



## Creating Small within Large

### Transforming Undergraduate Physics

*Redesign Alliance  
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## Acknowledgements


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### The University of Colorado LA Program

<http://cosmos.colorado.edu/stem/>



V. Otero, N.D. Finkelstein, S.J. Pollock and R. McCray (2006),  
*Science*, 313, 445

**STEM Colorado Phystec Team**  
University of Colorado, Boulder



## Participants

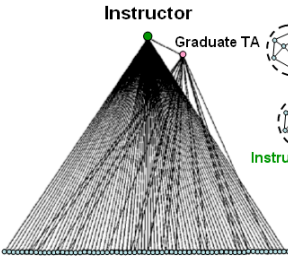
Applied Math	Astronomy	Chemistry	Education
Jim Curry	Dick McCray	Veronica Bierbaum	Valerie Otero
Mary Nelson	Doug Duncan	Margaret Asirvatham	Derek Briggs
Adam Norris	Nick Schneider	Linda Koch	Lorrie Shepard
Ann Dougherty	John Stocke	Laurie Langdon	Laura Moin
Jim Weiss	Fran Bagenal		David Webb
Susan Hallowell			
		Physics	
Geosciences	MCD Biology	Steve Pollock	Noah Finkelstein
Alan Lester	Mike Klymkowsky	Kathy Perkins	Mike Dubson
David Budd	Bill Wood	Carl Wieman	Ed Kinney
Andrea Bair	Jennifer Knight	Carl Rogers	Jim Shepard
Jennifer Stempfen	Sylvia Fromherz	Murray Holland	James Nagle
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K-12 Teachers	Graduate Students		155 Learning Assistants
Steve Iona	Danielle Harlow	Kim Geil	
Mike Fuchs	Bud Talbot	Kara Gray	
Roberta Tanner	Heidi Iverson	Julie Schneider	
Physics TAG	Rebecca Koopman	Chandra Turpen	



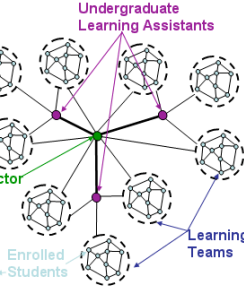
## Size built into our classes?



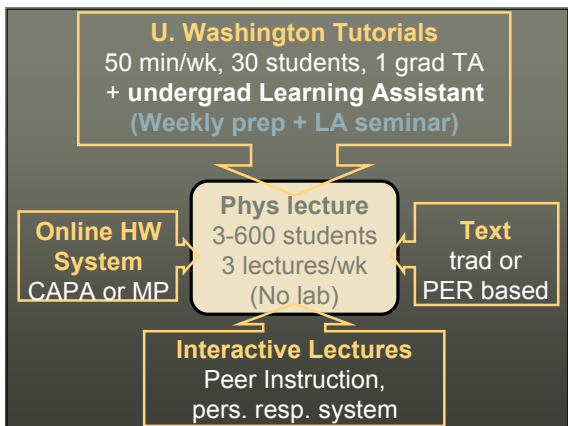
### Transformation of Large-Enrollment Introductory Courses with Undergraduate Learning Assistants (LAs)



**Traditional large enrollment lecture course:** one instructor and a graduate TA to serve 200+ students



**Course transformed using Learning Assistants to facilitate collaboration**



## 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/pubs.html>

## Tutorial Materials

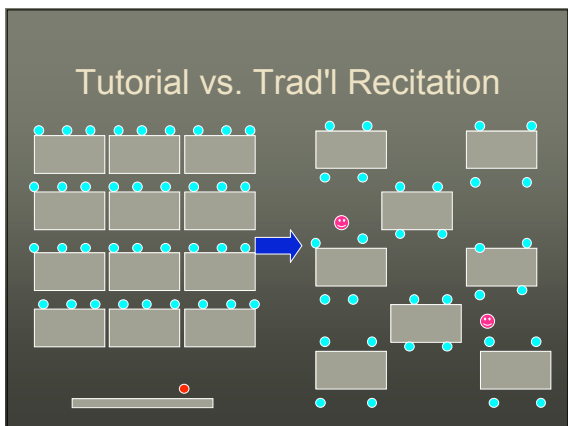
### Hands-on, Inquiry-based, Guided, Research-based

**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.

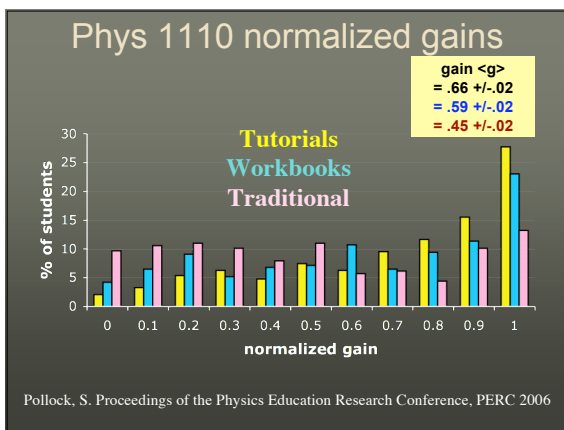
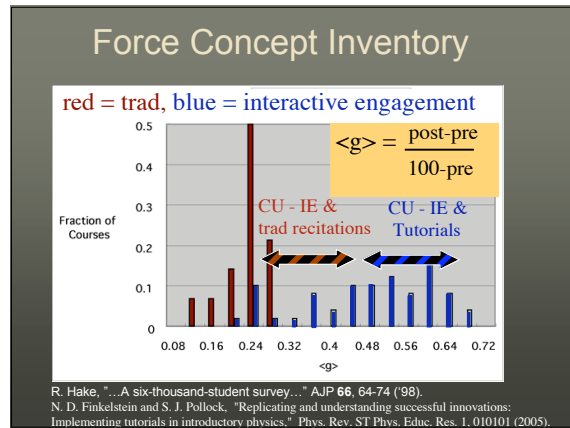
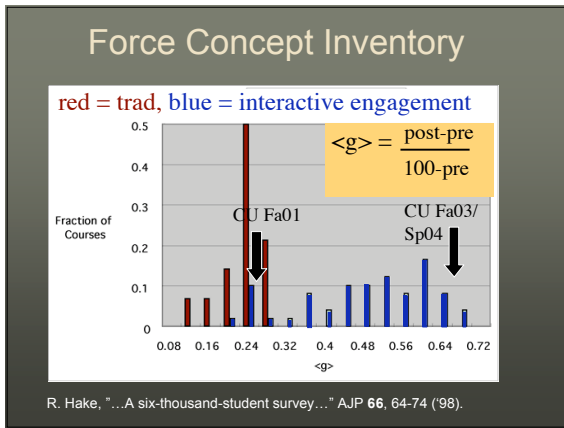
Object floats on top 	Object floats as shown 	Object sinks 
Is $m_{\text{object}} > m_{\text{displaced water}}$ ? Explain.	Is $m_{\text{object}} > m_{\text{displaced water}}$ ? Explain.	Is $m_{\text{object}} > m_{\text{displaced water}}$ ? Explain.



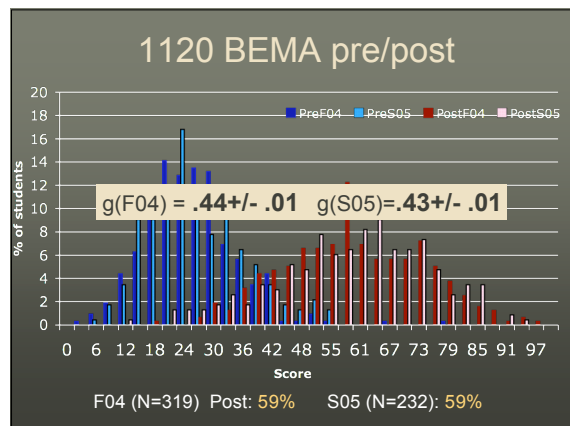
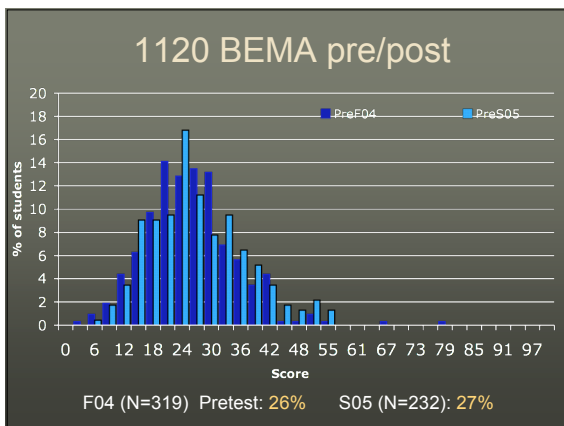
## CU Model of Teacher Prep

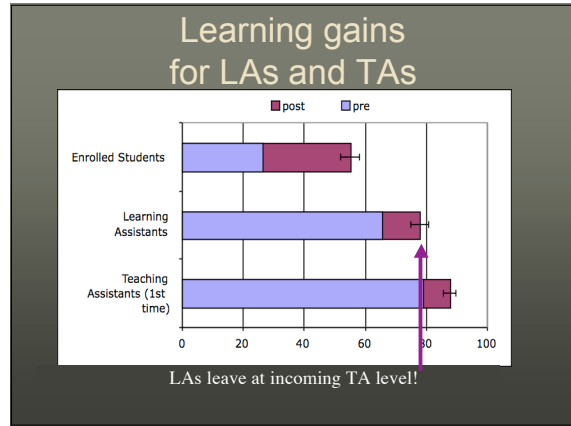
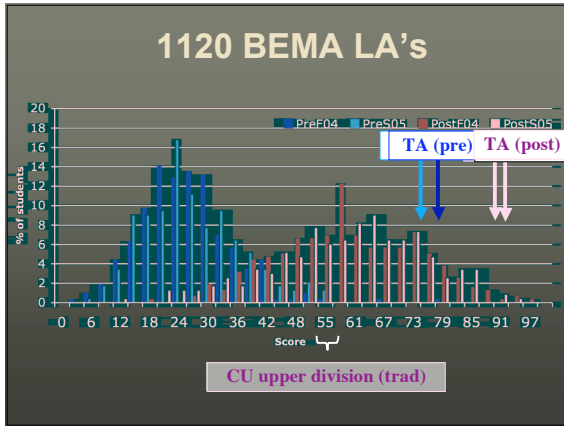
- Begin *within* physics department
- Learning Assistants:
  - Use UG's to implement PER-based materials
  - Model best-practices for all students
  - Improve education of all students
  - Increase likelihood students engage in teaching
- Improve content mastery of future teachers

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*Reproducibility II*  
 Systematically alter instructor  
 (Physics II)





*Fin*

Much more at: [per.colorado.edu](http://per.colorado.edu)