Characteristics of Successful Programs in College Calculus Project: Findings from the Two-Year Colleges

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The Two-Year Colleges
Context

- 46% of students taking a mathematics class are doing so at a two-year college
- 42% of low-income students*
- 55% with dependents*
- 60% working full-time*
- 44% Black/Hispanic*

Calculus I
- 2010 enrollment ~ 63K
- Average class size 20

* First time enrollment.
(Blair, Kirkman, Maxwell, 2013; NCES, 2011, NCES, 2011)
Orienting Question

What are the features that participants identify as being directly associated with the success of their calculus program at the two-year institutions identified in the CSPCC as successful?
## Selected Two-Year Institutions

<table>
<thead>
<tr>
<th>College</th>
<th>Size</th>
<th>Demographics</th>
<th>FT:PT</th>
<th>#Calc. I Sections/term</th>
<th>Class Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>South City College</td>
<td>&lt;5000</td>
<td>Minority: 51% 18-24 y.o.: 22% Part time: 72%</td>
<td>7:10</td>
<td>2</td>
<td>30-35</td>
</tr>
<tr>
<td>Midwest Urban College</td>
<td>&lt;10000</td>
<td>Minority: 62% 18-24 y.o.: 22% Part time: 67%</td>
<td>9:20</td>
<td>3 to 4</td>
<td>30</td>
</tr>
<tr>
<td>West Rural College</td>
<td>&lt;3000</td>
<td>Minority: 61% 18-24 y.o.: 43% Part time: 58%</td>
<td>7:0</td>
<td>1</td>
<td>30 (52)</td>
</tr>
<tr>
<td>Southeast Suburban College</td>
<td>&gt;10000</td>
<td>Minority: 26% 18-24 y.o.: 47% Part time: 58%</td>
<td>35:30</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>
## Data

<table>
<thead>
<tr>
<th>College</th>
<th>Interviews Instructors (Other)</th>
<th>Classroom Observations</th>
<th>Student Focus Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>South City College</td>
<td>3 (6)</td>
<td>2</td>
<td>4, 43 students</td>
</tr>
<tr>
<td>Midwest Urban College</td>
<td>5 (8)</td>
<td>2</td>
<td>1, 26 students</td>
</tr>
<tr>
<td>West Rural College</td>
<td>1 (5)</td>
<td>1</td>
<td>1, 42 students</td>
</tr>
<tr>
<td>Southeast Suburban College</td>
<td>8 (9)</td>
<td>5</td>
<td>3, 39 students</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17 (28)</strong></td>
<td><strong>10</strong></td>
<td><strong>9, 150 students</strong></td>
</tr>
</tbody>
</table>

Documents: exams, syllabi, homework, quizzes, worksheets, college publications and reports, college/department websites
Method

- Identification of *Facts and Features* at each case, by two researchers in the same case
- Member checking
- Identification of commonalities: facts and features that were common to three of the four cases, by all researchers
- Category reduction to identify themes, independently and then in collaboration
- High agreement in seven themes
- Confirmation with other data (e.g., observations)
- Testing with survey data
Cross-Case Themes

<table>
<thead>
<tr>
<th>THEME</th>
<th>Details</th>
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<tr>
<td>1.</td>
<td>High quality instructors</td>
</tr>
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<td>2.</td>
<td>Faculty autonomy and trust in the teaching of calculus</td>
</tr>
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<td>3.</td>
<td>Attention to placement</td>
</tr>
<tr>
<td>4.</td>
<td>Supporting students academically and socially</td>
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<td>5.</td>
<td>Transfer policies</td>
</tr>
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<td>6.</td>
<td>Informal instructional support</td>
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<td>7.</td>
<td>Assessment and data collection</td>
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## Cross-Case Themes

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<tr>
<th>THEME</th>
<th>CATEGORY</th>
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<tr>
<td>1. High quality instructors</td>
<td>INSTRUCTION</td>
</tr>
<tr>
<td>2. Faculty autonomy and trust in the teaching of calculus</td>
<td></td>
</tr>
<tr>
<td>3. Attention to placement</td>
<td>STUDENT SUPPORT</td>
</tr>
<tr>
<td>4. Supporting students academically and socially</td>
<td></td>
</tr>
<tr>
<td>5. Transfer policies</td>
<td>IMPROVEMENT EFFORTS</td>
</tr>
<tr>
<td>6. Informal instructional support</td>
<td></td>
</tr>
<tr>
<td>7. Assessment and data collection</td>
<td></td>
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Instruction

High quality instructors
- Knowledgeable, available, approachable
- Have high expectations for developing conceptual understanding in addition to procedural competency/fluency

Faculty autonomy; trust in their teaching
- Instructors have latitude and freedom
- No department-wide policies for instructional approaches or technology
- Loose coordination (textbook, master/state syllabus)
A 10-min Quiz

1. True or false. If true, explain why. If false, explain why or give an example to show it is false:
   
a. If \( \lim_{x \to a} f(x) = L \) then \( f(a) = L \).

b. A rational function has at least one vertical asymptote.

c. \( \lim_{x \to 5} \sqrt{x - 5} = 0 \).

d. The function \( f(x) = \begin{cases} \frac{x^2 - 6x + 5}{x - 5}, & x \neq 5 \\ 4, & x = 5 \end{cases} \) is discontinuous at \( x = 5 \).

2. Sketch the graph of a function that satisfies the following conditions:
   \( \lim_{x \to \infty} f(x) = 0 \), \( f(0) = 0 \), \( f(1) = 1 \), and \( f(-x) = -f(x) \) which means the function is odd.
## Selected vs. not-Selected Institutions

<table>
<thead>
<tr>
<th></th>
<th>Selected (N= 91)</th>
<th>Not Selected (N=307)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor(^a)</td>
<td>5.10 (.754)</td>
<td>4.68 (.948)</td>
<td>***</td>
</tr>
<tr>
<td>Expectations and Environment(^b)</td>
<td>5.27 (.703)</td>
<td>4.69 (.899)</td>
<td>***</td>
</tr>
<tr>
<td>Materials: exams, homework, good and fair</td>
<td>5.12 (1.01)</td>
<td>4.88 (1.01)</td>
<td>ns</td>
</tr>
</tbody>
</table>

a. asked questions to determine if I understood what was being discussed; listened carefully to my questions and comments; allowed time for me to understand difficult ideas; helped me become a better problem solver; provided explanations that were understandable; was available to make appointments outside of office hours, if needed.

b. made class interesting; presented more than one method for solving problems; encouraged students to enroll in Calculus II; acted as if I was capable of understanding the key ideas of calculus; made me feel comfortable in asking questions during class.
Student Support

Attention to Placement
- Intentional processes for accurate placement
- “Student oriented” placement policies
- Confidence in “in-house” preparation courses (two sites)

Academic and Social Support
- Learning centers, office hours, advising
- Extracurricular math competitions, clubs, study space
- Study groups

Transfer Policies
- Supported by the states
- Common course descriptions/articulation agreements
- Instructors’ personal experience
Selected vs. not-Selected Institutions

<table>
<thead>
<tr>
<th></th>
<th>Selected (N=90)</th>
<th>Not Selected (N=295)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attended office hours, tutoring sessions, study groups outside of class</td>
<td>1.12 (.621)</td>
<td>1.18 (.655)</td>
<td>ns</td>
</tr>
<tr>
<td>Learning Center availability</td>
<td>.93 (.254)</td>
<td>.91 (.285)</td>
<td>ns</td>
</tr>
<tr>
<td>Use online tutoring</td>
<td>1.41 (.993)</td>
<td>1.81 (1.404)</td>
<td>*</td>
</tr>
</tbody>
</table>

One of the concerns with the center is that... we’re giving all the support to developmental students and then some of the college-level students feel they’re left hanging in the lurch. Dr. X serves one of his office hours in the center specifically here to help. We encourage Calculus students to walk in during that hour and he’s here to help just Calculus students, because most of our staff here... they weren’t hired to help higher level and aren’t qualified.
Improvement Efforts

Instructional Support/Collegiality

Informally conducted on an ongoing basis

On-campus faculty development opportunities and funding → not widely used by math faculty

Assessment and Data Collection

- Student learning outcomes (college & department)
- Student success (e.g. pass rates, graduation rates)
- Student success in transfer institutions

The colleges used the data mostly for reporting purposes

Faculty did not describe using the data for programmatic decisions
## Selected vs. not-Selected Institutions

<table>
<thead>
<tr>
<th></th>
<th>Selected (N=42)</th>
<th>Not Selected (N=307)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouraged faculty to pursue professional development</td>
<td>1.00 (.00)</td>
<td>.72 (.447)</td>
<td>***</td>
</tr>
<tr>
<td>Resources available for attending UG teaching conferences</td>
<td>1.00 (.00)</td>
<td>.53 (.499)</td>
<td>***</td>
</tr>
<tr>
<td>Recognition of teaching</td>
<td>.00 (.00)</td>
<td>.20 (.397)</td>
<td>***</td>
</tr>
</tbody>
</table>

There was no variation here…
Understanding Three Themes: Models of Academic and Social Integration

Academic and social integration influence students’ choice to depart from college (Kuh et al, 2008; Tinto, 1975, 1988)
Mixed Results in the Two-Year Context

However:

1. Community college faculty are key:
   • Validating students as learners (Rendon, 2006)
   • Encouraging out-of-class interaction

2. Classrooms are the main point of contact with the institution (Hagedorn, 2000)

3. Institutional features—placement and transfer policies—are more relevant (Hagedorn et al., 2000)
Understanding Our Themes

• **Placement** as a first step in the integration process. Institutions and instructors
  • Make sure the student is where he or she needs to be—student oriented placement
  • Encourage students to take the preparatory courses in the college → creates common experiences, fosters use of rigorous language, sets-up expectations → creates a community ready for Calculus
Understanding Our Themes

• The **teacher** in the classroom facilitates students’:
  • Direct contact with knowledgeable and caring faculty
  • Learning of academic expectations
  • Interaction with other students

• **Study groups:**
  • Take advantage of the space available in learning centers
Implications—Research

Reconceive and localize definitions of success:

- Develop a system of criteria for indicators of success at the program, department or institution level that capitalizes on the data collected (Briggs et al., 2003)
- Consider other aspects of success explored in the literature
  - “involvement” (Astin, 1984)
  - “validation” (Rendon, 2006)
  - “engagement” (Kuh, 2008)
  - learning
Implications—Practice

• Reconceive the goal of placement: finding the (appropriate) class that will provide a space for social and academic integration within the culture of doing calculus

• Maintain and promote activities that target calculus students: clubs and competitions
References


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