Implementing PER-based Tutorials in the Second-semester Algebra-based Lecture-supported Mini-studio

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Talk Outline

- Briefly describe Lecture-supported Mini-studio
- Highlight success of Mini-studio in first-semester physics.
  - Use Jackie's plot from her PERC poster to show this.
- Describe the worksheet materials used for second-semester classes.
- Discuss how we faced major pushback and were very surprised.
  - Faculty claims of treating students like guinea pigs, worksheet giving misconceptions, etc.
- We were thus limited to one section with Mini-studio set-up.
  - But we have 4 sections to compare with constant lecture instructor.
- Further surprised by CSEM results.
  - Highlight incentive and class attitude effects.
- For later implementations, we are moving to a TA-run mini-studio.
  - More cohesion between worksheet and lab time.
  - Expose future faculty to more research based curricula.

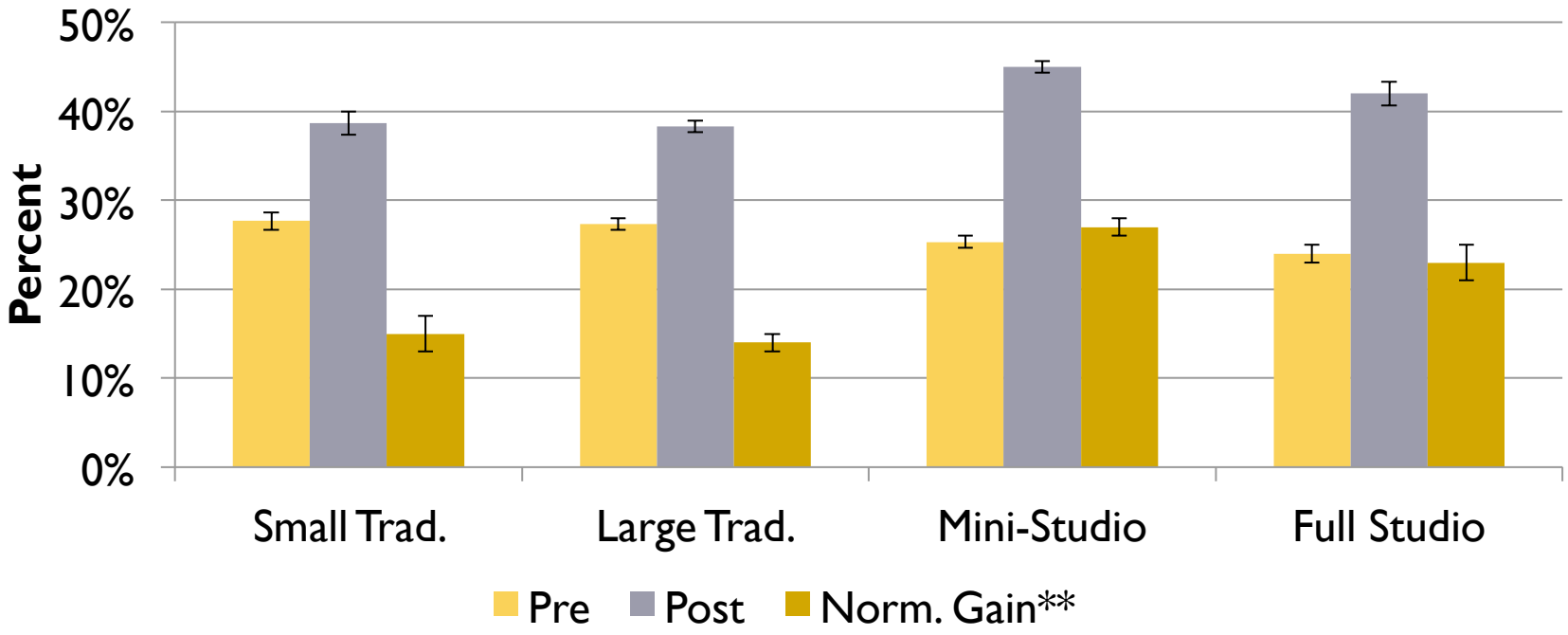
The Lecture-supported Mini-studio

- Review of Lecture-Supported Mini-Studio Format:
  - 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: First-semester Physics

- 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.

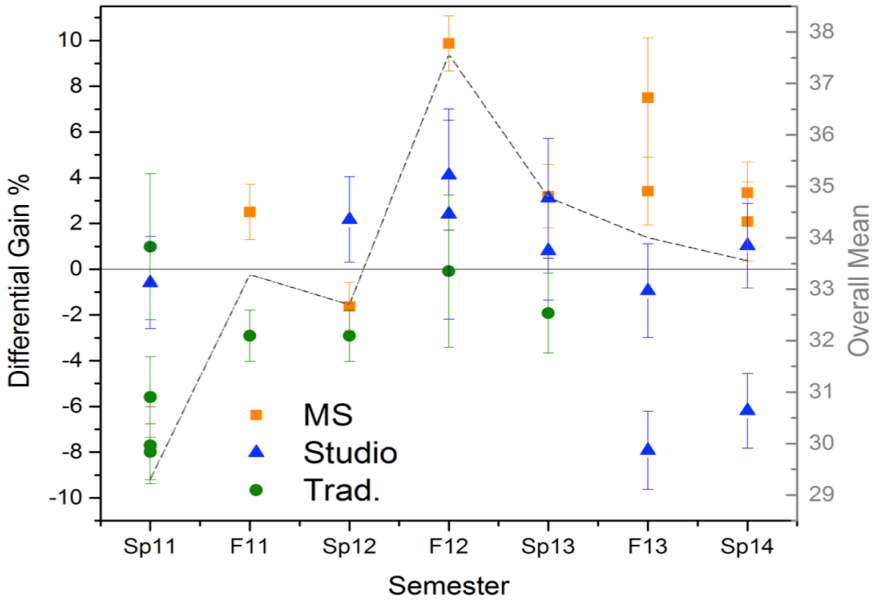


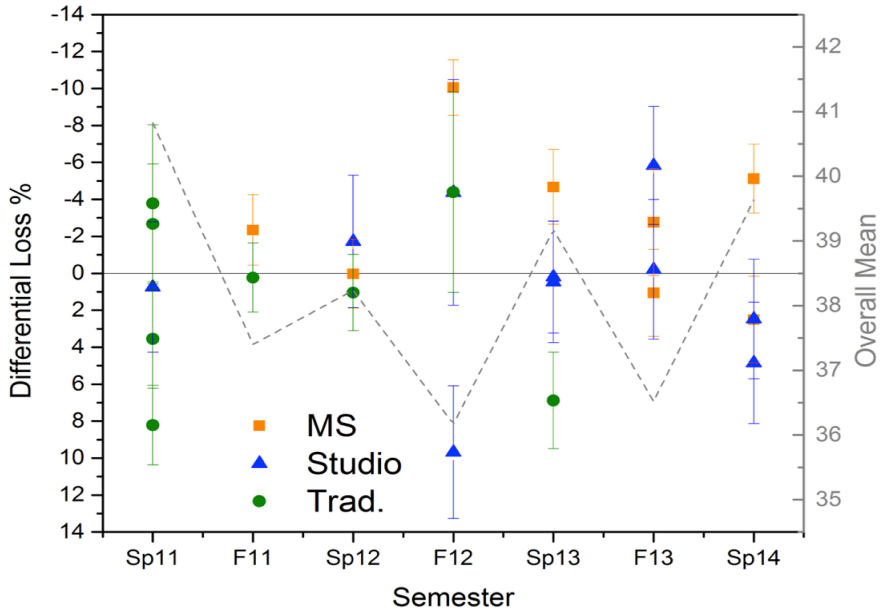
[1]Chini and Rahman (2013).

**Normalized gain averaged per student

Mini-studio/Full-studio vs. Traditional Lecture: First-semester Physics

- Previous implementation of Lecture-Supported Mini-Studio:
  - [1]: $G = (I_{pre} \rightarrow C_{post}) / I_{pre}$; $L = (C_{pre} \rightarrow I_{post}) / C_{Pre}$
  - Generally higher gain (G), lower loss (L) in Mini-Studio compared to Traditional, and even Studio.[2]

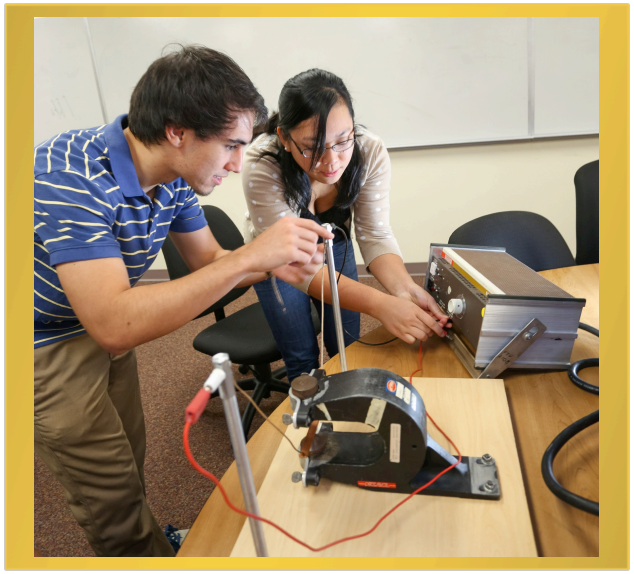




[1]Lasry, Guillemette, Mazur (2014), [2]Chini and Pond (2014).

Mini-studio in Second-semester, Algebra-based Physics

- ***Goal***: Integrate the Mini-studio into lab portions of second-semester physics lecture courses.
- We constructed conceptual / math skills worksheets from PER-based materials:
  - Maryland *Tutorials in Physics Sense-Making*[1] and Minnesota *Context Rich Problems*[2]
- Covering the topics of Electricity, Magnetism, and Optics.
- Hands-on group activities often incorporated into worksheets.



[1]Scherr and Elby (2007), [2]Heller, Keith, & Anderson (1992).

Initial Implementation

- Spring 2014: planned to implement Mini-studio format in all 13 second-semester physics lab sections.
- Surprised to face massive pushback by faculty.
- Some typical reactions:
  - Majority unwillingness to deviate from traditional recitation / problem solving.[1]
  - There is more material to cover than what the worksheets do.[2]
  - Persuaded by student reception of worksheets and student perception of how recitation time is best spent.[3]
- Less typical reactions:
  - Notion of treating students like "guinea pigs".
  - Idea that worksheets invent misconceptions in students, rather than dissolve them.

[1]Henderson and Dancy (2007), [2]Dancy and Henderson (2010), [3]Koening *et al.* (2007) .

Initial Implementation – Limitations

- Thus, out of the 13 second-semester lab sections:

9 Sections: Disapproving Lecture Instructor (DI) No Mini-studios	4 Sections: Approving Lecture Instructor (A1)	
	Mini-Studio: A1	Traditional Recitation: D2
	Non PER-based Worksheet: D3	Non PER-based Worksheet: D3

Initial Implementation – Limitations

- Only able to implement the Mini-studio in one section.
- Have 4 lab sections to compare
  - All sections have same lecture instructor, A1.
  - Compare CSEM assessment performance across sections.

Section	N Pre	N Post	N Matched
A1	23	21	20
D2	22	20	17
D3 - 1	24	23	20
D3 - 2	25	24	19

Average CSEM Results [%]

Section	Pre-score (SE)	Post-score (SE)	Raw Gain (SE)	Norm. Gain (SE)
A1	27.5 (2.0)	27.3 (2.8)	-0.16 (3.6)	-1.84 (4.9)
D2	24.1 (1.7)	39.9 (3.7)	15.8 (3.4)	20.9 (4.5)
D3 - 1	21.7 (1.3)	33.1 (3.0)	11.4 (3.3)	14.1 (4.2)
D3 - 2	22.5 (1.6)	48.8 (2.5)	26.3 (2.5)	33.8 (2.9)

Incentive Effects

Section	Pre-score (SE)	Post-score (SE)	Raw Gain (SE)	Norm. Gain (SE)
A1	27.5 (2.0)	27.3 (2.8)	-0.16 (3.6)	-1.84 (4.9)
		Post-test not counted a grade. Students reluctant to take test seriously without incentive.		
D2	24.1 (1.7)	39.9 (3.7)	15.8 (3.4)	20.9 (4.5)
		Post-test not counted as a grade. Students encouraged to take test seriously.		
D3 - 1	21.7 (1.3)	33.1 (3.0)	11.4 (3.3)	14.1 (4.2)
		Post-test not counted a grade. Students encouraged to take test seriously.		
D3 - 2	22.5 (1.6)	48.8 (2.5)	26.3 (2.5)	33.8 (2.9)
		Post-test counted as final quiz score.		

Incentive Effects

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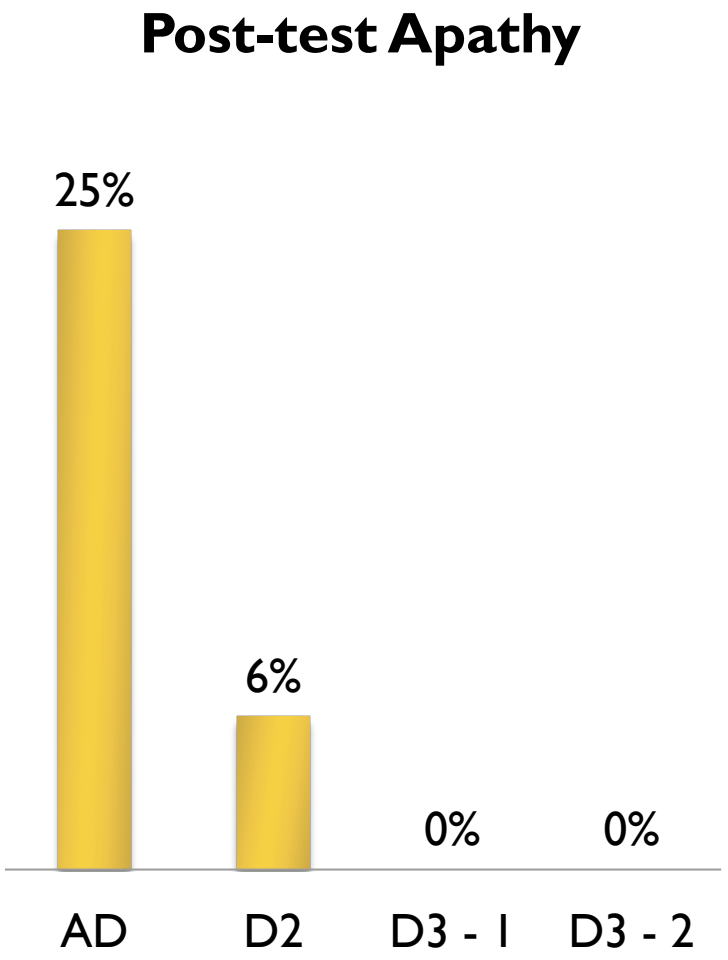
"Floor Effect" in Pre-test[1,2] seen in A1 Post-test.

[1]Madsen, McKagen, and Sayre (2013), Kost-Smith, Pollock, and Finkelstein (2010) .

Estimates of Apathy

- We see evidence of students not taking the CSEM seriously, especially in the Mini-studio section (A1).
- Inspecting responses for student apathy[1], such as:
  - Instance of ABCDE or EDCBA patterns, or
  - The same letter choice more than 6 times in a row.
- At right, we give the lower limit on the number of students exhibiting this apathetic behavior.



[1]Henderson (2002).

Discussion

- We see the Mini-studio format as an effective reformed classroom.
  - We want to extend beyond first-semester physics.
- Face several challenges and difficulties:
  - Faculty resistance to change.
    - Believing sufficient material not covered; favor traditional problem solving.
  - Students not taking CSEM seriously.
    - Incentive and apathy effects prevalent in this dataset
    - Makes assessment of initial implementation difficult.

Plans for Future Implementations

- Move toward TA-led Mini-studios.
  - Have Teaching Assistants administer PER-based worksheets and supervise labs.
  - Improve consistency of instruction between worksheet portion and lab portion of the Mini-studio.
  - Expose more of our future faculty to research-based instructional strategies.
- Incorporate inquiry activities into our laboratory sessions.
  - Adapting Investigative Science Learning Environment (ISLE) materials for use in our labs.[1]
- Create a student-centered environment fostering critical thinking:
  - Improving students' conceptual knowledge
  - Increase aptitude in experimental design and investigating phenomena.

[1] Etkina, Murthy, and Zou (2006).