LESSONS FROM SUCCESSFUL CALCULUS PROGRAMS

Characteristics of Successful Programs in College Calculus (CSPCC)

Calculus Case Collective

Overview

- Overall project (CSPCC) overview
- Identification of "characteristics"
  - Doctoral granting (PhD)
  - Masters granting (MA)
  - Bachelors granting (BA)
  - Community college (AS)
- Summary and conclusions
- Questions, comments, discussion

Characteristics of Successful Programs in College Calculus

Project Goals

1. To improve our understanding of the demographics of students who enroll in **mainstream** calculus,
2. To measure the impact of the various characteristics of calculus classes that are believed to influence student success,
3. To conduct explanatory case studies of exemplary programs in order to identify why and how these programs succeed,
4. To develop a model that articulates the factors under which students are likely to succeed in calculus, and
5. To use the results of these to leverage improvements in calculus instruction across the United States.

Phase I: Six web-based surveys to identify factors that are correlated with success in Calculus I

207 two-year colleges (AS)	→	40 (19%) participated
134 undergraduate colleges (BA)	→	41 (31%) participated
60 master's universities (MA)	→	21 (35%) participated
120 research universities (PhD)	→	66 (55%) participated

Phase II: Case studies of 16 successful calculus programs

- Persistence in calculus
- DFW rate
- Change in confidence, interest, and enjoyment of mathematics

Data Overview

Case Study Site Visits – Fall 2012

- 2-3 days in duration
- Interviewed faculty, GTAs, relevant administrators, engineering and science faculty, & student focus groups
- Observed classrooms (lectures and recitations)
- Retained copies of relevant documents

Data Corpus (Per institution type)

- Site visits at 4-5 institutions
- 50-100 interviews
- 10-25 class observations
- ~10 student focus groups

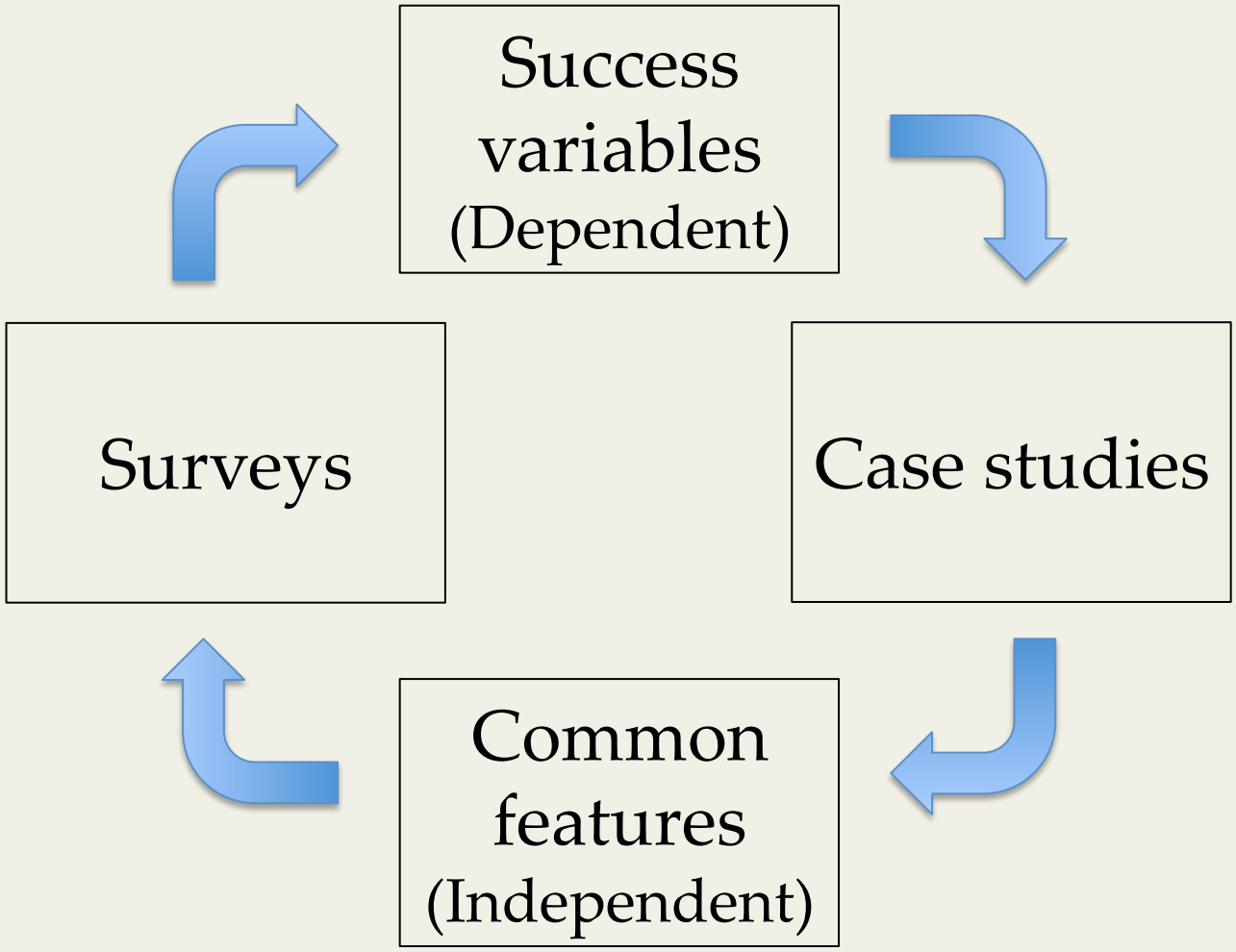
Arriving at the Common Features

- Reflective summaries written immediately after each site visit
- Summaries focused on what was learned about the calculus program, including facts and features coming from key interviews
- After transcribing and reviewing all transcripts and reflective summaries, a report was sent to each institution highlighting key features of their calculus program
- Cross analyses of institution reports and reflective summaries resulted in identification of the common features
  - Existence
  - Evidence from multiple interviewees that it contributed to success

Summary of findings across institution types

Characteristics	PhD	MA	BA	AS
Student supports	X	X	X	X
Staffing (at PhD this is different, and absorbed into supporting transient instructors)	X	X	X	X
Placement	X		X	X
Coordinated Independence (blend of support and faculty autonomy)	X		X	
Instructional/ instructor support (PhD includes GTA training)	X		X	
Innovative approach to calc (student centered instruction and/or technology use)	X		X	
Local Data	X			X
Transfer policies				X
Rigorous Courses	X			

Mixed Method Analysis



FEATURES OF SUCCESSFUL CALCULUS PROGRAMS AT FIVE PHD-GRANTING INSTITUTIONS

Chris Rasmussen, San Diego State University
Jessica Ellis, Colorado State University
Dov Zazkis, Rutgers University

Selected PhD Institutions

School	Enroll.	Demographics	Description
Large Public University 1	32,000	14% Hispanic/Latino 2% African American 47% Asian 25% White	• Large number of visiting faculty and post docs who teach calculus • Calculus taught in large lectures with discussion section
Large Public University 2	45,000	4% Hispanic/Latino 5% African American 12% Asian 65% White	• Math PhD students teach almost all sections of Calculus I • Calculus I is taught in small sections with active student engagement
Large Private University	40,000	84% White	• Religious affiliated institution • Strong math "PR" program
Private Technical University	6,000	6% Hispanic/Latino 3% African American 6% Asian 69% White	• Three "teaching professors" who run masters programs • Offer a stretched out Calculus I
Public Technical University	8,000	2% Hispanic/Latino 2% African American 81% White	• 97% of first-time, full-time students receive financial aid • Offer a Calculus I that meets an extra day

Seven Common Features of Calculus Programs at Selected PhD Institutions

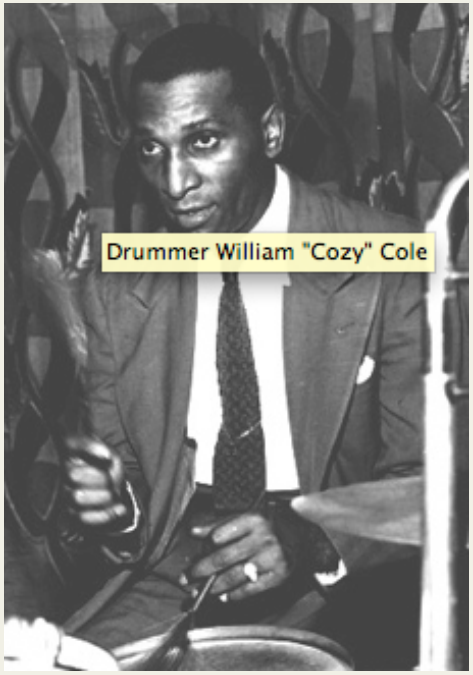
- GTA professional development
- Coordinated Independence
- Attending to local data
- Supporting teaching and active learning
- Rigorous courses
- Learning resources
- Responsive placement systems

GTA Professional Development

- The more successful Calculus program had substantive and well thought out TA training programs.
- These ranged from a weeklong training prior to the semester together with follow up work during the semester to a semester course taken prior to teaching.
- PD included a significant amount of mentoring, **practice teaching**, and observing classes.
- GTAs were mentored in the use of active learning strategies in their recitation sections.
- The standard model of GTAs solving homework problems at the board was not the norm.

Coordinated Independence – an oxymoron

- "Coordinated" is synonymous with "synchronized" or "in step."
- "Independence" is synonymous with "autonomy" or "freedom," the very notion of which eschews mandated sameness.
- "Coordinated Independence" is intended to embrace how both "in step" elements of a calculus program work together with elements that allow for individual autonomy.



Father of Coordinated Independence

Coordinated Independence

- Calculus I course Coordinator is not a rotating position or committee assignment
- Regular meetings take place where calculus instructors discuss issues of teaching and learning
- Instructors have pedagogical autonomy
- Exams and finals (and in some cases homework) are common
- All of this helps establish the teaching of calculus as a "joint enterprise" where calculus is community property

Coordinated Independence

Coordinator at public technical university
"The nice thing about working as a team to teach calculus, there's a weekly meeting, so you have tenured faculty with graduate students having conversations about teaching, which is very nice. Then we have common exams, and again you have your graduate students exposed to the full-time faculty, again having good conversation, whether it be about teaching or about grading."

Coordinator at large public university
"That's one of the advantages to having a coordinator is that I can tell them, 'You don't have to do that [referring to historical grade data]. You can do whatever.' So we meet at the end of the quarter and they'll say, 'This is how I want to assign the grades,' and I'll say, 'That's fine.' We like to have the historical data as sort of a guideline, but that's not forced on anybody."

Attending to Local Data

- Collected and used local data to inform changes in program

Types of Data	Used to Inform

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Returning to Survey Data

GTA professional development activity:	Selected	Non-selected
Faculty observation of GTAs for the purpose of evaluating their teaching	100%	83.9%
Seminar or class for the purpose of GTAs professional development	100%	82.1%
Interview process to select prospective GTAs	50%	34%
Screen GTAs before assigning them to a recitation section	75%	77.4%
Pairs new GTAs with faculty mentors	60%	63%
Other program for GTA mentoring or professional development	75%	50%

Returning to Survey Data

Coordination activity:	Selected	Non-selected
In my Calculus I course, a common final was used for all section.	100%	70.8%
In my department, Calculus I instructors meet as a group frequently or sometimes.	81.2%	57.7%

Supporting Teaching and Active Learning

- Calculus instructors were encouraged (nudged) to use and experiment with active learning strategies.
- In some cases faculty received regular emails with links to articles or other information about teaching.
- One institution even had biweekly teaching seminars led by the math faculty or invited experts.
- Particular instructional approaches were not, however, prescribed or required for faculty at any of the institutions. Faculty had choices.

Returning to Survey Data

Frequency of instructional activities: *(1=not at all, 6=very often)*	**Selected**	**Non-selected**
ask students to explain their thinking	4.30 (1.42)	3.78 (1.50)
have students work with one another	4.28 (1.84)	2.72 (1.65)
hold a whole-class discussion	3.32 (1.66)	2.68 (1.56)
have students give presentations	2.35 (1.74)	1.46 (0.90)
show students how to work specific problems	5.22 (0.89)	5.13 (1.13)
have students work individually on problems or tasks	3.18 (1.66)	2.82 (1.60)
lecture	5.12 (1.17)	5.26 (1.19)
ask questions	5.08 (1.09)	5.15 (1.09)

Returning to Survey Data

Switcher Rates for Good and Ambitious Teaching

	Good Teaching Low	**Good Teaching High**
Ambitious Teaching Low	16.2%	10.4%
Ambitious Teaching High	11.9%	7.0%