Physics 5460/4460 Week 4 - Rollin!

Days 7:
- Field Sites
  - quick feedback: any questions / comments
- Feedback on your work
- Structure of course
- Designing Research-based materials:
  - methodology (Redish, McDermott, diSessa,…)
  - Student difficulty of X &
    - Creation of *Tutorials*

Admin

- Returning work -- comment about feedback & expectations
- Fieldwork / Sites
- Preliminary project this week
- Optional: Think of course Topic to lead!

?

Class Roadmap & Direction

Warm up: Consider Lecture Say here at CU- Phys 1

<u>In Groups</u>

- The Good
- The Bad

- **I've definitely noticed a disconnect between the Tuesday and Thursday readings, and I happily expect these two papers to bridge the gap between the theory that we've been studying and the papers on curriculum development. Hopefully I'll begin to see more and more of how theory informs our curricula throughout the class.**

In-Class Structure

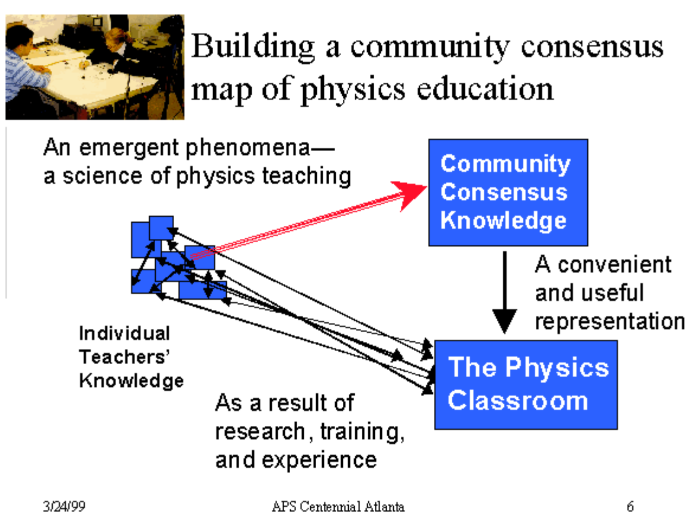
PER studies

- Intro/ State of Affairs
- Theory 1: cognitive
- Theory 2: social
- Student conceptions
- Epistemology (resources)
  Attitudes / beliefs
- Problem Solving
- Assessment
- Inclusion
- …

Curricula & Pedagogy

- Lecture
- PI/
- JITT / ILD
- Tutorials
- Sims
- Open Source Tutorials
- Cooperative Group PS
- …

Redish's community map



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- …

PER Theoretic Background

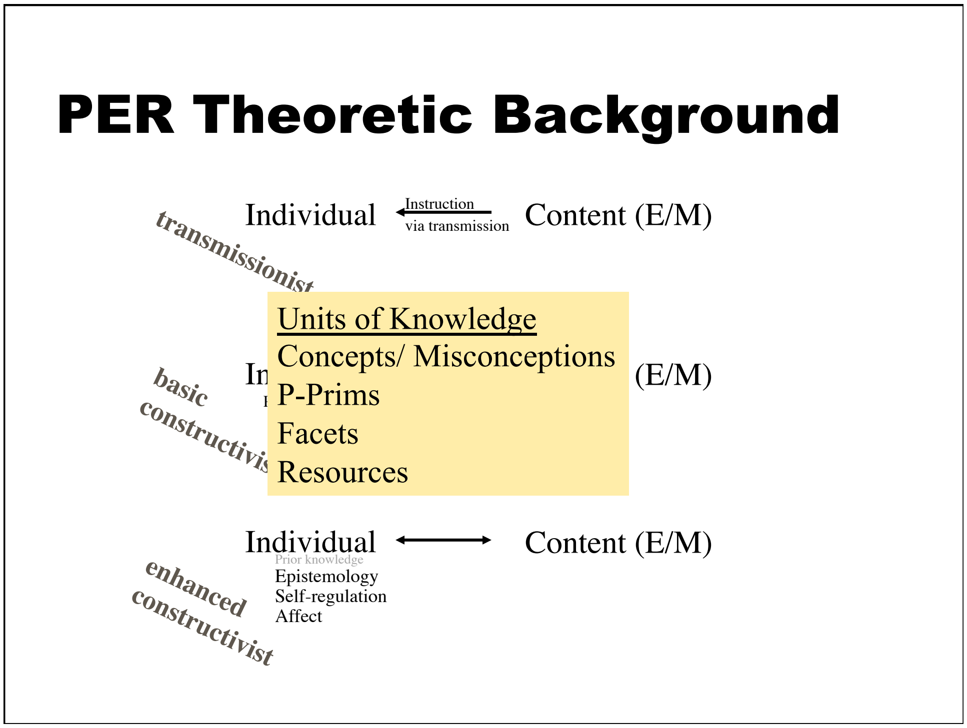
transmissionist

Individual ← Instruction via transmission — Content (E/M)

basic constructivist

Individual (Prior knowledge) ↔ Construction constructivist — Content (E/M)

Units of Knowledge
Concepts/ Misconceptions
P-Prims
Facets


PER Theoretic Background
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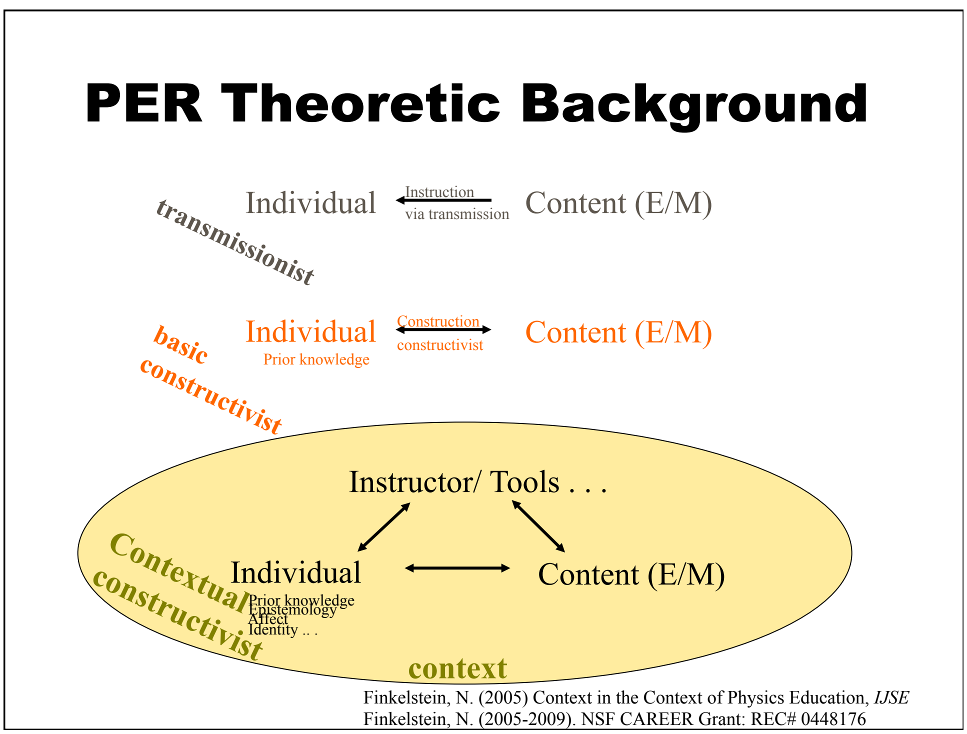
Resources
(E/M)
basic
constructivist
Individual
Content (E/M)
Prior knowledge
Epistemology
Self-regulation
Affect
enhanced
constructivist


PER Theoretic Background
Individual
Instruction
via transmission
Content (E/M)
transmissionist
Individual
Construction
constructivist
Content (E/M)
Prior knowledge
basic
constructivist
Instructor/ Tools . . .
Individual
Content (E/M)
Prior knowledge
Epistemology
Affect
Identity .. .
Contextual
constructivist
context
Finkelstein, N. (2005) Context in the Context of Physics Education, IJSE
Finkelstein, N. (2005-2009). NSF CAREER Grant: REC# 0448176

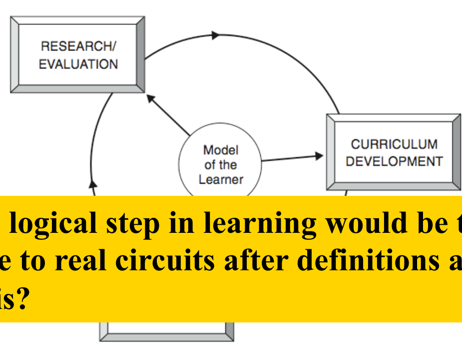
A word or two on Theory

Purpose of Theory?

So diSessa would argue they [student concepts] are intuitive? That they are based in p-prims

- What theories does McDermott draw from?
- Peer Instruction?
- ILDs / JITT?

Designing Materials



GOALS?

It seems like the logical step in learning would be to learn how to apply knowledge to real circuits after definitions are understood. Any ideas on this?

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

For the complicated circuits shown in fig. 6. (a), students had difficulty drawing them in a cleaner form. McDermott writes that students "lacked an adequate procedure." To me this suggests that she would like develop a prescribed problem solving method. Even if they were successful in doing so, wouldn't that be just asking students to memorize something instead of develop a deeper understanding?

The article makes this [connection to the real world/ intuition] sound like a bad thing. Reconciling our beliefs with reality is what physics is all about. Reconciling reality with what we learn is, I think, the main role of labs (though I am sure labs serve other purposes as well)...

??

Goals from the readings:

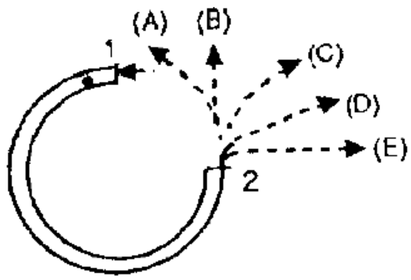
- McDermott / Tutorials
- JITT/ ILDs
- Peer Instruction
- Lecture

- Constructivist Approaches
  - Posner / (McDermott?)
  - DiSessa
- Socio-Cultural Approaches

NF's take:

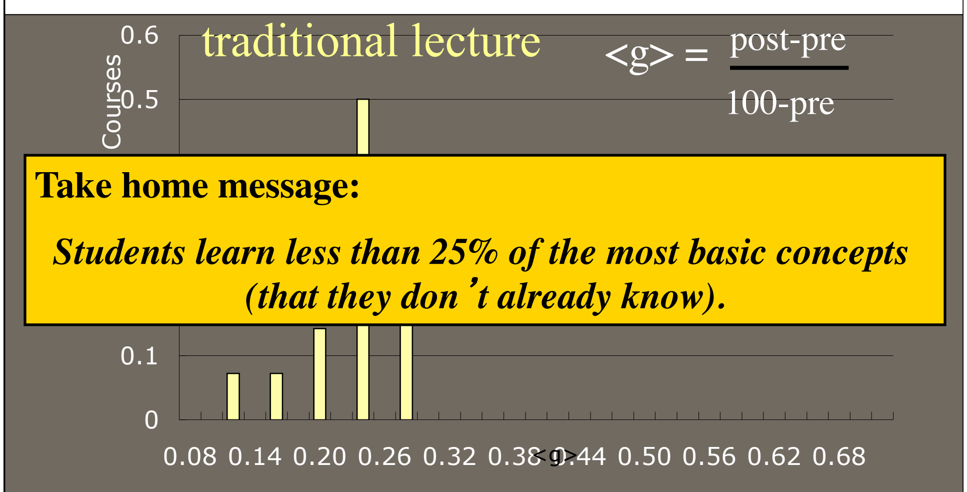
- Goals should drive
- Theoretical constructs drawn from to
- Create/ Use / Adapt Curricula & Pedagogy

Sample question



Looking down at a track (flat on table), a ball enters at point 1 and exits at point 2. Which path does it follow as it exits (neglect all friction)?

We are not teaching students: concepts



Take home message:

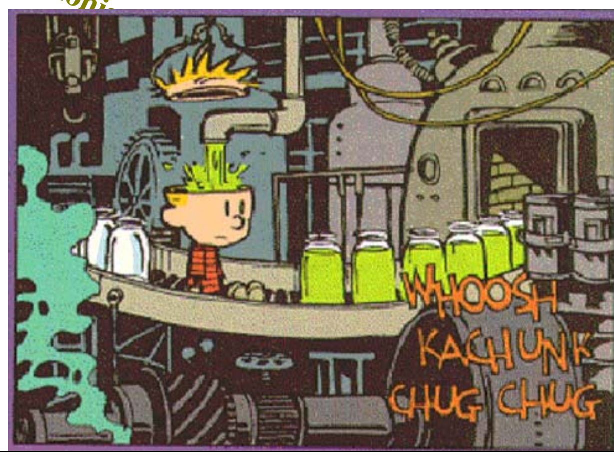
Students learn less than 25% of the most basic concepts (that they don't already know).

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

Trad'l Model of Education

transmissioni

Individual ← Instruction via transmission — Content (e.g. circuits)



Built in to our classes?

Where does our model come from…

– Sumer, circa 3000 BCE

PER Theoretic Background

transmissionist

Individual ← (Instruction via transmission) Content (E/M)

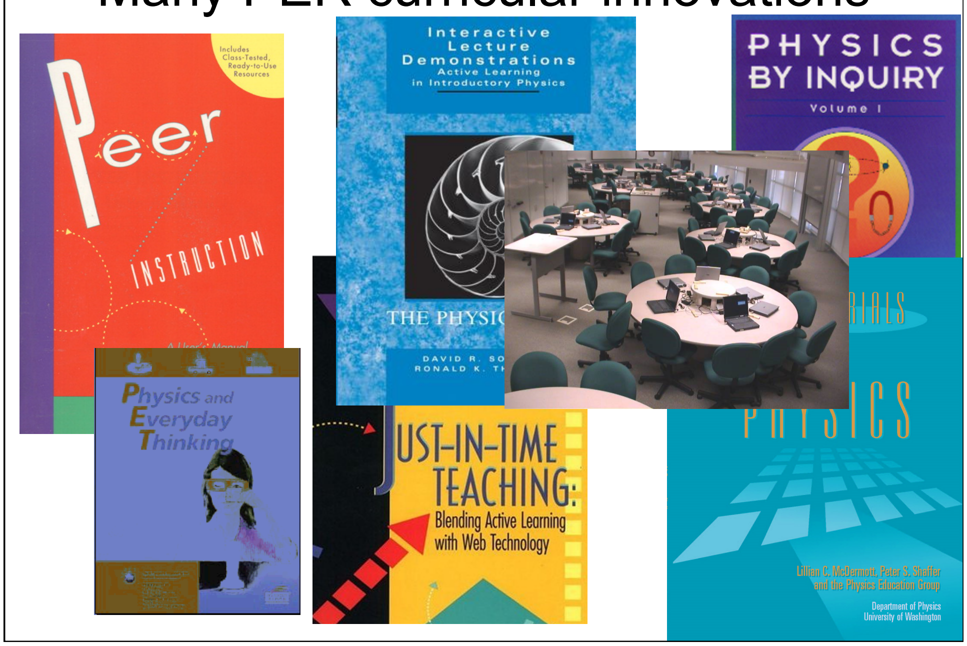
constructivist

Individual ↔ (Active construction) Content

Prior knowledge

Teach by actively engaging students…
based on what they know . . .

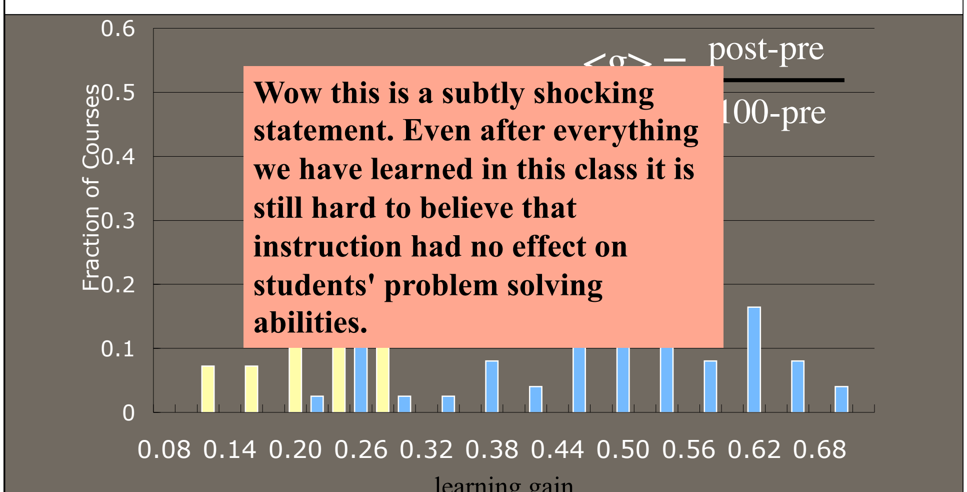
Many PER curricular innovations



- Echoing a comment from part 1, it would be nice to see some of the data behind these comparisons.

Engagement Improves Learning

traditional lecture   interactive engagement



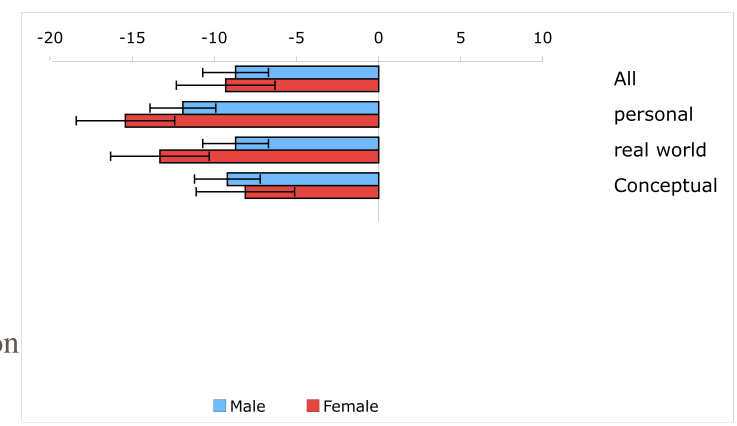
Pollock & Finkelstein, Physical Review, 4, 010101 (2008).

- The article makes this [connection to the real world/ intuition] sound like a bad thing. Reconciling our beliefs with reality is what physics is all about. Reconciling reality with what we learn is, I think, the main role of labs (though I am sure labs serve other purposes as well)...

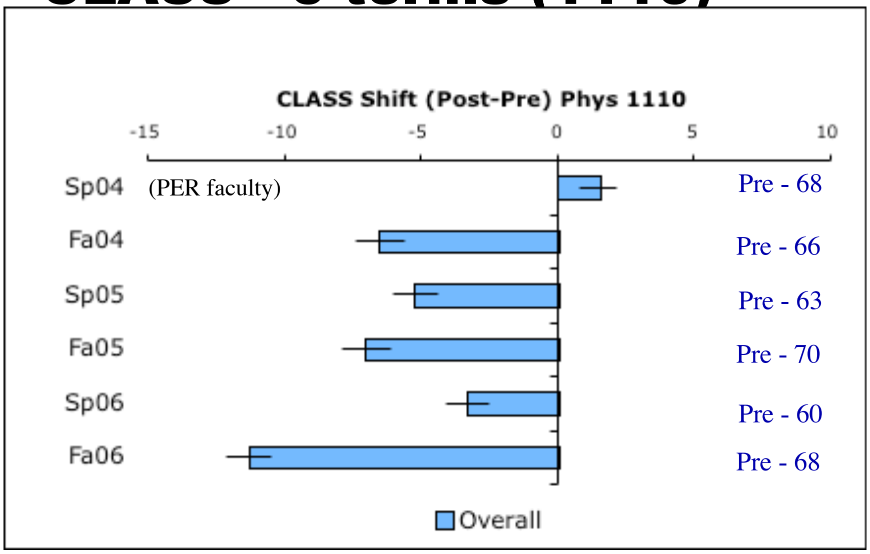
CLASS shifts (post-pre)

CU
Partly trad

CU
Reformed
(some attention to A&B)



CLASS - 6 terms (1110)



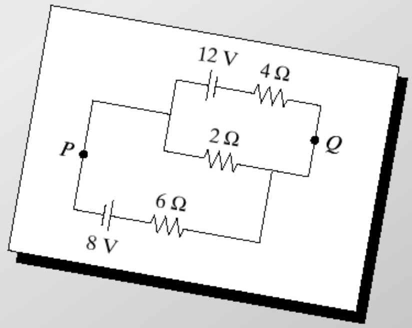
by actively engaging students…

But my students learn . . .

Calculate:

(*a*) current in 2-Ω resistor

(*b*) …

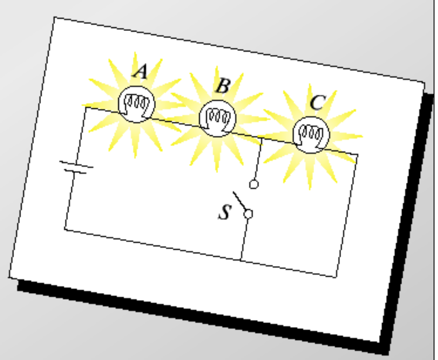


Mazur (1997; 2004)

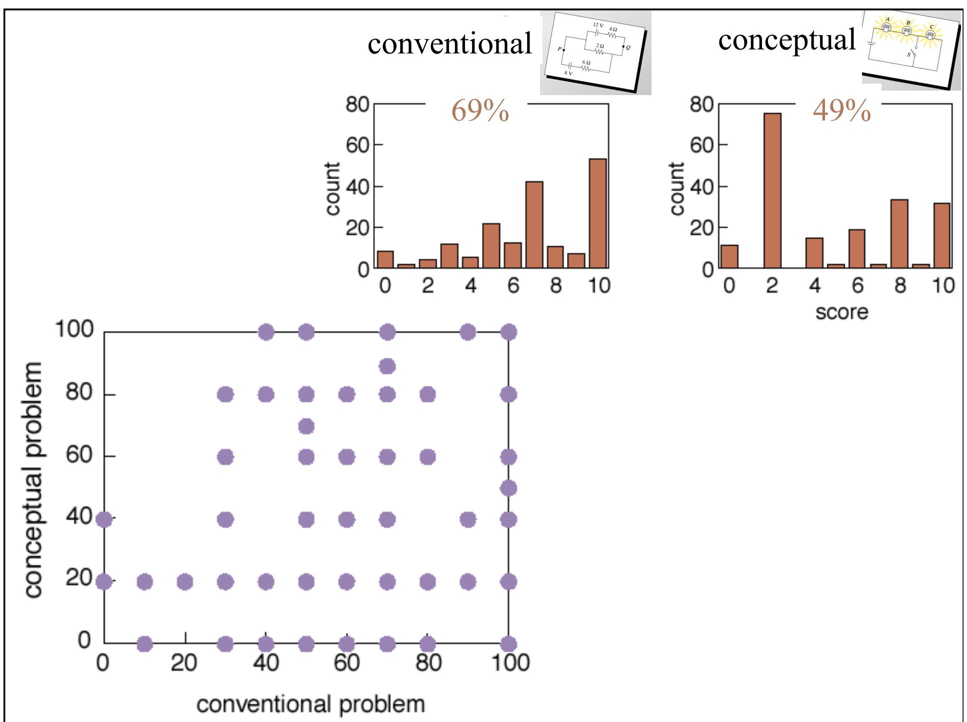
When *S* is closed, what happens to:

(*a*) intensities of A and B?

(*b*) …



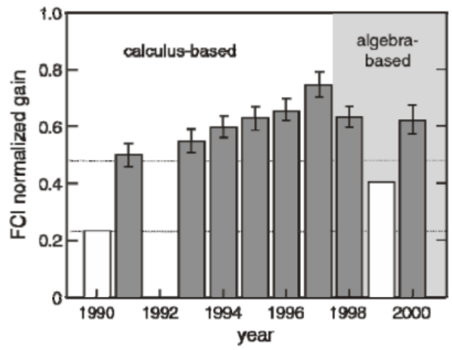
- Is it possible for a student to have a qualitative understanding without quantitative?



PI Results (2 slides)

Table I. Force Concept Inventory (FCI) and Mechanics Baseline Test (MBT) results.[a]

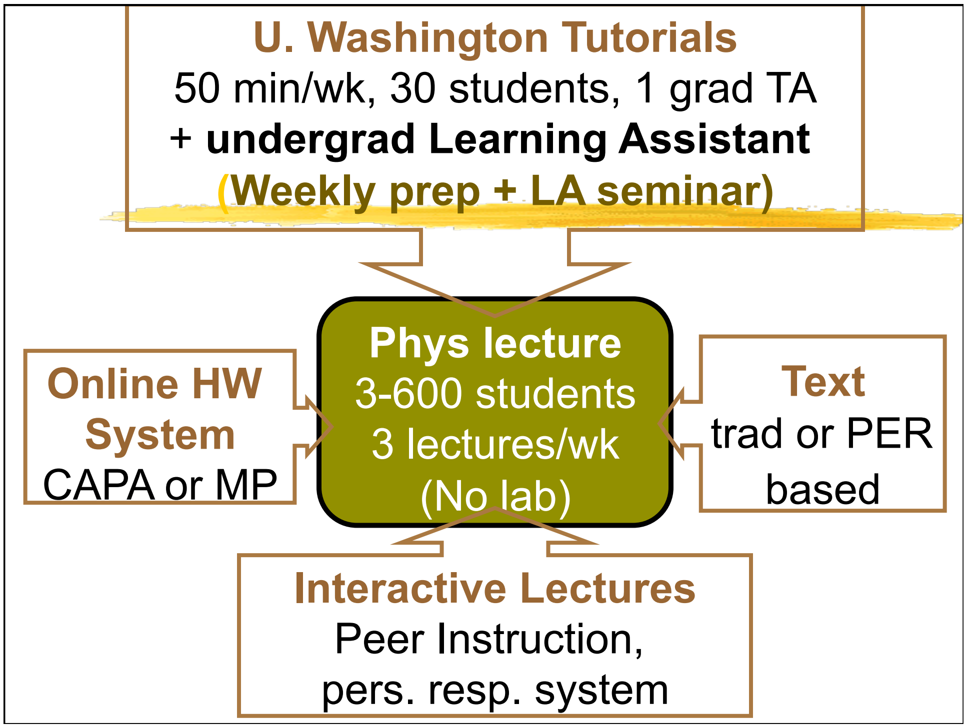
Year	Method	FCI pre	FCI post	Absolute gain (post−pre)	Normalized gain ⟨g⟩	MBT	MBT quant. questions	N
Calculus-based								
1990	Traditional	(70%)	78%	8%				
1991	PI	71%	85%	14%				
1993	PI	70%	86%	16%				
1994	PI	70%	88%	18%				
1995	PI	67%	88%	21%				
1996	PI	67%	89%	22%				
1997	PI	67%	92%	25%				
Algebra-based								
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

Another modest reframing of class context

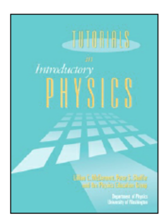
w/
Steven Pollock



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

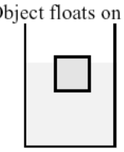
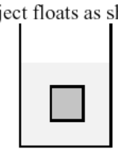
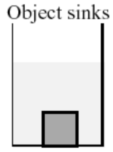
Tutorial Materials

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

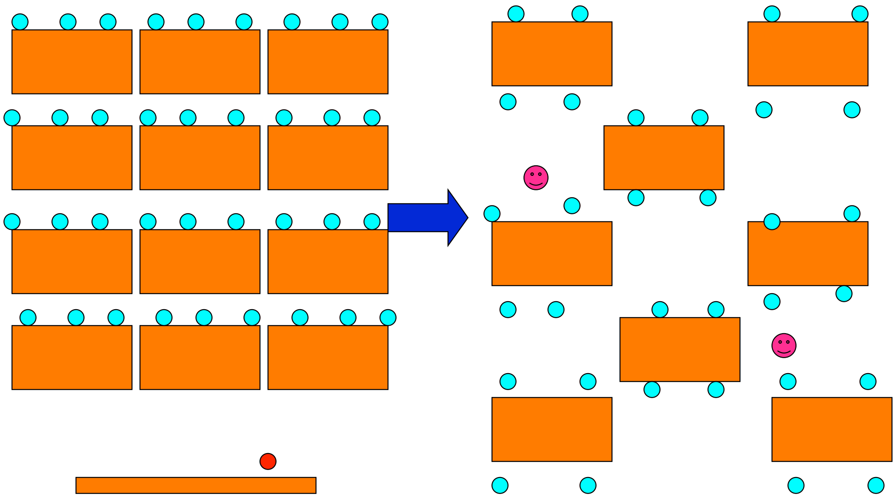
Assignment 11M: Name ________________

Buoyancy Tutorial section________________

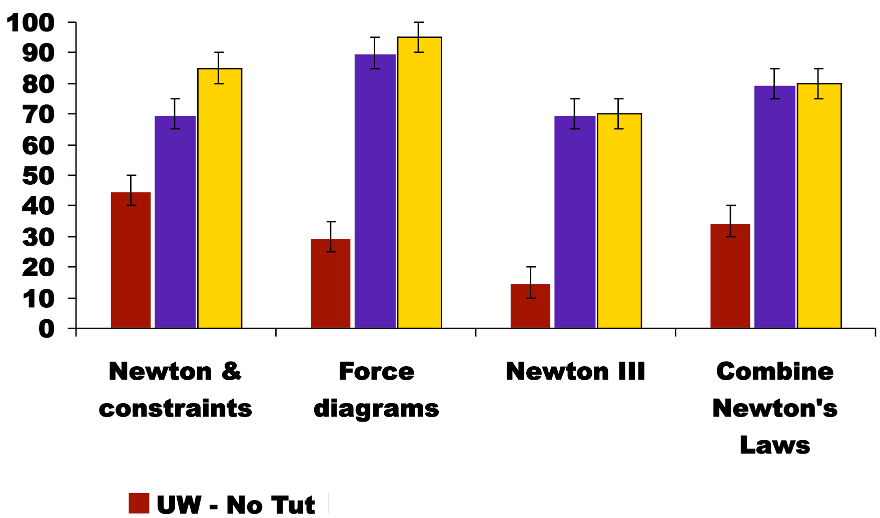
1. Three objects are at rest in three beakers of water as shown.
   a. Compare the mass, volume, and density of the objects to the mass, volume, and density of the displaced water. Explain your reasoning in each case.

Object floats on top	Object floats as shown	Object sinks
		
Is m_{object} (> < =) $m_{displaced\ water}$? Explain	Is m_{object} (> < =) $m_{displaced\ water}$? Explain	Is m_{object} (> < =) $m_{displaced\ water}$? Explain

Tutorial vs. Trad'l Recitation

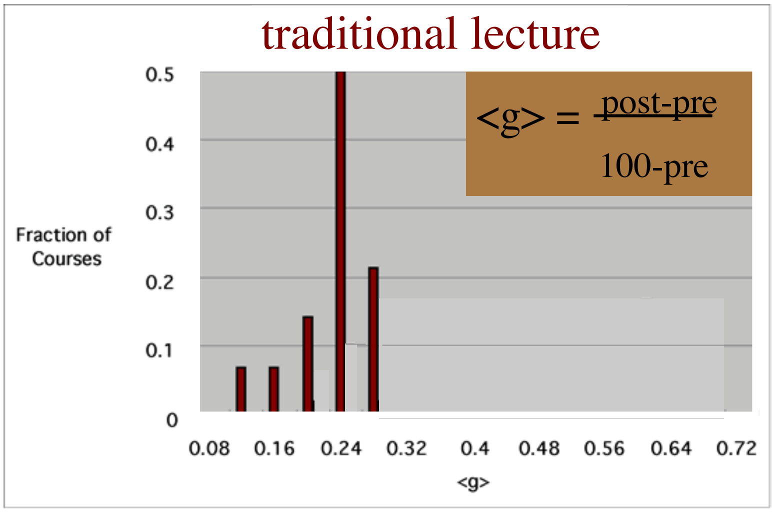


Impact and Reproducibility



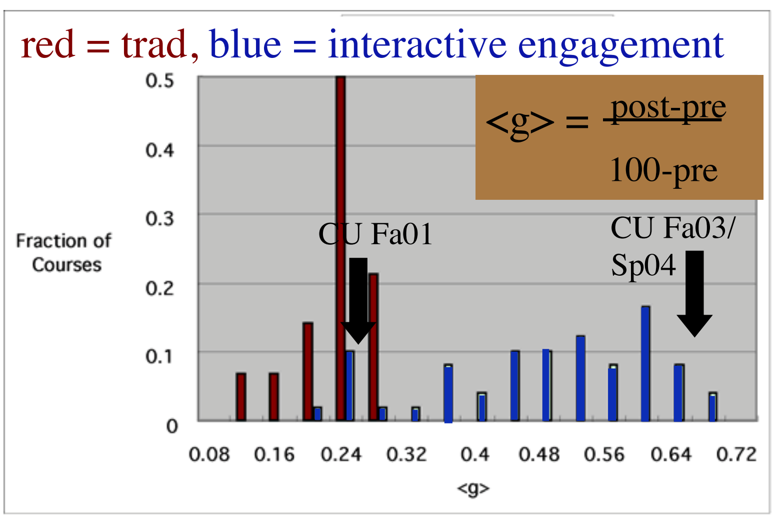
Trowbridge and McDermott," *Am. J. Phys*. **49** (3), 242 (1981).
Finkelstein and Pollock, (2005). *Phys Rev ST PER*, 1,1.010101

Force Concept Inventory



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

Force Concept Inventory



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The impact of recitation/ pedagogy

Physics 1, 300+ students,
Peer Instruction in lecture, and:

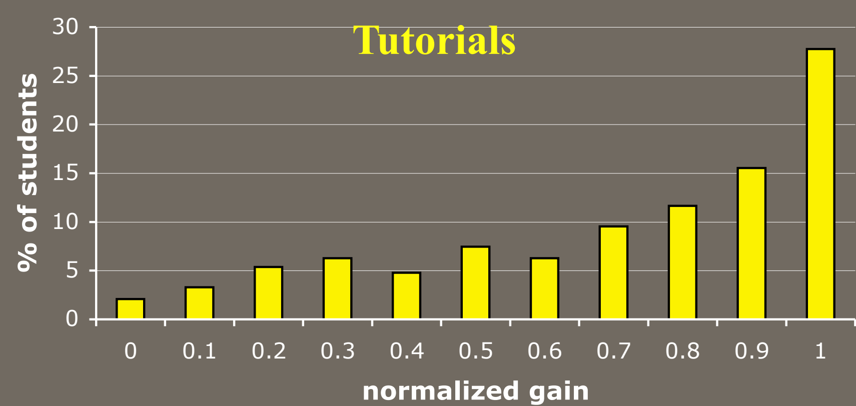
1: "Tutorials" (Sp04) *Tutorials*

2: "Workbook" (Fa04) *Knight Workbook*

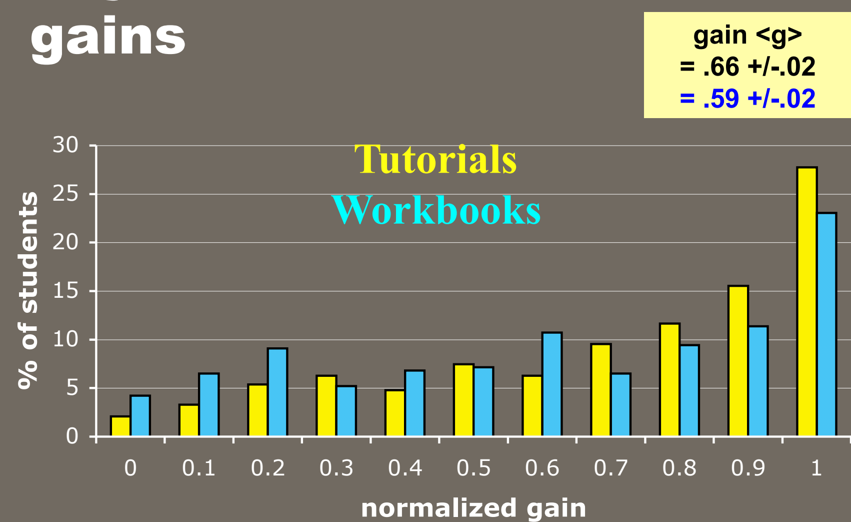
3: "Traditional" (Sp05) Mostly traditional

Phys 1110 normalized gains

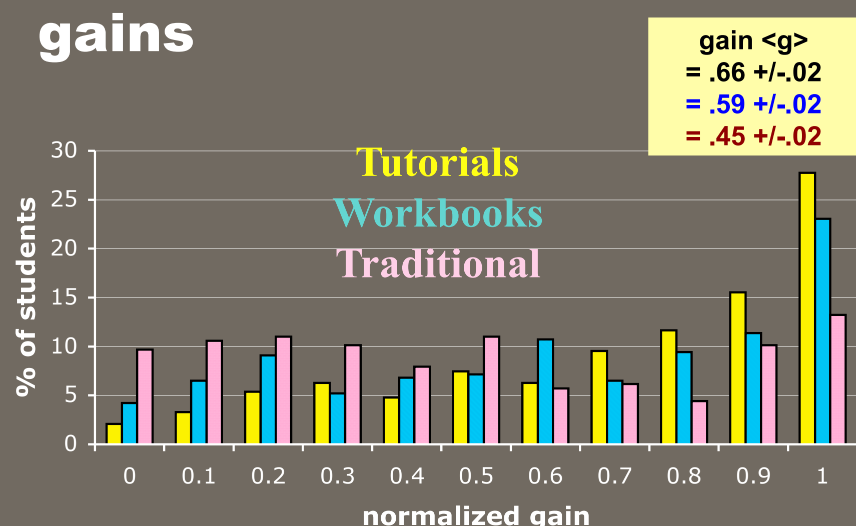
gain <g>
= .66 +/-.02



Phys 1110 normalized gains

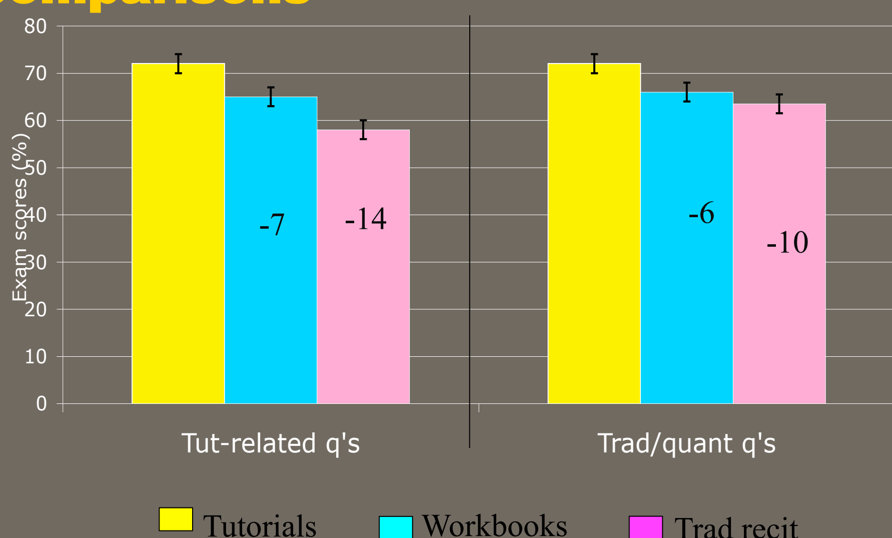


Phys 1110 normalized gains

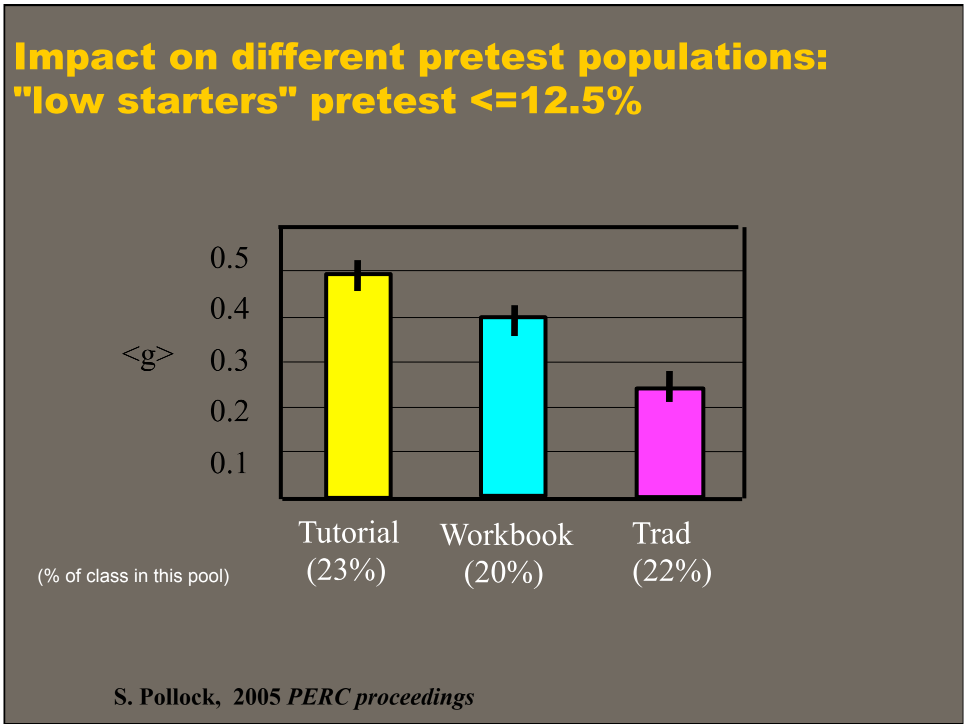


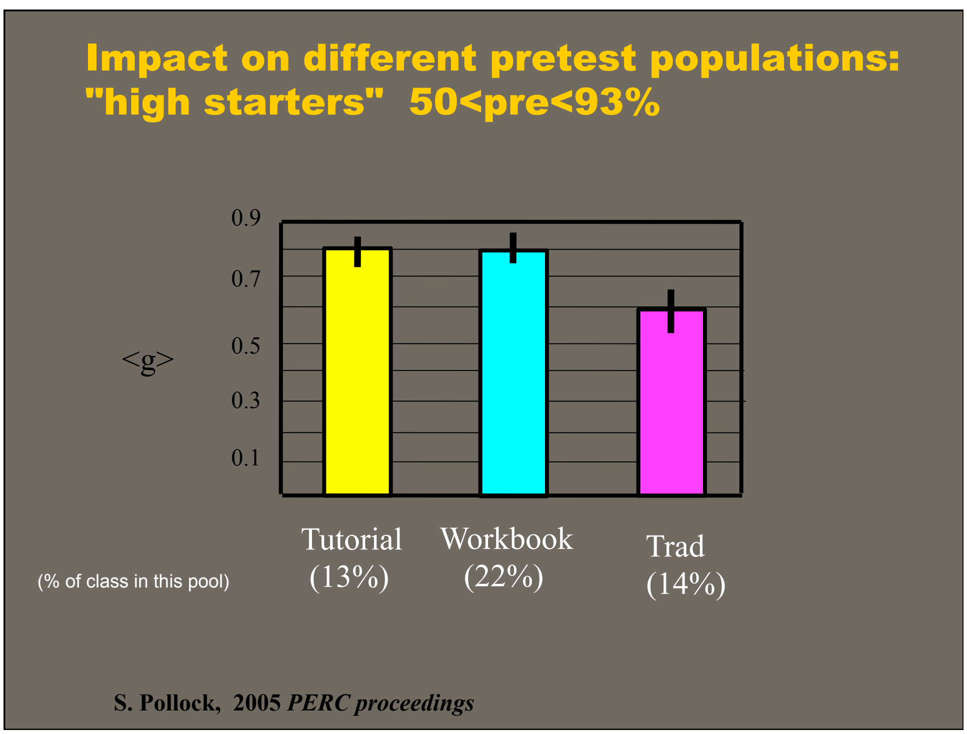
Strong indication: *CURRICULA* matters

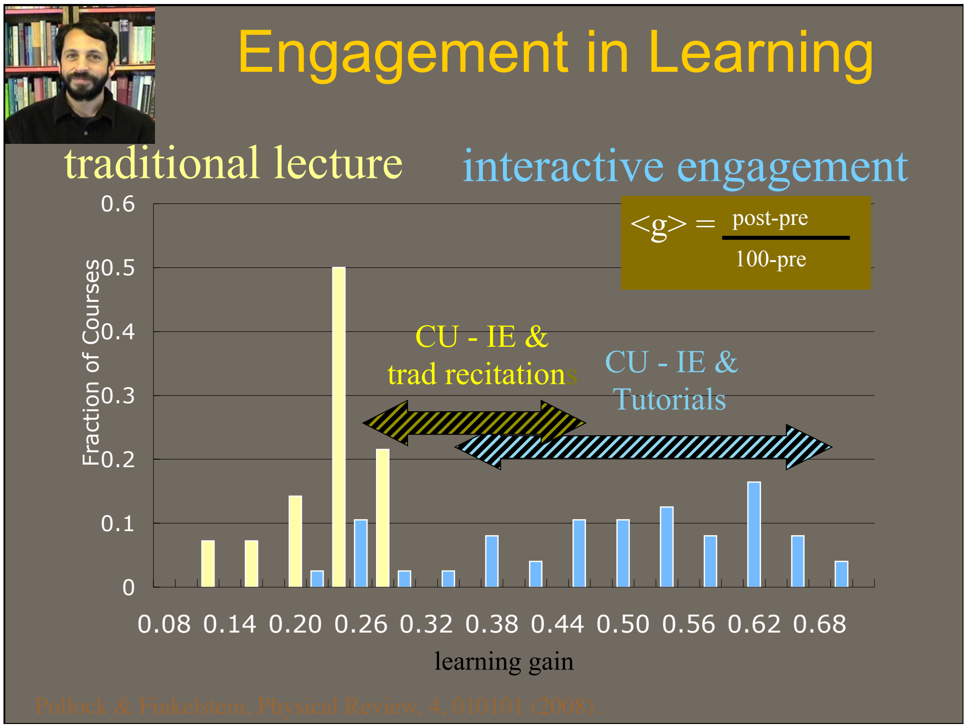
Beyond the FMCE: Exam comparisons



N.B. 12 points is roughly 1 letter grade.

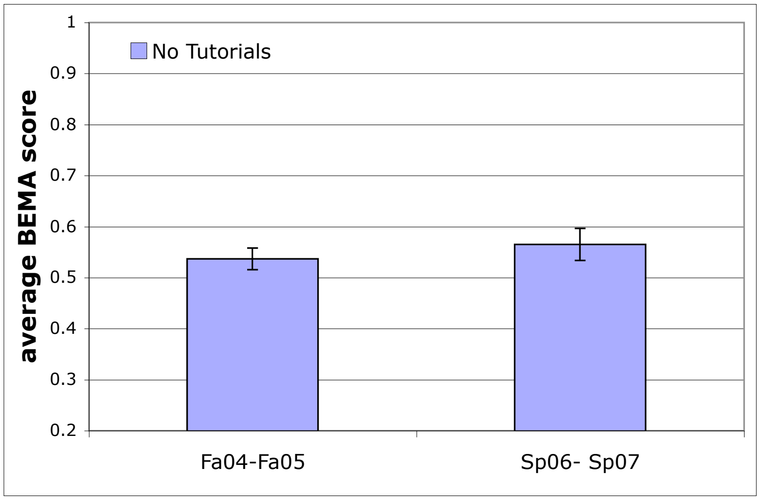

Impact on different pretest populations:
"low starters" pretest <=12.5%
0.5
0.4
0.3
0.2
0.1
<g>
Tutorial (23%)
Workbook (20%)
Trad (22%)
(% of class in this pool)
S. Pollock, 2005 PERC proceedings


Impact on different pretest populations:
"high starters" 50<pre<93%
0.9
0.7
0.5
0.3
0.1
<g>
Tutorial (13%)
Workbook (22%)
Trad (14%)
(% of class in this pool)
S. Pollock, 2005 PERC proceedings



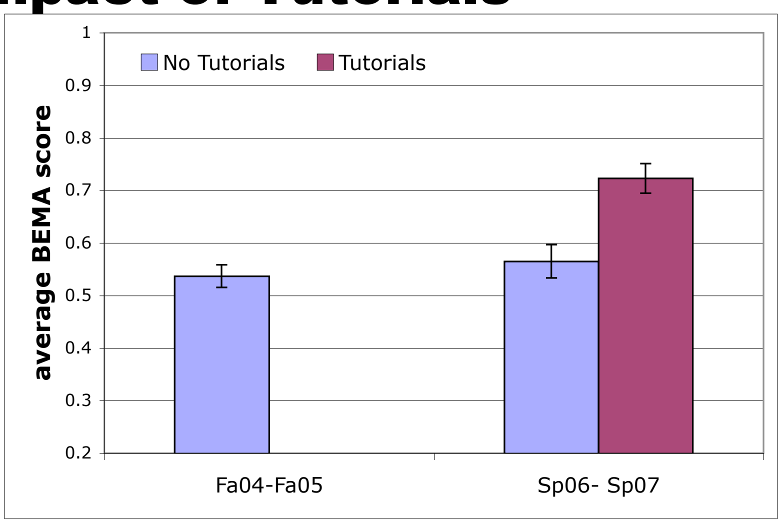
Lasting Impacts
Longitudinal Studies

How Junior level E&M fair on BEMA?



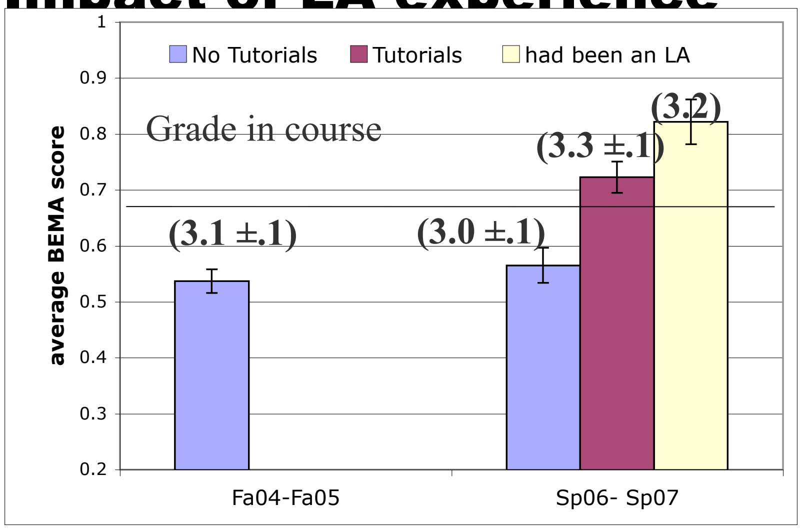
After completing Jr Level E/M (3310 or 3320)
Only students who took Phys 2 (1120) *without* Tutorials

Impact of Tutorials



Red bins: students who had taken
Freshman physics (1120) *with* Tutorials (~2 years prior)

Impact of LA experience



Beige: students who had been 1120 LAs

Methods for Curriculum Design

- What methods are used?
- Why?
- *I'm curious as to why they included people with majors/minors in physics.*
- *What do they mean by "descriptive study"?*
- *I was surprised that they shifted their methods from interviews to written tests.*
- *I'm curious about how they evaluated the explanations.*

Following the UW Approach

- Review the Pre-Test
- Review student responses
- What conclusions can you make?
- How do these compare to Knight's claims?

Student Reasoning – universal?

- **I find that many instructors base their teaching off of what naive conceptions, as Redish puts it, they have personally seen in students as they have taught. However, in order to address naive conceptions in the most efficient manner, I think research should be done. Washington along with many other PER groups are doing this successfully. It's now just a matter of continuing this process and getting the results to instructors. This seems to be the big problem.**
- **"Results from Cross-cultural studies indicate that similarly incorrect ideas flourish in countries with very different systems of education"**