

Mar 23rd, 4:00 PM

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

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## Recommended Citation

Dagley, Melissa A.; Li, Xin; Moore, Brian; Saitta, Erin; Chini, Jacquelyn; and Gill, Michele, "Using Active Learning Strategies in Calculus to Improve Student Learning and Influence Mathematics Department Cultural Change" (2018). *Interdisciplinary STEM Teaching & Learning Conference*. 20.

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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



# MATH-GAINS:

## Growing as Adaptive INstructors

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



ESTABLISHED  
**1963**

FIRST CLASS  
**1968**



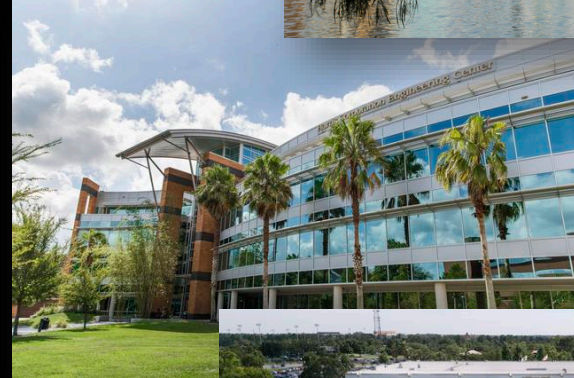
A photograph of three young women with long dark hair, all wearing sunglasses and smiling. They are outdoors in front of a brick building with green foliage in the background. The woman on the left is wearing a black shirt and gold-rimmed sunglasses. The woman in the middle is wearing a white t-shirt with a gold 'F' logo and gold-rimmed sunglasses. The woman on the right is wearing a maroon shirt and blue-rimmed sunglasses.

CURRENT ENROLLMENT

**66,138 STUDENTS**

# University of Central Florida

- 13 colleges
- Metropolitan university
- 4 year public institution
- 45% FTIC, 55% Transfer
- Freshman Profile
  - 6,500 annually

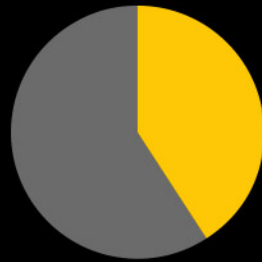




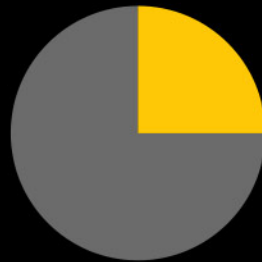


FALL 2017 FRESHMAN

**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

**900** 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

Course	Year One		Year Two		Total (course)
	Fall	Spring	Fall	Spring	
Calculus 1	392	271	439	414	1516
Calculus 2	49	49	48	49	195
Calculus 3	49	49	49	50	197
Total (term)	490	369	536	513	<b>1908</b>

# 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

Training Component	Training Category	Term			Participant	
		Su	Fa	Sp	Fac	GTA
Training Workshops	Professional development	X			X	X
TeachLive simulator	Support & feedback		X	X		X
Winter meeting	Professional development		X		X	X
Observation & mentor meeting	Support & feedback		X	X	X	
Monthly meetings	Professional development		X	X	X	X
Implementation (initial)	Intervention		X		X	X
Implementation (revised)	Intervention			X	X	X
Faculty conference	Sharing experience	X			X	



# 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

Variable	MATH-GAINS	Comparison
First Generation	368	954
Low Income	391	1,068
First-Time in College Admit	1,169	2,995
Transfer Admit	433	1,419
Second or Non-Degree Admit	52	114
Female	523	1,072
Male	1,131	3,456
African American	150	338
Hispanic	442	1,136
White	781	2,331
Other or non-specified	281	723

# Outcomes (Performance)

***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)

	MATH-GAINS			All STEM
Year	Calculus 1 (%)	Calculus 2 (%)	Calculus 3 (%)	(%)
Two-Year	63	76	76	57
One-Year	74	81	86	69

# 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

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