Lessons Learned from Calculus I Programs at Selected Research Universities

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Acknowledgements

SDSU team

• Jessica Ellis
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• Natalie Selinski
• Dov Zazkis
Research Questions

1. What features are common among the five selected Calculus I programs at research universities?

2. What roles do calculus coordinators play at these five selected Calculus I programs?
Case Study Site Visits – Fall 2012

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

Data Corpus

- Site visits at 5 research universities
- Nearly 100 interviews
- Over 25 class observations
- Over 10 student focus groups
Theoretical Perspective

A Communities of Practice Perspective (Lave & Wenger, 1991; Wenger, 1998)

• A community of practice is a collective construct in which there is a “joint enterprise” of achieving particular goals
• Broker: someone who has membership status in more than one community and is in a position to infuse some element of one practice into another
• Boundary objects: material things that allow people to cross between different communities and facilitate progress on their joint enterprise
# Selected Research Universities

<table>
<thead>
<tr>
<th>School</th>
<th>Enrollment</th>
<th>Demographics</th>
<th>Description</th>
</tr>
</thead>
</table>
| 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 public relations 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 percent of first-time, full-time students receive financial aid  
• Offer a Calculus I that meets an extra day |
Arriving at the Common Features

• Reflective summaries written immediately after each site visit
• Summaries focused on what was learned about the calculus program, including key facts and features
• 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 7 common features
• Ongoing analysis is more systematically and rigorously parsing and synthesizing the data corpus
Seven Common Features of Calculus Programs at Selected Research Institutions

• Rigorous courses
• Attending to local data
• GTA professional development
• Supporting teaching and active learning
• Coordinated Independence
• Learning resources
• Placement
Combining Qualitative and Quantitative Results

Surveys

Success variables

Case studies

Common features
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.
• GTA’s were mentored in the use of active learning strategies in their recitation sections.
• The standard model of GTA’s solving homework problems at the board was not the norm.
## Returning to Survey Data

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

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

### Switcher Rates for Good and Ambitious Teaching

<table>
<thead>
<tr>
<th>Ambitious Teaching</th>
<th>Good Teaching Low</th>
<th>Good Teaching High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>16.2%</td>
<td>10.4%</td>
</tr>
<tr>
<td>High</td>
<td>11.9%</td>
<td>7.0%</td>
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</table>
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.”
## Returning to Survey Data

<table>
<thead>
<tr>
<th>Coordination activity</th>
<th>Selected</th>
<th>Non-selected</th>
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<tbody>
<tr>
<td>In my Calculus I course, a common final was used for all section.</td>
<td>100%</td>
<td>70.8%</td>
</tr>
<tr>
<td>In my department, Calculus I instructors meet as a group frequently or sometimes.</td>
<td>81.2%</td>
<td>57.7%</td>
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Reflecting on Common Features

Wenger’s communities of practice perspective

• Calculus Coordinator as broker
  – All five selected doctoral institutions had someone whose official job included being the calculus coordinator
  – This role was a designated, semi-permanent, and valued position
  – Coordinator did not “own” calculus or prescribe how to teach
  – Created and sustained a joint enterprise of teaching and learning of calculus (e.g., regular meetings) and functioned as a broker between the more central members in the department and newcomers.

• Boundary objects that helped to facilitate the enculturation of newcomers into the joint enterprise of teaching calculus:
  – Historical records of passing rates,
  – current grade and persistence data,
  – student evaluations,
  – various training manuals (especially for GTAs and visiting faculty),
  – common assignments and assessments
Effective Calculus Coordinators

• Function as a Broker
• Function as a “Choice Architect”


Choice Architects
  – Make life easier by setting default options
  – Expects deviations and provides feedback
  – Makes mappings easy to understand
  – Inform colleagues about what others are doing
Calculus Coordinator as Choice Architect

Instructor

“For me starting as a new instructor …. the big question I had, 'How do I fit into this program?' And so having the common syllabus made that as easy as it could be, to just get up to speed with what the department is doing. I really like having a mapping between the homework problems and the learning objectives. That's actually a document that I've only gotten in the last couple of weeks, but I'd heard it referred to. And as we were writing this test in particular, they said, 'Pay attention to these learning objectives, you want to make sure that your test questions match what we want them to know.' And so that I really like, because it saves me a little bit of time as I'm preparing my lecture, I do look at the homework and I can see what's going to be important, or what the department thinks is important for the students, so I know how to spend my time in class…. And it also, for me, it helps me get an accurate gauge of how I'm doing as an instructor. I can see if my scores are above or below the average. I know that the other sections are following the same syllabus, gives me a gauge.”
Questions please contact me at chris.rasmussen@sdsu.edu