10,000
- B: 100,000
- C: 1,000,000
- D: 10,000,000
- E: There is no way to know this without looking it up

How many liters of Scotch Whiskey are stored in Scotland?

Hints: Scotch is aged ~10 years before sale. All Scotch is made in Scotland.

- A) 3 million
- B) 30 million
- C) 300 million
- D) 3 billion
- E) This is a "fact" which must be looked up, there is no way to estimate it.

**The Message:**  
The answer is NOT important.  
The **strategy** for getting the answer is the goal.

**Strategy:**

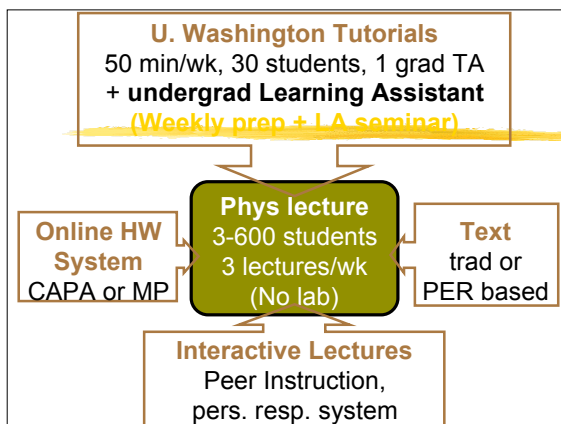
- The Scots will store as much Scotch as they can sell.
- Sales depends on the Earth's population and the average demand per person.

The student must be convinced that:

- understanding strategies = high exam score.
- remembering answers to specific questions = low exam score.

**Another modest reframing  
of class context**

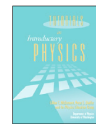
w/  
Steven Pollock



**Tutorials in Introductory  
Physics**

**Reconceptualize Recitation Sections**

- Materials
- Classroom format / interaction
- Instructional Role



## Proven Curricula

D.E. Trowbridge and L. C. McDermott, "Investigation of student understanding of the concept of acceleration in one dimension," *Am. J. Phys.* **49** (3), 242 (1981).

D.E. Trowbridge and L. C. McDermott, "Investigation of student understanding of the concept of velocity in one dimension," *Am. J. Phys.* **48** (12), 1020 (1980)

R.A. Lawson and L.C. McDermott, "Student understanding of the work-energy and impulse-momentum theorems," *Am. J. Phys.* **55** (9), 811 (1987)

L.C. McDermott and P.S. Shaffer, "Research as a guide for curriculum development: An example from introductory electricity, Part I: Investigation of student understanding," *Am. J. Phys.* **60** (11), 994 (1992); Erratum to Part I, *Am. J. Phys.* **61** (1), 81 (1993).

P.S. Shaffer and L.C. McDermott, "Research as a guide for curriculum development: An example from introductory electricity, Part II: Design of instructional strategies," *Am. J. Phys.* **60** (11), 1003 (1992)

L.C. McDermott, P.S. Shaffer and M. Somers, "Research as a guide for curriculum development: An illustration in the context of the Atwood's machine," *Am. J. Phys.* **62** (1) 46-55 (1994).

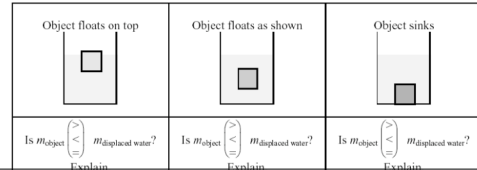
More: see <http://www.phys.washington.edu/groups/peg/pubsa.html>

## Tutorial Materials

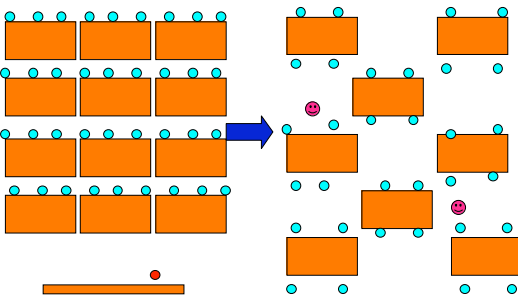
Hands-on, Inquiry-based, Guided, Research-based

Assignment 11M: \_\_\_\_\_ Name \_\_\_\_\_  
**Buoyancy** \_\_\_\_\_ Tutorial section \_\_\_\_\_

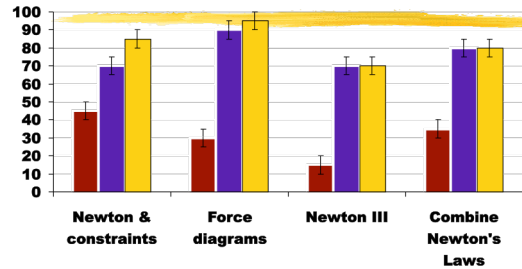
1. Three objects are at rest in three beakers of water as shown.
  - a. Compare the mass, volume, and density of the objects to the mass, volume, and density of the displaced water. Explain your reasoning in each case.



## Tutorial vs. Trad'l Recitation

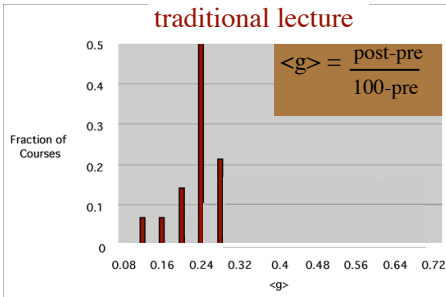


## Impact and Reproducibility



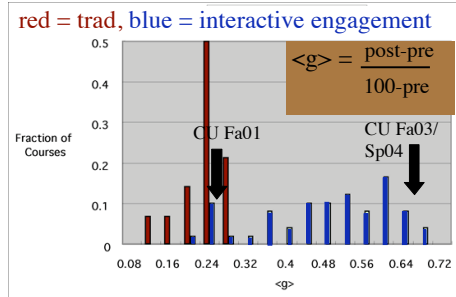
■ UW - No Tut  
 Trowbridge and McDermott, *Am. J. Phys.* **49** (3), 242 (1981).  
 Finkelstein and Pollock, (2005). *Phys Rev ST PER*, 1,1.010101

## Force Concept Inventory



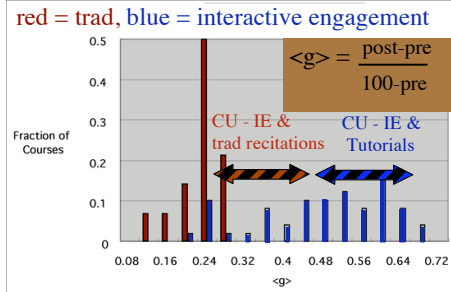
R. Hake, "...A six-thousand-student survey..." *AJP* **66**, 64-74 ('98).

## Force Concept Inventory



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## Force Concept Inventory



R. Hake, "...A six-thousand-student survey..." AJP 66, 64-74 ('98).

## Role of asking students: importance of methodology

- When I began reading the article, I was sure that many students could correct their thinking about motion if they are asked to consider the familiar situation of cars on a road instead of balls on a track. Clearly my intuition and understanding of what novices think was wrong.
- Not only was I shocked how student could think that when objects are side by side for an instant implies they have the same speed, ...

## Tutorial Queries

??

- What did you see in the papers that look like Tutorials? [examine Tutorials in groups!]

## What's missing

- In Theory
- Research Approach
- In Pedagogical Goals