Calculus in High School

Too much of a good thing?

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DeWitt Wallace Professor of Mathematics
Macalester College

Maseeh Lecture
Portland, OR
May 12, 2011

PowerPoint available at
www.macalester.edu/~bressoud/talks
In the Fall of 2010: 210,000 students entered four-year undergraduate programs with the intention of majoring in engineering, a physical science, mathematics, or statistics. About half will succeed.
Students in college or university Calculus I:

68% studied calculus in high school
68% of them studied AP Calculus
half of them took the AP Calculus exam and earned 3 or higher
(22% of all students in college Calculus I)

MAA survey of 700 instructors, over 14,000 students, all types of colleges and universities across US, Fall, 2010
Grade for college Calculus I:

- 22% A
- 28% B
- 23% C
- 27% D, F, or Withdrew
Me and AP:

1968 took AP Calculus exam

1990–1991 taught AP Calculus at State College Area High School

1993–2007 AP Reading
   (Reader, Table Leader, Question Leader)

1999–2005 AP Calculus Development Committee
   (Chair from 2002 to 2005)
The Chronicle of Higher Education

January 17, 2010

The Rocky Transition From High-School Calculus

http://chronicle.com/article/High-School-Calculus-The-E/63533/
Over 600,000 students are studying calculus in high school this year, roughly 1/3 of the 1.8 million who will go directly from HS to college.
Math-intensive Bachelor's degrees divided by number of 22 year-olds

- Engineering
- Physical Science
- Math & Stat

NCES & US Census data
A quick History of AP Calculus
1953–55:
College Admission with Advanced Standing

Bowdoin, Brown, Carleton, Haverford, Kenyon, MIT, Middlebury, Oberlin, Swarthmore, Wabash, Wesleyan, and Williams

1956:
First Advanced Placement exams administered by College Board
1970’s and 1980’s

1984: South Carolina’s Education Improvement Act

Jaime Escalante

Richard Riley, Governor of South Carolina at the time, later Secretary of Education under President Clinton
AP Calculus

AB exams

BC exams

Total Calculus exams
1990’s

1995: Graphing Calculators

1998: AB subscore

Today, two-thirds of the exam is calculator-free, one-third allows and may require use of graphing calculator.

Students who do best on both parts of exam have teachers who allow use of calculators ¼ to ½ of time.
2000’s

Gasper Caperton, College Board President since 1999

2007: AP Course Audit
Effect of math teacher quality (TQI) on readiness for college of students who have completed calculus in high school (Illinois, 2002).

<table>
<thead>
<tr>
<th>TQI percentile</th>
<th>0–10</th>
<th>11–25</th>
<th>26–50</th>
<th>51-75</th>
<th>76–100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black students</td>
<td>50%</td>
<td>67%</td>
<td>73%</td>
<td>74%</td>
<td>75%</td>
</tr>
<tr>
<td>White students</td>
<td>*</td>
<td>94%</td>
<td>95%</td>
<td>96%</td>
<td>97%</td>
</tr>
</tbody>
</table>

24% of Black students were in schools with math teachers in the 0–10 percentile.

Presley & Gong, Demographics and Academics of College Readiness in Illinois, IERC Report #2005-3
2000’s

Gasper Caperton, College Board President since 1999

2007: AP Course Audit
How effective is AP Calculus?
Morgan & Klaric, 2007: study of 22 colleges and universities in fall, 1994; grades weighted so that SAT scores are comparable

<table>
<thead>
<tr>
<th>Placed via</th>
<th>average grade in Calculus II</th>
<th>SAT Adjusted grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passed Calculus I</td>
<td>2.43</td>
<td></td>
</tr>
<tr>
<td>3 on AB exam</td>
<td>2.69</td>
<td>2.64</td>
</tr>
<tr>
<td>4 on AB exam</td>
<td>2.90</td>
<td>2.78</td>
</tr>
<tr>
<td>5 on AB exam</td>
<td>3.34</td>
<td>3.15</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>Passed Calculus I</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>3 on BC exam</td>
<td>3.00</td>
<td>2.92</td>
</tr>
<tr>
<td>4 on BC exam</td>
<td>3.45</td>
<td>3.35</td>
</tr>
<tr>
<td>5 on BC exam</td>
<td>3.46</td>
<td>3.27</td>
</tr>
</tbody>
</table>


Students who earned 3 or higher on AB exam and chose to retake Calculus I did worse in Calculus II then those who went directly to Calculus II.

_Caveats_: Difference was statistically significant at .05 only 1 out of 4 years.

Not controlled for comparability of ability levels
Students who study Calculus in HS and do well on AP exam ($\geq 3$ on AB exam) do significantly better in Calculus I as well as intro Biology, Chemistry, and Physics.

There is little or no discernible benefit from simply taking Calculus in High School.
Of the high school students who graduated in 1992 and earned credit for “calculus” while in high school, 31% took *precalculus* in college, and a further 32% took *no calculus* in college.

Of the high school students who graduated in 2004 and earned credit for “calculus” while in high school, 17% took *remedial mathematics* in college.

NCES, NELS:88 and ELS:2002/06 data.
Of the high school students who graduated in 2004 and earned credit for “calculus” while in high school, 17% took remedial mathematics in college.

We must have clear, enforced guidelines for what it means to be ready for calculus in high school.

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NCES, NELS:88 and ELS:2002/06 data.
Those who do not have access to a good calculus program in high school are at a serious disadvantage in pursuing engineering or science.

High teacher quality is essential for an effective AP Program, especially for minority students.
We need to screen students to ensure that they are prepared for calculus in high school, and we need strong alternatives to calculus for those students whose precalculus skills are inadequate.
All evidence suggests that calculus in high school works well for most of the top 200,000, the top third of the students who take it.

We don’t know enough about the other 400,000 students.