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

Jacquelyn J. Chini and Talat S. Rahman
Department of Physics, University of Central Florida

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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\(^1\)
    - 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?

~3 classroom hours
~32 students @ 8 tables

Initial Lab Structure

75 min conceptual/math skills worksheet & problem-solving
Led by faculty

Mini-Studio Format

15 min quiz

75 min experiments
Led by GTA

Starting Materials

In-house designed worksheets to target concept & related math skill
-and-
end-of-chapter probs.

Traditional experiments
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)
  - Colorado Learning Attitudes about Science Survey (CLASS)
- **Data:**

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<th># of Instructors</th>
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<tr>
<td>Large TRAD</td>
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<td>3</td>
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<td>3</td>
<td>2</td>
<td>587</td>
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<tr>
<td>Full Studio</td>
<td>4*</td>
<td>2</td>
<td>176</td>
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</table>

*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*

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- Pre-test score is significantly related to post-test score
- There is a significant effect due to **course type**
Both FS and MS had significantly higher post-test scores than TRAD courses.

No significant different between FS and MS or Large & Small TRAD.
Positive shifts for conceptual understanding and one problem-solving category for FS

Less severe negative shifts in MS than TRAD
Similar results, with more positive shifts for FS but less dramatic difference between MS and TRAD
CLASS - Fall 2012

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

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 & 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

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\(^{1}\)Hake, 1998; \(^{2}\)E.g., Brewe, Kramer & O’Brien, 2009 and Marušić & Sliško, 2012; \(^{3}\)E.g., Maryland Tutorials in Physics Sense-Making and Investigating Science Learning Environments
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Contact info: jchini@ucf.edu