The MAA-CSPCC Study: Two-Year Colleges Case Study Findings
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ABSTRACT

Understanding how institutions manage to keep students in the calculus track is an issue of national importance and the impetus behind the study of *Characteristics of Successful Programs in College Calculus* (CSPCC) undertaken by the Mathematical Association of America (MAA). This session presents the two-year colleges case study findings.

DESCRIPTION OF CSPCC STUDY

CSPCC is a study of Calculus I instruction in colleges and universities in the United States conducted by MAA and sponsored by NSF (DRL REESE #0910240). Dr. David Bressoud (Macalester College) and Linda Braddy (MAA) lead the study. The study goals are:

- To improve our understanding of the demographics of students who enroll in calculus
- To measure the impact of the various characteristics of calculus classes that are believed to influence student success.

Phase I: Large-scale, web-based survey administered to a stratified sample of colleges and universities during fall term of 2010 (over 700 instructors and 14,000 students) to identify factors that are correlated with success in Calculus I.¹

Table 1: CSPCC stratified sample and response rates

<table>
<thead>
<tr>
<th>Institution Type</th>
<th>Sampled</th>
<th>Participated</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>207</td>
<td>40 (19%)</td>
</tr>
<tr>
<td>BA</td>
<td>134</td>
<td>41 (31%)</td>
</tr>
<tr>
<td>MA</td>
<td>60</td>
<td>21 (35%)</td>
</tr>
<tr>
<td>PhD</td>
<td>120</td>
<td>66 (55%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>521</strong></td>
<td><strong>168 (32%)</strong></td>
</tr>
</tbody>
</table>

Each sector team (AA, BA, MA, PhD) consists of a researcher in undergraduate mathematics education, a mathematician, and a graduate student or post-doctoral researcher. Leaders, by sector, are: AA - Vilma Mesa (University of Michigan), BA – Sean Larsen (Portland State University), MA – Eric Hsu (San Francisco State University), PhD – Chris Rasmussen (San Diego State University).

¹ Stratified sample based on highest mathematics degree awarded: AA – Associate’s, BA – Bachelor’s, MA – Master’s; PhD - Doctorate. Initial surveys were completed by chair, undergraduate director, or calculus coordinator. Calculus I faculty completed pre-surveys (start of fall term) and post-surveys (end of the term). Calculus I students completed pre-surveys around the third week of class and post-surveys at the end of the term.
Phase II: Case studies of 18 colleges and universities identified as having successful Calculus I programs based on criteria including the proportion of students taking Calculus II and gains in students' confidence, interest, and enjoyment in mathematics. The sample included four associates-granting (AA or two-year) colleges. Site visits began in fall term, 2012.

Table 2: Characteristics of the two-year colleges in the CSPCC sample.

<table>
<thead>
<tr>
<th>College</th>
<th>US Region</th>
<th>FTE(^a) (2010)</th>
<th>FT:PT(^b)</th>
<th>Number Calc I sections/term</th>
<th>Class Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>City College</td>
<td>Southeast</td>
<td>4,292</td>
<td>7:10</td>
<td>2</td>
<td>30-35</td>
</tr>
<tr>
<td>Urban College</td>
<td>Midwest</td>
<td>9,488</td>
<td>9:20</td>
<td>3 to 4</td>
<td>30</td>
</tr>
<tr>
<td>Rural College</td>
<td>West</td>
<td>2,788</td>
<td>7:0</td>
<td>1</td>
<td>30 (52(^c))</td>
</tr>
<tr>
<td>Suburban College</td>
<td>Southeast</td>
<td>12,492</td>
<td>35:30</td>
<td>10</td>
<td>30 (15(^d), 22(^e))</td>
</tr>
</tbody>
</table>

a. Full-Time Equivalency student enrollment from IPEDS.
b. FT:PT is the ratio of Full-Time to Part-Time instructors in the mathematics department.
c. Number of students in the day of the observation, clearly exceeding the college’s norm.
d. For honors sections; e. Average by the end of the course.

Table 3: Data collected at the two-year colleges in the CSPCC sample

<table>
<thead>
<tr>
<th>College</th>
<th>Instructor Interviews</th>
<th>Other Interviews</th>
<th>Classroom Observations</th>
<th>Student Focus Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>City College</td>
<td>3(^a)</td>
<td>6</td>
<td>2</td>
<td>4 (43 students)</td>
</tr>
<tr>
<td>Urban College</td>
<td>5(^b)</td>
<td>8</td>
<td>2</td>
<td>1 (26 students)</td>
</tr>
<tr>
<td>Rural College</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1 (42 students)</td>
</tr>
<tr>
<td>Suburban College</td>
<td>8(^c)</td>
<td>9</td>
<td>5</td>
<td>3 (39 students)</td>
</tr>
</tbody>
</table>

a. Includes interviews with a Calculus II instructor and a Calculus III instructor.
b. Includes two current Calculus I instructors and three instructors who have taught it regularly in the past.
c. Includes five current Calculus I instructors and three instructors who have taught it regularly in the past.

MAJOR FINDINGS

High quality instruction was the main factor identified as contributing to successful Calculus I

- Instructors described as available and approachable.
- Instructors described as knowledgeable and setting high expectations.
- Predominant pedagogy was interactive lecture with time for students to work problems.
- Computer-generated animations and visualizations used frequently in instruction.
- Student engagement and faculty-student interactions promoted by small class size and instructor social skills.

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\(^2\) See Hsu, Mesa, & the Calculus Collective (2014) for complete case selection details.

\(^3\) Findings draw from several rounds of analysis of survey, interview, and focus-group data. See References.
The national survey data revealed three features of “Good Teaching:”

1) Classroom interactions that acknowledge students (e.g., asked questions to determine if students understand; listened carefully to student questions and comments).
2) Encouraging and available instructor (e.g., made students comfortable in asking question, encouraged students to seek help during office hours).
3) Fair assessment (e.g., student felt exams were a good assessment of what they learned and fairly graded).

Cognitive orientation of tasks varied by type (e.g., homework, exams) and by instructor

- Bookwork and Webwork homework had same cognitive orientation and highest proportion of simple procedures relative to other tasks.
- Exams contained more “rich tasks” than homework (49% versus 25%).
- Large differences emerged across instructors in cognitive orientation of tasks regardless of common textbook. Instructors can be differentiated by cognitive orientation of tasks.

Organizational factors emerged as influencing successful Calculus I

- Faculty had latitude and freedom in teaching Calculus I. There were no program-wide policies about common final, technology, or pedagogy.
- Administrators trusted Calculus I faculty to do the best for their students.
- Instructor support around Calculus I was mainly through informal peer communication.
- In the colleges studied, Calculus I instructional staff was mainly full-time or tenured.
- Coordination across sections sought through informal faculty collaboration as well as more formal calculus committees that provided coordination through common course outlines and/or common textbooks.

Student support and improvement efforts identified as associated with successful Calculus I

- All cases attended to effectively placing students in Calculus I using various methods. Three of four colleges in the study had mandatory placement. In two cases, most students “coursed in” through precalculus. This was true for 66% of two-year college students on the national survey.
- Student support available through learning centers, office hours, and advising. Socially, students had access to extracurricular math clubs and/or competitions and study space. Study groups were encouraged.
- Transfer was mediated by state documents such as common course descriptions or articulation agreements (either between schools or coordinated by the state). Calculus I faculty often used personal knowledge of transfer institutions to advise students and ease transfer.
- Use of data to support students included: learning outcomes assessment, pass/graduation rates, and transfer data. Data used mainly for reporting or accountability rather than for internal decision-making and improvement.
IMPLICATIONS AND RECOMMENDATIONS

In the case of calculus learning in the two-year college setting, the instructor might be the most important resource for students. If students' interest in taking more mathematics hinges on the quality of their experiences in the classroom—that is, the everyday contact with a knowledgeable, caring, and supportive instructors, and other peers—how instructors are chosen to teach calculus is fundamental.

Instructors in the case-study colleges described attending both to students' academic and social needs. According to Tinto's (1975/1993) model of student departure, the more complex the network of relationships a student develops with the institution, academically and socially, the less likely it is that the student will drop out. Academic integration occurs mainly in the classroom mediated by the instructor and by classroom tasks (Doyle, 1983). Students' social integration can occur either within the classroom or through out-of-class support. Encouraging participation in informal study groups can be a simple strategy for Calculus I faculty to try out.

The findings suggest topics for professional development of Calculus I faculty. Computer-generated visualizations and animations for Calculus I concepts were common instructional tools. Thus, Calculus I instructors can benefit from professional development around computer algebra systems to develop these skills. Further, given that interactive lecture appears to be a stable pedagogy in Calculus I in two-year colleges, professional development could focus on effective classroom questioning techniques, understanding cognitive orientation of tasks, and fair assessment practices in mathematics.

Lastly, the findings reveal that, regardless of common course objectives and textbooks and efforts to coordinate Calculus I, students will be held to different standards based on the cognitive orientation of tasks assigned by instructors. Faculty collaboration around assessment tools and measures is one means for Calculus I instructors to explore and/or mitigate this.

REFERENCES

Characteristics of Successful Programs in College Calculus (CSPCC) website for information, research, and data on the project: http://www.maa.org/programs/faculty-and-departments/curriculum-development-resources/characteristics-of-successful-programs-in-college-calculus

The following conference papers and publications are available at http://www.curriculumresearchgroup.org/.


Mesa, V., Burn, H.E., & White, N. (in press). Future MAA Notes Volume for CSPCC Study


