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Using Active Learning Strategies in Calculus to Improve Student Learning and Influence Mathematics Department Cultural Change

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**Presenter Information**
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MATH-GAINS:
Using Active Learning Strategies in Calculus to Improve Student Learning and Influence Mathematics Department Culture

Dr. Melissa A. Dagley
University of Central Florida
March 23, 2018

NSF IUSE project 1505322
Create an ecosystem where mathematics faculty persistently and sustainably apply active learning strategies in their teaching of calculus courses.

Positively affect
• wide-spread adaptation of active learning strategies
• student learning, retention and graduation
Overview

- Project implementation
- Instruments
- Research methodologies
- Active learning strategies
- Faculty projects
- Preliminary results
CURRENT ENROLLMENT

66,138 STUDENTS

November 2017
University of Central Florida

• 13 colleges
• Metropolitan university
• 4 year public institution
• 45% FTIC, 55% Transfer
• Freshman Profile
  • 6,500 annually
FALL 2017 FRESHMAN

SAT: 1318
ACT: 28.1
GPA: 4.06
46% of students are minorities

More than 25% are first-generation students
Scale x Excellence = Impact
MATH-GAINS Activities

• Designed to ensure the department could sustain a culture of using evidence-based practices

• Use existing state and national partnerships to disseminate best practices
The Numbers

6 faculty

10 PhD students

9000 undergraduates annually
Objectives

**Develop & Retrain**
- 2 learning communities (3 Fac/5 GTAs)
- Year long, on-going training

**Implement & Reinforce**
- Self-selected evidence-based practices
- Fall and Spring

**Disseminate**
- UCF faculty
- Florida institutions
- Consortia and partnerships
Implementation

**Interdisciplinary Team**

- Math Chair & Associate Professor *(leads)*
- Physics & FCTL *(professional development)*
- Education *(research)*
- iSTEM *(operational lead, student learning)*
Courses

- Calculus sequence (1 – 3)
- Fall and Spring
- No identifier

<table>
<thead>
<tr>
<th>Course</th>
<th>Year One</th>
<th>Year Two</th>
<th>Total (course)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
</tr>
<tr>
<td>Calculus 1</td>
<td>392</td>
<td>271</td>
<td>439</td>
</tr>
<tr>
<td>Calculus 2</td>
<td>49</td>
<td>49</td>
<td>48</td>
</tr>
<tr>
<td>Calculus 3</td>
<td>49</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>Total (term)</td>
<td>490</td>
<td>369</td>
<td>536</td>
</tr>
</tbody>
</table>
Instruments (students)

**Characteristics of Successful Programs in College Calculus (CSPCC)**
- student attitudes
- efficacy about learning mathematics

**Calculus Concepts Inventory (CCI)**
- understanding of Calculus concepts
Instruments (faculty)

**Culture, Cognition, and Evaluation of STEM Higher Education Reform (CCHER)**

**Calculus Teaching Efficacy**

To measure demonstrated positive change in attitudes and beliefs about the efficacy of evidence-based teaching practices in the identified courses.
Instruments (faculty)

Validity of belief change beyond simple self-report

- *ratings of teacher scenarios*
- *interviews and training sessions* faculty rationales for their instructional decisions

Gauge extent to which faculty implemented the evidence-based practices

- *Classroom observations using the Reformed Teaching Observation Protocol (RTOP)*
Training

Learning Community

designed to be a *forum for exchange* of information regarding evidence-based teaching strategies and the *environment that nurtures support* for the implementation of these practices
Training

**Strategies centered** on
- active engagement
- effective use of technology
- classroom assessment techniques

**Menu** of evidence-based practices

Developed *learning materials*
# Training

<table>
<thead>
<tr>
<th>Training Component</th>
<th>Training Category</th>
<th>Term</th>
<th>Participant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Su</td>
<td>Fa</td>
</tr>
<tr>
<td>Training Workshops</td>
<td>Professional development</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>TeachLive simulator</td>
<td>Support &amp; feedback</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Winter meeting</td>
<td>Professional development</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Observation &amp; mentor meeting</td>
<td>Support &amp; feedback</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Monthly meetings</td>
<td>Professional development</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Implementation (initial)</td>
<td>Intervention</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Implementation (revised)</td>
<td>Intervention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty conference</td>
<td>Sharing experience</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Outcomes (Interventions)

*Active learning* activity
- Suited to the day’s objectives
- Every lesson taught

Modifying the *discussions sections* of the course led by GTAs
- Designed student-centered lesson plans
- Assisted in mentoring the GTAs to lead an active discussion section once a week

*Flipped course* using the majority of face-to-face time for active student-centered learning.
Outcomes (Efficacy & Attitudes)

Held more *positive views of reform instruction* (using evidence-based practices) following the intervention in Year One

*Changes in instructor practice* varied across instructors (RTOP)

- One showed a strong change in practice, which continued across the second year
- Multiple showed moderate change in practice continued across the second semester
- Couple of faculty whose practice did not show noticeable change despite a change in efficacy and attitudes
Students

1,908 students who enrolled in a MATH-GAINS course
• Removed: graduate non-degree seeking, participation in a STEM learning community

1,654 eligible students
• Calculus 1 1,329
• Calculus 2 163
• Calculus 3 162

Comparison group (n=4,528)
• Calculus 1 1,456
• Calculus 2 1,573
• Calculus 3 1,499
## Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>MATH-GAINS</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Generation</td>
<td>368</td>
<td>954</td>
</tr>
<tr>
<td>Low Income</td>
<td>391</td>
<td>1,068</td>
</tr>
<tr>
<td>First-Time in College Admit</td>
<td>1,169</td>
<td>2,995</td>
</tr>
<tr>
<td>Transfer Admit</td>
<td>433</td>
<td>1,419</td>
</tr>
<tr>
<td>Second or Non-Degree Admit</td>
<td>52</td>
<td>114</td>
</tr>
<tr>
<td>Female</td>
<td>523</td>
<td>1,072</td>
</tr>
<tr>
<td>Male</td>
<td>1,131</td>
<td>3,456</td>
</tr>
<tr>
<td>African American</td>
<td>150</td>
<td>338</td>
</tr>
<tr>
<td>Hispanic</td>
<td>442</td>
<td>1,136</td>
</tr>
<tr>
<td>White</td>
<td>781</td>
<td>2,331</td>
</tr>
<tr>
<td>Other or non-specified</td>
<td>281</td>
<td>723</td>
</tr>
</tbody>
</table>
No statistically significant difference in student performance based on DFW rates when compared to the control

- MATH-GAINS sections of Calculus 1 offered in fall had lower DFW rates, opposite in spring
- Calculus 2, the comparison group outperformed MATH-GAINS
- MATH-GAINS outperformed the comparison group in Calculus 3
Outcomes (MATH-GAINS participants)

91 students took at least two courses in the calculus sequence with the program.
  • 56 passed (61%) the second course

7 students took all three courses in the sequence with MATH-GAINS

96 repeated a course in the sequence with MATH-GAINS
  • 59 passed (61%) the second attempt
## Outcomes (Persistence)

<table>
<thead>
<tr>
<th>Year</th>
<th>MATH-GAINS</th>
<th>All STEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calculus 1 (%)</td>
<td>Calculus 2 (%)</td>
</tr>
<tr>
<td>Two-Year</td>
<td>63</td>
<td>76</td>
</tr>
<tr>
<td>One-Year</td>
<td>74</td>
<td>81</td>
</tr>
</tbody>
</table>
Sustainability

*Purpose:* to examine and sustain faculty change

*Changes*

- Regular (semi-weekly) *math education seminar series* showcasing teaching practices and results
- *Mathematics colloquium* devoted to mathematics education each year.
- Hire of *tenured professor* who has secondary research interests in math education and a *tenure-track faculty member*, whose primary research interest is math education.
Sustainability

**Purpose:** to examine and sustain faculty change

**Changes**

- Four MATH-GAINS faculty *participants serve on the department’s Calculus Committee*; one as chair
- A new *Mathematics Education Committee* created to assess, promote and implement further developments