Implementing PER-based Materials in the Introductory Algebra-based Lecture-supported Mini-studio

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UCF 50 1963–2013 YEARS

Mini-studio/Full-studio vs. Traditional Lecture

- Lecture-Supported Mini-Studio:
  - Restructure existing ~3 classroom hours for recitation + lab.
  - ~32 students work in 8 groups of ~4 people.

75 minutes: Conceptual / math skills worksheet & problem-solving; *Instructor led.*	15 minutes: Quiz	75 minutes: Laboratory Experiment; *GTA led.*

Mini-studio/Full-studio vs. Traditional Lecture

- Previous implementation of Lecture-Supported Mini-Studio[1]:
  - Mini-studio courses resulted in higher FCI post-test scores compared to both the Small and Large Traditional lecture courses.
  - Mini- and Full-studio produced similar post-test scores.

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[1]Chini and Rahman (2013)

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  - ~3 classroom hours.
    - 75 minutes: conceptual/ math skills worksheet & problem-solving; Instructor led.
    - 15 minutes: Quiz.
    - 75 minutes: Laboratory Experiment; GTA led.
- Previous implementation of Lecture-Supported Mini-Studio[1]:
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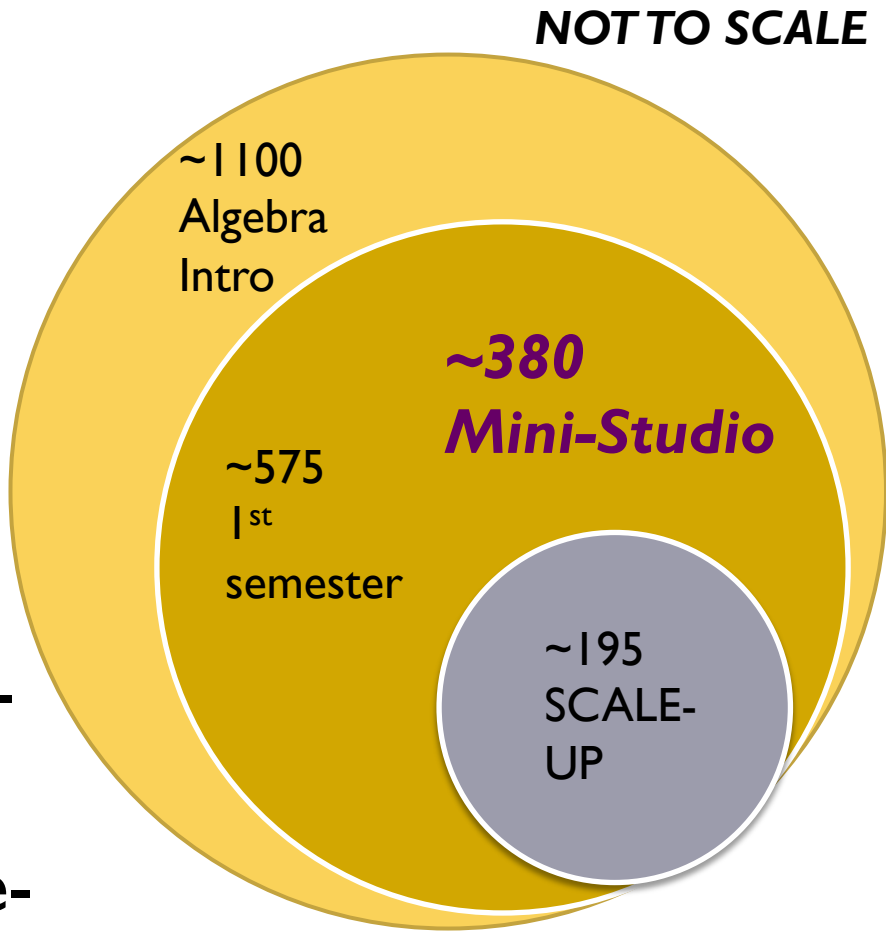
Student Enrollment for Mini-studio

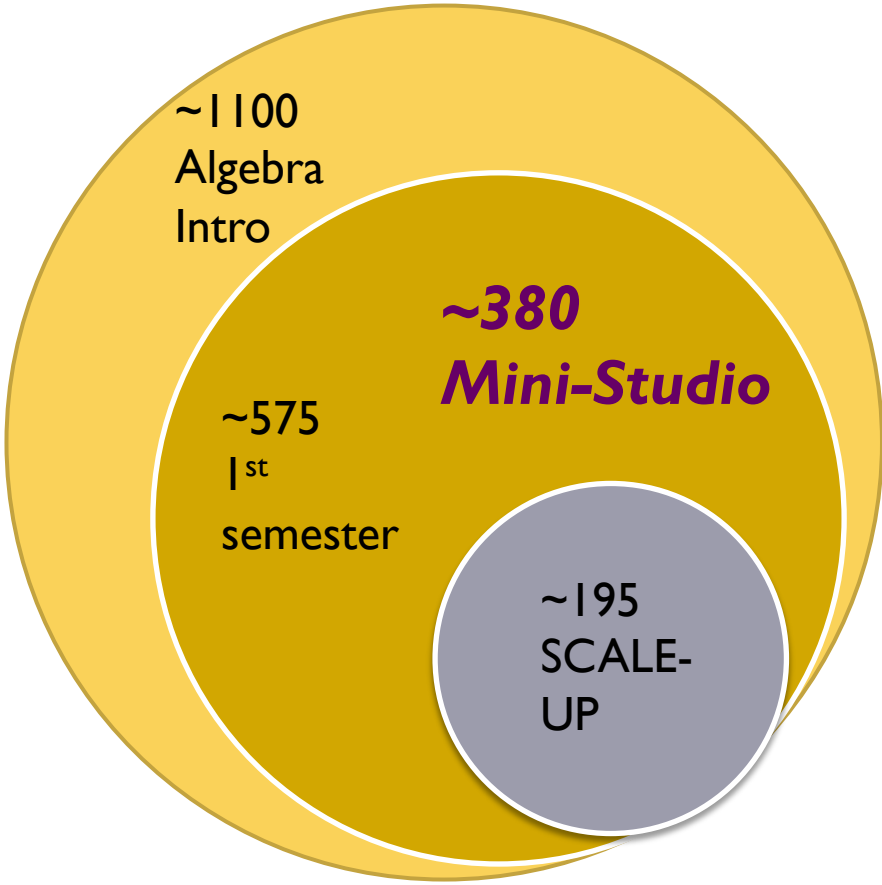
- For Fall 2013, ~ 1100 Students enrolled in the algebra-based introductory physics courses at UCF.
- ~575 enrolled in the 1st semester algebra-based physics.
- ~195 enrolled in the SCALE-UP[1] style Full-studio course.
- ~380 enrolled in the Lecture-supported Mini-studio course.



[1] Beichner *et al.*, 2000

Student Enrollment for Mini-studio

- Thus, less than half are served by the Full-studio course.
- Previous results show Mini-studio as an effective alternative to the Full-studio class.
- ***Goals***:
  - Improve assessment gain even further.
  - Foster environment to shift students beliefs to more expert-like.



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  - ~575 enrolled in the 1st semester algebra-based physics.
    - ~195 enrolled in the SCALE-UP[1] style Full-studio course
    - ~380 enrolled in the Lecture-supported Mini-studio course.
- Thus, less than half of the 1st semester algebra-based students can be served by the Full-studio course.
- Previous results show Mini-studio as a effective alternative to the Full-studio class.
- ***Goal***: To improve assessment gain even further and foster environment to shift students beliefs to more expert-like with the Mini-studio environment.

[1]Beichner *et al.*, 2000

Motivation for PER-based Material Incorporation

- PER-based Materials:
  - Maryland *Tutorials in Physics Sense-Making*[1] and Minnesota *Context Rich Problems*[2]
- These resources have shown to improve assessment post-test scores and problem solving ability.[2,3,4]
- The Mini-studio format has helped increase post-test scores at UCF.
  - Using In-House designed worksheets.
- Thus, we move to incorporate PER-based materials into worksheets to further improve student understanding and problem solving skills at UCF.

[1]Scherr and Elby (2007), [2]Heller, Keith, & Anderson (1992), [3]Redish and Steinburg (1999) [4]Finkelstein and Pollock (2005)

Course Type Description

- The following codes are used for the analysis:
  - SP13IH-A = Spring 2013, Instructor 1, Mini-studio, In-House
  - SP13IH-B = Spring 2013, Instructor 2, Mini-studio, In-House
  - FA13PER-C = Fall 2013, Instructor 3, Mini-Studio, PER-Based
  - FA13PER-D = Fall 2013, Instructor 4, Mini-Studio, PER-Based
- In-House vs PER-Based:
  - In-House = worksheets designed by department
  - PER-Based = worksheets borrow heavily from PER-developed materials.
- Main Interests:
  - The effect of PER-based materials on student understanding.
  - The effect of PER-based materials on student beliefs.

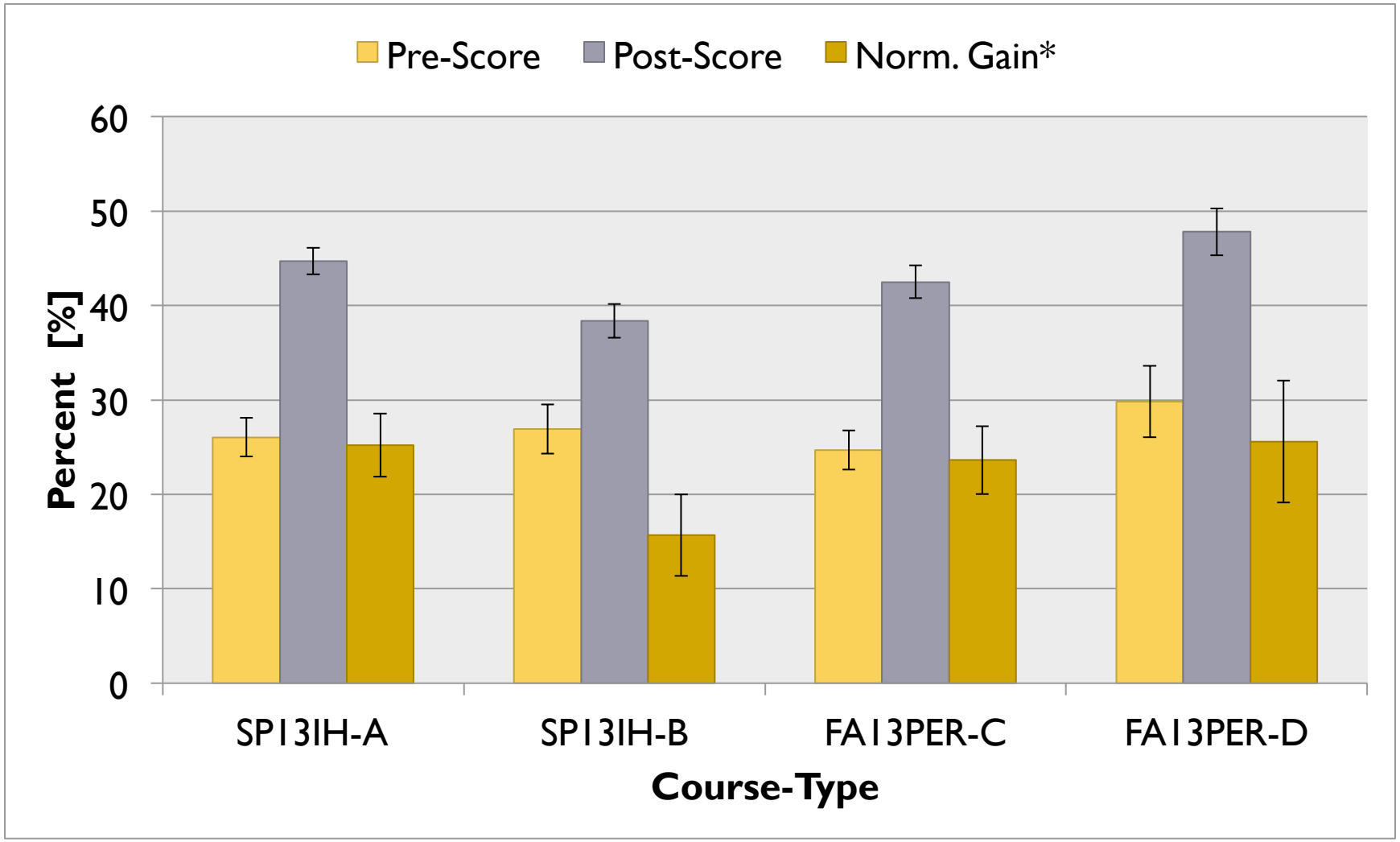
Data Collected

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

Course Type	Number of Respondents
SP13IH-A	163
SP13IH-B	107
FA13PER-C	140
FA13PER-D	62

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

Results – FCI



*Normalized Gain of average Pre- and Post-score

Results – FCI Continued…

- Analysis of Co-Variance for FCI Post-test Score by Course-type; Covariate: Pre-test Score

Source	SS	df	MS	F	p
Pre-score	4475.538	1	16696.642	725.955	.000
Course Type	6407.169	3	4475.538	194.592	.000
Error	10740.788	467	1601.792	69.645	.000
Total	94224.000	472	23.000		

- Pre-test score has a significant effect on Post-test score.
- Course type also has a significant effect on Post-test score.
- We thus further investigate the effect course-type has on the Post-test scores.

Results – FCI Post-Hoc Follow-Up

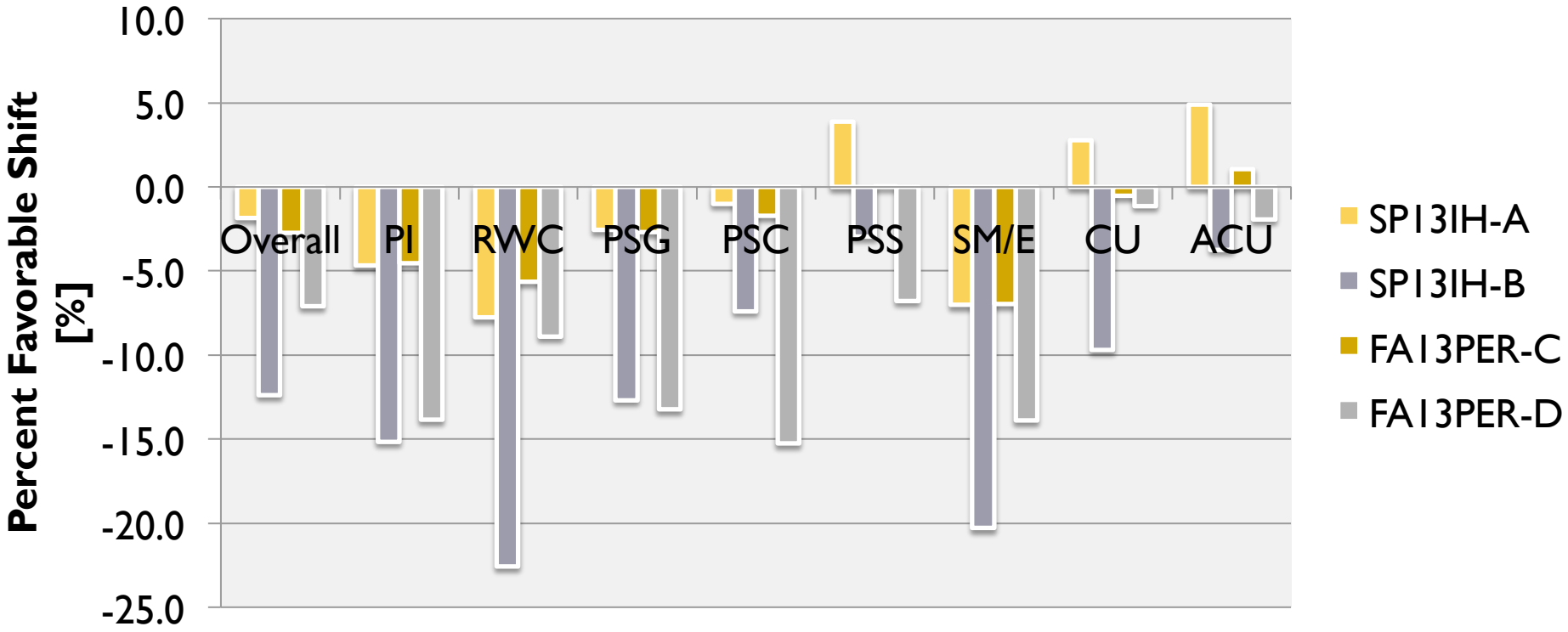
- Pair-wise Comparison of Course-Type Adjusted Means

Course-Type	Adjusted Mean Difference (Column – Row)			
	SP13IH-A	SP13IH-B	FA13PER-C	FA13PER-D
SP13IH-A	----------			
SP13IH-B	2.029*	----------		
FA13PER-C	0.379	-1.7*	----------	
FA13PER-D	-0.13	-2.209*	-0.510	----------

- Significant difference relative to SP13IH-B only.
- SP13IH-B has significantly lower Post-test scores compared to other course-types.
- No significant difference between all other course-types.

* Difference in means is significant

Results – CLASS



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

Discussion

- No significant effect of PER-based material on post-test scores.
- However, we see this as an initial step toward higher gains!
  - Maintained post-test results from initial Mini-studio implementation.
  - Take steps to improve post-test scores with PER-based material by looking at previous implementations.
- Comparing our implementation to that of Finkelstein and Pollock (2005):
  - Similarities: Sufficient collaborative space, trained and prepped TAs and LAs, graded post-lab (tutorial) homework assignments.
  - Differences: teacher-to-student ratio, tutorial material in lecture and on exams.

Plans for Future Implementations

- Encourage faculty to make connections in lecture.
  - Tutorial-style exam questions.
  - Tutorial-style clicker questions.
- Change laboratory session activities.
  - From "Cookie Cutter" to Inquiry-Based labs.
- Determine Effect LAs have on student understanding.
  - Designing experiment to isolate effect of LAs.
  - Potential to motivate investment in more LAs at UCF.