SEMINAL: A grant aimed at helping institutions develop and maintain active learning in the P2C2 sequence.

Panel at TPSE MATH, March 11, 2017
Allan Donsig, Vice Chair, Dept of Mathematics, UN-Lincoln
David Grant, Professor, Dept of Mathematics, CU-Boulder,
Michael O’Sullivan, Chair, Dept of Mathematics and Statistics, SDSU
Undergrads in active learning environments can learn more effectively, resulting in increased achievement and improved dispositions (Freeman et al., 2014; Laursen et al., 2014; Rasmussen & Kwon, 2007), particularly for underrepresented groups (Laursen et al., 2011).

44% of all departments think active learning strategies are very important for successful P2C2 courses. However, of those, 75% report that they are not very successful at doing so (Bressoud & Rasmussen, 2015).
**Goal:** better understand how to enact and support institutional change aimed at implementing active learning in undergraduate mathematics learning environments

**Collaborative Research: NSF I-USE Grant**

- 5-year, $3 million, 2016-2020
- APLU (Association of Public and Land-grant Universities (Howard Gobstein, David Webb)
- University of Colorado Boulder (David Webb, Rob Tubbs, David Grant)
- University of Nebraska-Lincoln (Wendy Smith, Allan Donsig, Nathan Wakefield)
- San Diego State University (Chris Rasmussen, Michael O’Sullivan, Janet Bowers)
- NSF#1624610, DUE
Primary Research Question: What conditions, strategies, interventions and actions at the departmental and classroom levels contribute to the initiation, implementation, and institutional sustainability of active learning in the undergraduate calculus sequence (Precalculus through Calculus 2—P2C2) across varied institutions?

- **Phase 1**: 6 Retrospective Case Studies
  - Spring 2016

- **Phase 2**: 9 Transformation Case Studies
  - Starting Fall 2016; seed money of 50K-100K
  - RFP on [www.aplu.org/seminal](http://www.aplu.org/seminal) about April 1, 2017
A Tale of Three Cities

• What do we do with active learning in the P2C2 sequence at Lincoln, Boulder, and San Diego

• How we got there, and who helped.
### UNL by the Numbers (Fall 2016)

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>25,897</td>
</tr>
<tr>
<td>Undergrads</td>
<td>20,833</td>
</tr>
<tr>
<td>Grad/Prof</td>
<td>5,064</td>
</tr>
<tr>
<td>ACT – first time freshmen</td>
<td>25.2</td>
</tr>
<tr>
<td>Freshman/Soph Retention</td>
<td>82.2%</td>
</tr>
<tr>
<td>6-year graduation</td>
<td>66.7% [UNL goal = 70%]</td>
</tr>
</tbody>
</table>

- Math Faculty: 32 (down from ~ 37)
- Other Faculty: 25 (mostly adjuncts, a few postdocs)
- Grad Students: 78
<table>
<thead>
<tr>
<th>Course</th>
<th>Enrollments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 100A Intermediate Algebra</td>
<td>436</td>
</tr>
<tr>
<td><strong>Math 101 College Algebra</strong></td>
<td><strong>545</strong></td>
</tr>
<tr>
<td>Math 102 Trigonometry</td>
<td>191</td>
</tr>
<tr>
<td><strong>Math 103 College Alg &amp; Trig</strong></td>
<td><strong>492</strong></td>
</tr>
<tr>
<td>Math 104 Business Calculus</td>
<td>738</td>
</tr>
<tr>
<td>Math 106 Calculus 1</td>
<td>1,038</td>
</tr>
<tr>
<td>Math 107 Calculus 2</td>
<td>448</td>
</tr>
<tr>
<td>Honors Calc II &amp; III</td>
<td>90</td>
</tr>
</tbody>
</table>

- Two thirds of first-time-freshmen took Math in fall.
- 13.3% of fall enrollment overall was in Math courses.
- No other department even garners half that percentage.
DFW Rates

Fall Enrollment & Passing Rates

- M101 2011
- M103 2011
- M101 2012
- M103 2012
- M101 2013
- M103 2013
- M101 2014
- M103 2014
- M101 2015
- M103 2015

Legend:
- Blue: Pass
- Orange: DFW
How did courses change?

- Class time extended
  101: from 3 weekly classes of 50 min to 3 of 75 min
  103: from 5 weekly of 50 to 3 of 50 and 2 of 75
- Workbooks and Lesson Plans
  created lesson plans and worksheets (make active learning easy to do)
- Common Exams, graded in common
  consistency in evaluation, emphasize concepts, reasoning, word problems – change from HS
- Online homework – in-house WebWork server
  consistency across courses; ease of use; lack of “templates” - primitive is better!
How did courses change? II

• Dedicated classrooms – round tables, lots of board space not fit for lecturing, no back of the room
• Course Readiness Activity – online mastery exam of prerequisite material in first two weeks; engage students early & identify who needs extra help
• First Year Math Task Force – faculty leadership (by the right faculty); ensure academic credibility; analyze data take responsibility for course design
• Active Administrative Support (Chair, College, University) crucial to success of program; need many changes quickly to transform course; need resources for this, overcome inertia
• MATH 1300 (Calculus 1): 5-credit class in small sections serving 1200 students/year.
  Got small sections by trading in faculty lines.
• Active learning (group projects) (2008) 1 day/week developed by dedicated colleagues.
• (2014) daily active learning achieved with Helmsley Funding
• Uses learning assistants (LAs)
• Have courses to train graduate instructors, TAs & LAs
• Coordinated by small pool of instructors
Calculus II

• MATH 2300 (Calculus II): 5-credit class in small sections serving 1000 students/year
• Active learning (group projects) (2010) 1 day/week. (2015) active learning achieved with Helmsley Funding
• Same set-up as Calculus I
• MATH 1150 (Precalculus): 4-credit class in small sections serving 625 students/year
• (2016) Active learning most days.
• About 1/3 of students in active learning supplemental education lab (2 hours/week) No longer teach algebra or trigonometry.
• Changes funded by College administration.
## Improvement in DFW rates

<table>
<thead>
<tr>
<th></th>
<th>Fall 2013</th>
<th>Fall 2014</th>
<th>Fall 2015</th>
<th>Spr 2014</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MATH 1300</td>
<td></td>
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</tr>
<tr>
<td>N sections</td>
<td>26</td>
<td>21</td>
<td>23</td>
<td>21</td>
<td>16</td>
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<tr>
<td>n students</td>
<td>738</td>
<td>647</td>
<td>708</td>
<td>597</td>
<td>486</td>
</tr>
<tr>
<td>DFW</td>
<td>0.286</td>
<td>0.272</td>
<td>0.215</td>
<td>0.325</td>
<td>0.303</td>
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<tr>
<td>MATH 2300</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>N sections</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>n students</td>
<td>257</td>
<td>351</td>
<td>387</td>
<td>402</td>
<td>428</td>
</tr>
<tr>
<td>DFW</td>
<td>0.297</td>
<td>0.292</td>
<td>0.278</td>
<td>0.307</td>
<td>0.270</td>
</tr>
</tbody>
</table>
Improvement in DFW rates

Math 1300: Fall only

ALM infusion

ES = 0.55
# FCQ Course & Instructor Means

## MATH 1300

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<tr>
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<td>647</td>
<td>708</td>
<td>597</td>
<td>486</td>
</tr>
<tr>
<td>FCQ Course Mean</td>
<td>4.420</td>
<td>4.525</td>
<td>4.704</td>
<td>4.372</td>
<td>4.586</td>
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<tr>
<td>FCQ Course StDev</td>
<td>0.432</td>
<td>0.475</td>
<td>0.296</td>
<td>0.416</td>
<td>0.294</td>
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<tr>
<td>FCQ Instr Mean</td>
<td>4.824</td>
<td>5.006</td>
<td>5.157</td>
<td>4.861</td>
<td>5.178</td>
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<tr>
<td>FCQ Instr StdDev</td>
<td>0.556</td>
<td>0.548</td>
<td>0.353</td>
<td>0.469</td>
<td>0.360</td>
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</table>

## MATH 2300

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<td>351</td>
<td>387</td>
<td>402</td>
<td>428</td>
</tr>
<tr>
<td>FCQ Course Mean</td>
<td>4.419</td>
<td>4.868</td>
<td>4.701</td>
<td>4.736</td>
<td>4.732</td>
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<tr>
<td>FCQ Course StDev</td>
<td>0.438</td>
<td>0.276</td>
<td>0.439</td>
<td>0.308</td>
<td>0.397</td>
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<tr>
<td>FCQ Instr Mean</td>
<td>4.689</td>
<td>5.098</td>
<td>5.176</td>
<td>5.296</td>
<td>5.086</td>
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<tr>
<td>FCQ Instr StdDev</td>
<td>0.703</td>
<td>0.336</td>
<td>0.434</td>
<td>0.303</td>
<td>0.568</td>
</tr>
</tbody>
</table>
San Diego State University

29,000 FT Undergraduates
5,000 FT graduates (primarily master’s)
1,400 FTEs in math/stat courses

Fall P2C2 Enrollment

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall Enrollment</th>
<th>Lecture</th>
<th>Breakouts of 30-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreCalculus</td>
<td>700</td>
<td>Lectures of 100+</td>
<td>1/week</td>
</tr>
<tr>
<td>Calculus I</td>
<td>600</td>
<td>Lectures of 150</td>
<td>2/week</td>
</tr>
<tr>
<td>Calculus II</td>
<td>600</td>
<td>Lectures of 150-220</td>
<td>2/week</td>
</tr>
</tbody>
</table>

250 math majors, 60 math grad students
Dept TT faculty: 14 math; 6 math education; 7 statistics
Guideposts: 7 characteristics of Successful Calculus Programs (Bressoud et. at.)

• Placing students appropriately into their first P2C2 course
• Use local data, aim for continual improvement.
• Student support services (e.g., tutoring centers, first-generation students)
• Coordination of instruction: uniform textbook, assessments: Regular P2C2 meetings

• Challenge and engage students with mathematics
• Student-centered pedagogies, including active learning strategies
• Teaching development program
Reform of P2C2 began in 2015-16

- ALEKS for placement
- Analysis of success in sequences of courses
- Math Learning Center: Math ed faculty director, TAs have office hours there
- Coordination: uniform syllabus, exams, grading standard.

- Extra contact hour with “labs”
- Active learning in the “labs” leaking into other aspects
- Training of TAs by the Math Ed faculty
Outcomes

• Calculus 2:
  In Fall 2016, the mean, Q1, median, and Q3 are each 12-14 points higher than in Fall 2015.

• Other courses less conclusive.
Levers for change at SDSU

• Support from administration:
  • Strategic Plan emphasized graduation rates
  • Mathematics Learning Center
  • Class Size Task Force resulted in 90K for extra TAs
  • Funding for TAs to do data analysis
  • Funding for TAs to create labs

• Determination in the department:
  • New faculty with fresh ideas
  • Discouragement at skills of upper division students
  • Math Education faculty
  • Calculus Task Force: representative of the department
  • Department chair committed to this
1) What do you currently have in terms of active learning?
2) Where do you want to be in using active learning?
3) For chairs: what changes should you start with, considering leverage and impact?
4) For administrators — what do you want to see from a math department to support innovation and sustain it? How do you see your math department contributing to college/campus instructional priorities?
5) What have you just learned from your discussion partners?