Lecture Supported Mini-Studio Approach to Algebra-based Physics: First Steps

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Funded in part by NSF DUE-1246024.

UCF 50 1963–2013 YEARS

Introduction & Context

- At UCF, 2200+ students per semester enroll in intro physics courses

- New SCALE-UP[1] style classroom opened in Fall 2012
  - 10 sections of studio courses offered, *but served less than half of students*

- Other sections taught as large (~300 student) lecture + laboratory, which face difficulties such as:
  - lack of interactive engagement
  - lack of synchronization between lecture and lab

[1]Beichner *et al.*, 2000

Lecture Supported Mini-Studio

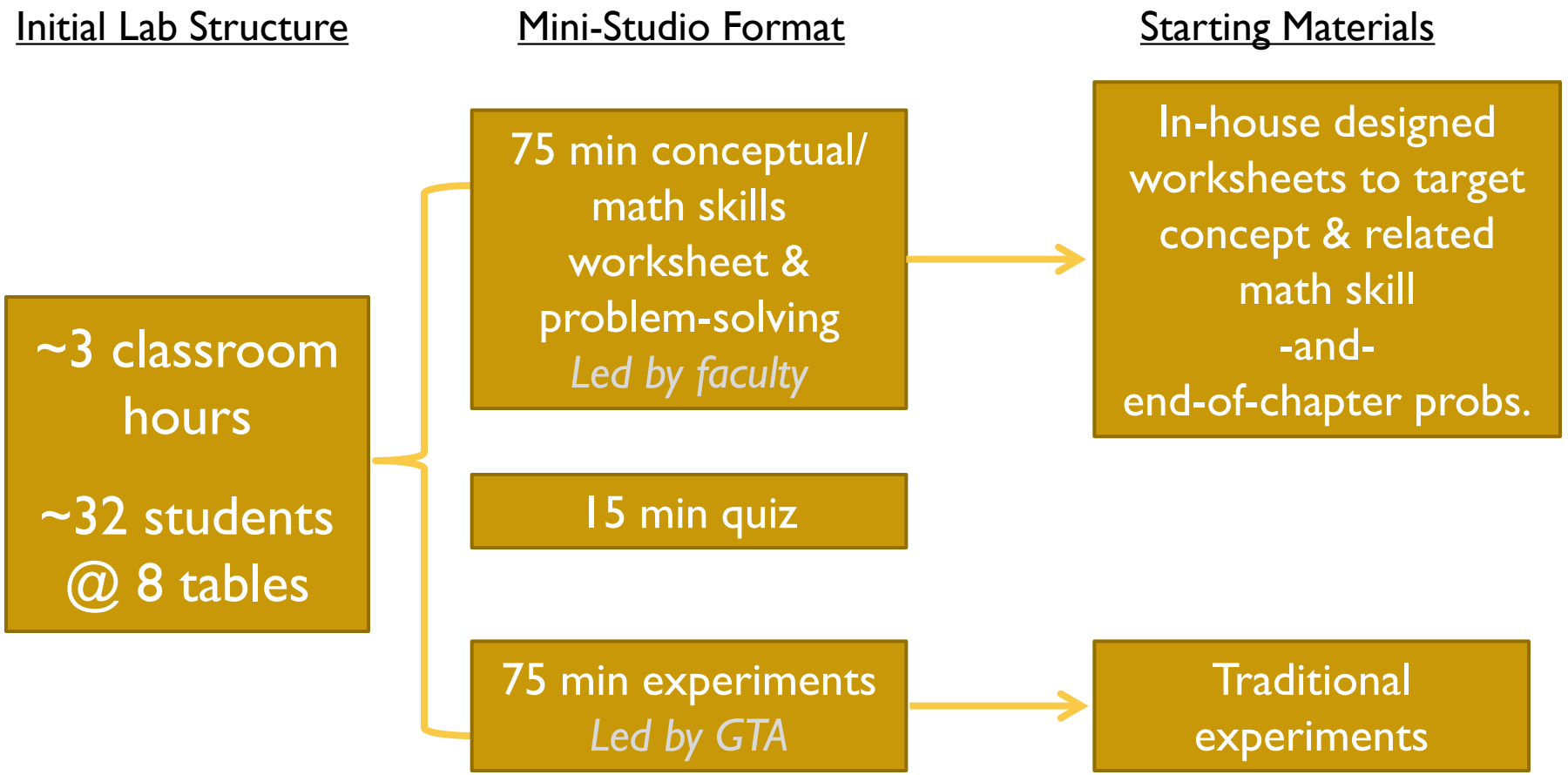
- Goal: Course format that recreates the useful aspects of a Studio course without requiring a new space or additional faculty time.

- Approach: Lecture-supported Mini-Studio
  - Typical course time format maintained
  - 3-hour laboratory transformed into "mini-studio" (MS)

- Potential benefits:
  - Fewer barriers to implementation than full studio (FS)
  - FS may not be the best fit for algebra-based physics students
    - Some research shows differences between calc- and algebra-based students[1-3]
    - Some claim fully guided instruction is more beneficial for novices[4]
  - Learning gains similar to FS
  - *Professional development for faculty/GTAs for FS?*

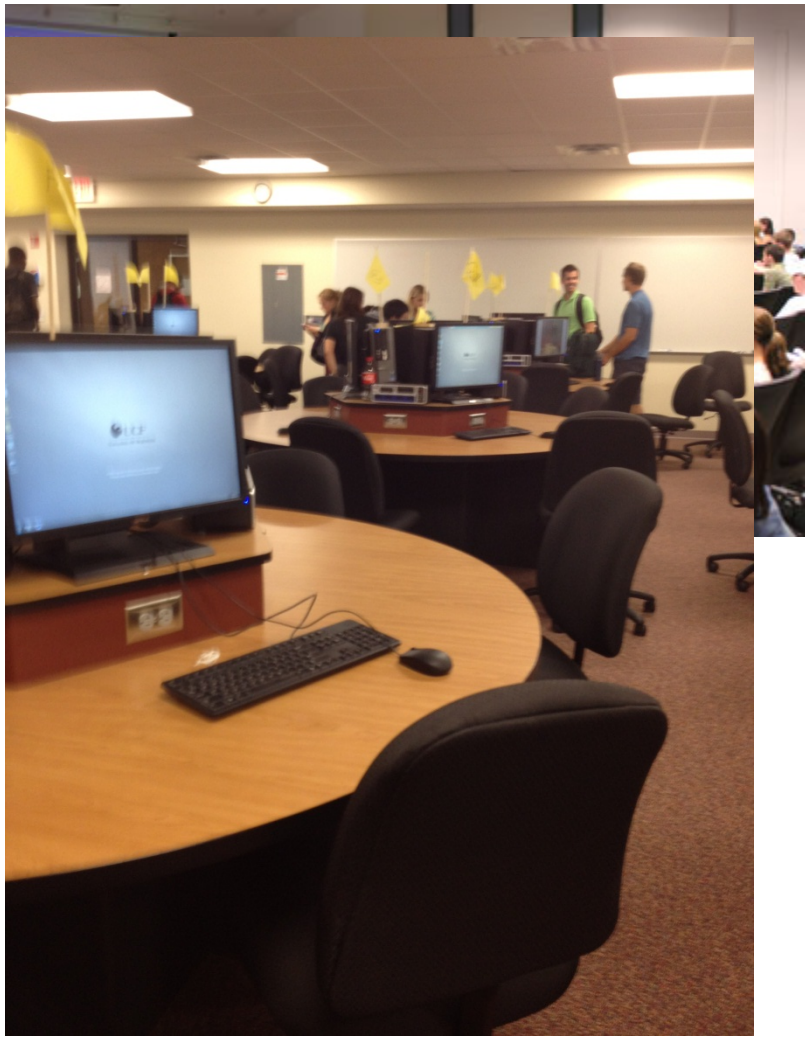
[1]Loverude *et al.*, 2008; [2]Nguyen & Meltzer, 2003; [3]Mason & Singh, 2011; [4]Kirschner, Sweller & Clark, 2006

What is Mini-Studio?



Other Course Structures

- Small traditional course (Small TRAD)
  - ~90 students, 3 associated laboratory sections
  - Phased out in Fall 2011
- Large traditional course (Large TRAD)
  - ~300 students, ~10 associated laboratory sections
- Full studio (FS)
  - Until Fall 2012, ~54 students
  - Starting Fall 2012, ~99 students



Data Sample

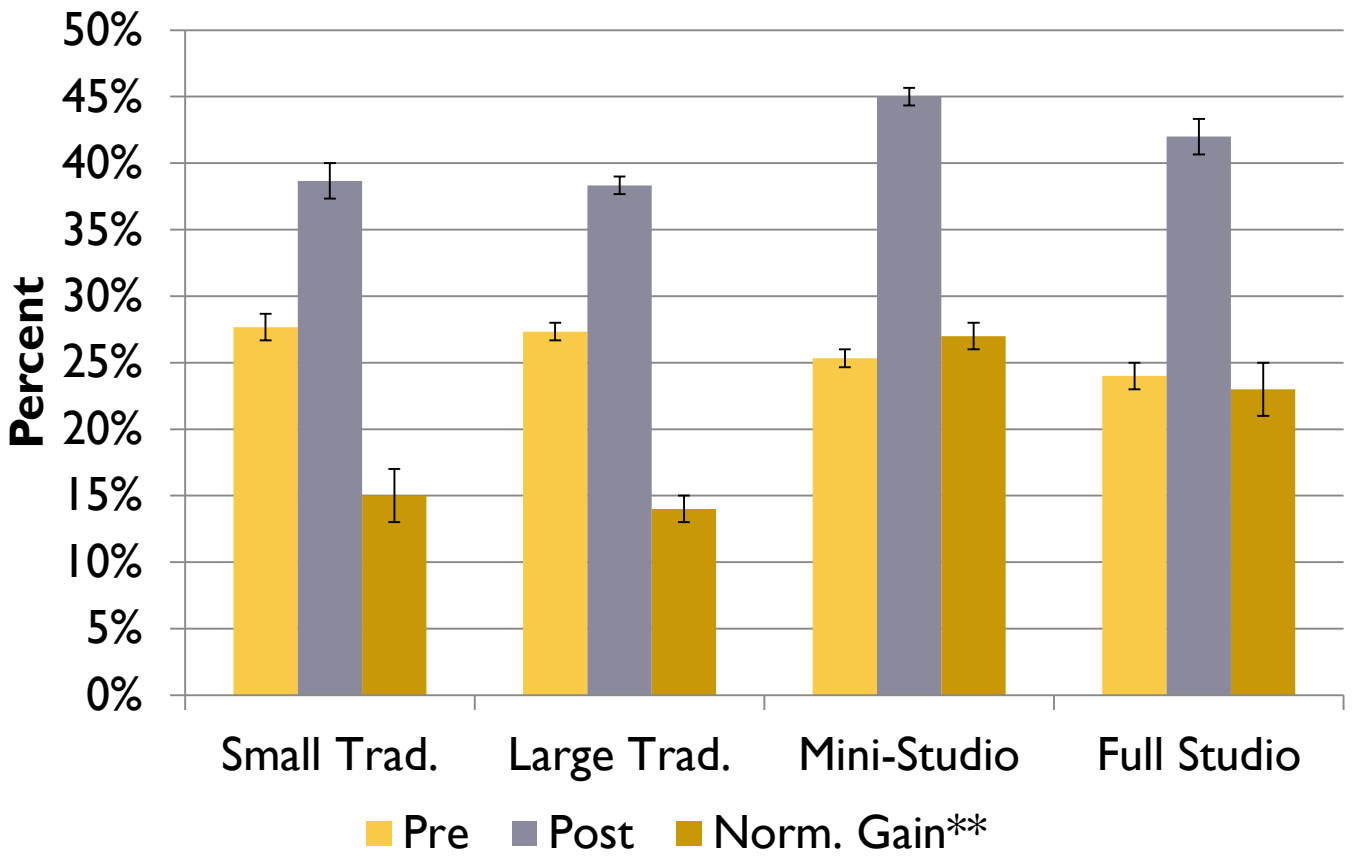
- Course: 1st semester algebra-based introductory physics
- Assessments:
  - Force Concept Inventory (FCI)[1]
  - Colorado Learning Attitudes about Science Survey (CLASS)[2]
- Data:

	# of Sections	# of Instructors	N
Small TRAD	3	3	185
Large TRAD	4	3	492
Mini-Studio	3	2	587
Full Studio	4*	2	176

*One section removed because students did not have adequate time to complete survey

[1]Hestenes, Wells & Swackhamer, 1992; [2]Adams *et al.*, 2006

Results– FCI (1)



**Normalized gain averaged per student

Results– FCI (2)

Analysis of Co-Variance for FCI Post-test Score by Course Type

Covariate: Pre-test Score

Source	SS	df	MS	F	p
Pre-test	12351.5	1	12351.5	678.2	.000
Course Type	1902.1	3	634.0	34.8	.000
Error	26134.9	1435	18.2		
Total	262567.0	1440			

- Pre-test score is significantly related to post-test score
- There is a significant effect due to **course type**

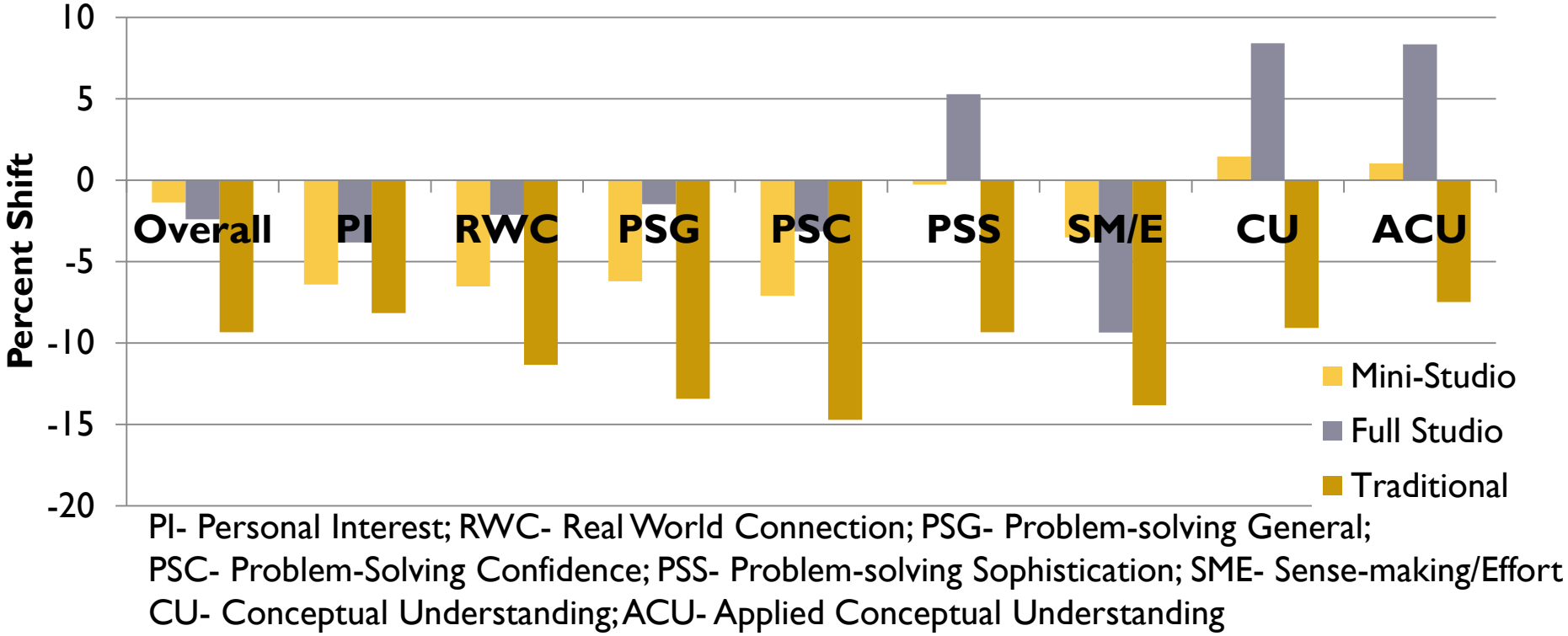
Results- FCI (2)

Pairwise Comparisons and Effect Sizes of FCI Post-test Score by Course Type			Adjusted Mean Differences $(\bar{X}'_i - \bar{X}'_j)$ (Effect Sizes are indicated in parentheses)			
Group	Mean	Adjusted Mean	1. Sm. TRAD	2. Lg. TRAD	3. MS	4. FS
1. Small TRAD	11.6	11.2	—			
1. Large TRAD	11.5	11.2	0.01	—		
1. Mini-studio	13.5	13.7	2.43* (.57)	2.43* (.57)	—	
1. Full studio	12.6	12.9	1.75* (0.41)	1.75* (0.41)	0.68	—

*$p < 0.008$ (Bonferroni adjusted $\alpha' = 0.05/6$)

- Both FS and MS had significantly higher post-test scores than TRAD courses
- No significant different between FS and MS or Large & Small TRAD

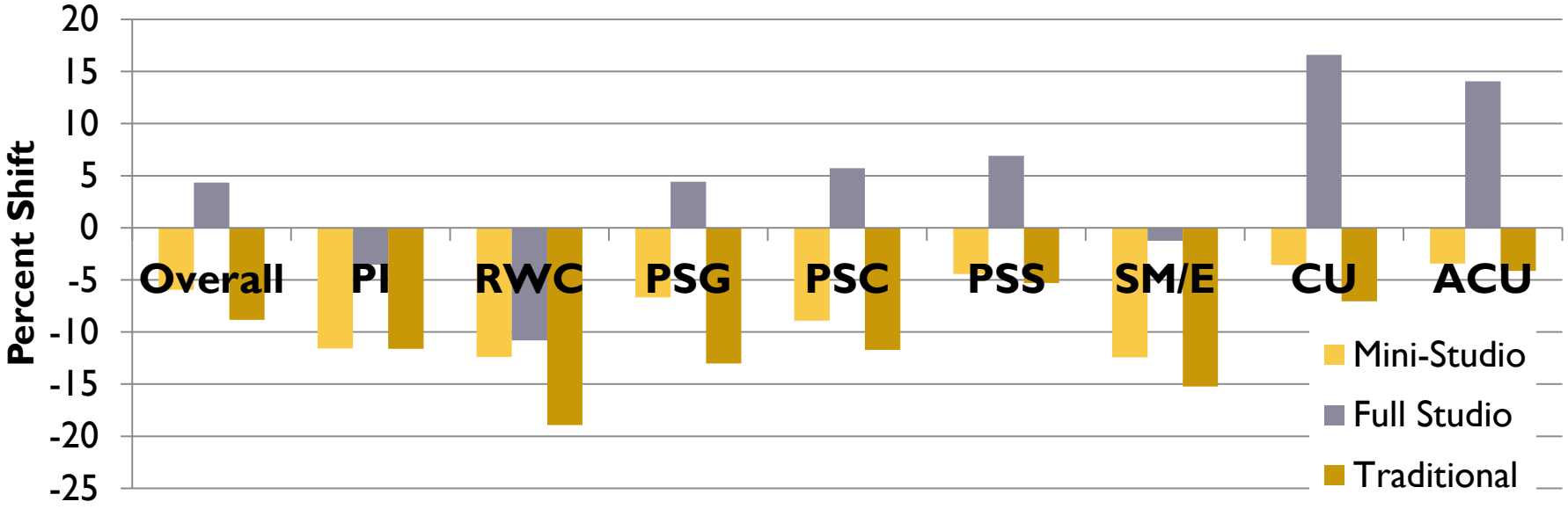
CLASS- Fall 2011



PI- Personal Interest; RWC- Real World Connection; PSG- Problem-solving General; PSC- Problem-Solving Confidence; PSS- Problem-solving Sophistication; SME- Sense-making/Effort CU- Conceptual Understanding; ACU- Applied Conceptual Understanding

- Positive shifts for conceptual understanding and one problem-solving category for FS
- Less severe negative shifts in MS than TRAD

CLASS- Spring 2012



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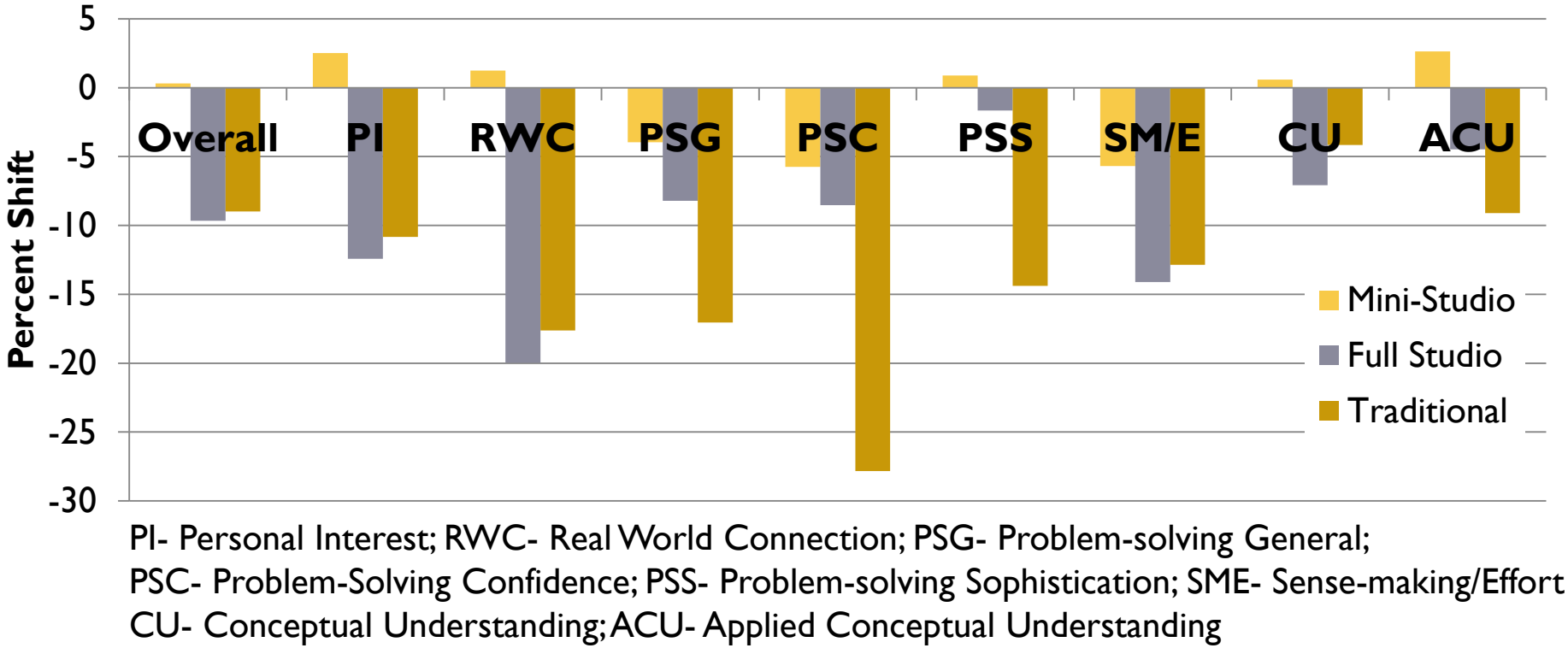
- Similar results, with more positive shifts for FS but less dramatic difference between MS and TRAD

CLASS- Fall 2012



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- No positive shifts for FS (first semester w/ 99 students)
- Some positive shifts for MS

Discussion & Next Steps

Mini-studio (MS) resulted in similar student outcomes for 1st semester algebra-based intro course as Full Studio (FS)

- MS and FS resulted in similar post-test scores
  - Both are significantly higher than traditional course (TRAD)
  - However, both are still "low gain" ($g < 0.30$)[1]
- CLASS shifts are more favorable in MS & FS than TRAD
  - Both fluctuate across semesters
  - Neither reach desired levels[2]
- Next steps
  - Adapt existing PER materials for worksheets & experiments[3]
  - Measure additional student and instructor outcomes

[1]Hake, 1998; [2]E.g., Brewe, Kramer & O'Brien,2009 and Marušic & Sliško, 2012;
[3]E.g., Maryland Tutorials in Physics Sense-Making and Investigating Science Learning Environments

Acknowledgements

- Ahlam Al-Rawi
- Josh Colwell
- Archana Dubey
- Elena Flitsiyan
- Abdelkader Kara

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