THE COUNCIL OF INDEPENDENT COLLEGES

Strengthening the STEM Pipeline: The Contributions of Small and Mid-Sized Independent Colleges

A Report by the Council of Independent Colleges

This report was prepared as a component of the Council of Independent Colleges' public information campaign, Securing America's Future: The Power of Liberal Arts Education. *The initiative promotes the effectiveness and contributions of private liberal arts colleges and universities and the importance of the liberal arts as fields of study. In addition to this report, the campaign includes a website with related news, social media activity, data and analyses, editorials, speeches, alumni testimonials, and additional reports. Generous support for* Securing America's Future *is provided by the Carnegie Corporation of New York, Christian A. Johnson Endeavor Foundation, Jessie Ball DuPont Fund, and Gladys Krieble Delmas Foundation.*

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MARCH 2014

The Council of Independent Colleges is an association of 744 nonprofit independent colleges and universities and higher education affiliates and organizations that has worked since 1956 to support college and university leadership, advance institutional excellence, and enhance public understanding of private higher education's contributions to society. CIC is the major national organization that focuses on providing services to leaders of independent colleges and universities as well as conferences, seminars, and other programs that help institutions improve educational quality, administrative and financial performance, and institutional visibility. CIC also provides support to state fundraising associations that organize programs and generate contributions for private colleges and universities. The Council is headquartered at One Dupont Circle in Washington, DC. For more information, visit *www.cic.edu*.

About the Authors

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Strengthening the STEM Pipeline: The Contributions of Small and Mid-Sized Independent Colleges

EXECUTIVE SUMMARY

Science, technology, engineering, and mathematics (STEM) expertise is necessary to sustain American competitiveness in the global economy. Many assume that research universities, especially public institutions, are the backbone of American efforts to prepare undergraduate students in STEM fields and that these institutions are fulfilling this responsibility. This report demonstrates that many small and mid-sized independent colleges are preparing postsecondary students for a career and/or graduate study in STEM fields, and they are doing so in a more efficient way than larger institutions, contrary to public assumptions about the importance of scale.

Report findings suggest that, as a sector, small and mid-sized private institutions perform better than public institutions in students' persistence and undergraduate degree completion rates in STEM fields and they substantially outperform public nondoctoral institutions. Small and mid-sized private colleges also perform better on the time-to-degree metric, as an overwhelming proportion (80 percent) of bachelor's degree recipients in STEM fields earned their degrees in four years or less at these institutions, compared with 34 percent at public four-year nondoctoral institutions and 52 percent at public four-year doctoral institutions. Study results also suggest that STEM graduates of small and mid-sized private colleges are more likely to plan to attend graduate school and just as likely to enroll immediately in a graduate program as their peers who graduated from larger public universities.

The productivity and efficiency of small and mid-sized independent colleges and universities are further demonstrated by comparisons between specific private colleges and larger research universities. Report findings indicate that in many individual academic disciplines, small and mid-sized colleges produce as many or more science majors who obtain PhDs than large research universities. For example, the number of students graduating from Allegheny College (Meadville, PA; 1,849 undergraduate enrollment) who later received doctorates in chemistry between 2006 and 2010 was 25, an output comparable to that of two nearby research universities. During the same period, 30 graduates of the University of Pittsburgh (17,413 undergraduate enrollment) and 25 graduates of Carnegie Mellon University (5,484 undergraduate enrollment) obtained doctorates in chemistry. Moreover, a higher percentage of students who attained a baccalaureate degree in chemistry from Allegheny College between 2001 and 2005 subsequently completed a PhD in the discipline (36 percent) than did graduates from the University of Pittsburgh (13 percent) or Carnegie Mellon University (24 percent).

Report findings suggest similar results in the biological sciences. For example, one out of every four graduates in biological sciences from Swarthmore College (Swarthmore, PA; 1,500 undergraduate enrollment), Haverford College (Haverford, PA; 1,163 undergraduate enrollment), Grinnell College (Grinnell, IA; 1,524 undergraduate enrollment), and Oberlin College (Oberlin, OH; 2,907 undergraduate enrollment) went on to complete a PhD, a rate higher than that of the large public research universities in their respective states: Pennsylvania State University (16 percent; 35,002 undergraduate enrollment), the University of Iowa (13 percent; 20,233 undergraduate enrollment), Iowa State

University (10 percent; 22,230 undergraduate enrollment), and Ohio State University (8 percent; 37,605 undergraduate enrollment). Additional results in computer science, physics, and mathematics and statistics confirm that a number of smaller private colleges produce a higher percentage of science majors who pursue PhDs in STEM fields than many large research universities produce.

At a time when federal and state officials have made a priority of increasing the number of Americans with advanced degrees in STEM fields and when state and federal spending is under increasing pressure, the educational effectiveness and contributions of small and mid-sized independent colleges and universities in meeting these national goals must not be overlooked. Indeed, the most cost-effective strategy for increasing the supply of STEM workers for the U.S. economy is to reduce college student attrition in STEM fields. In order to reap the full benefits of a strong STEM workforce through higher education, policy makers should assist the sector of education in which colleges and universities have demonstrated that they can prepare many people for STEM careers effectively and efficiently—namely, small and mid-sized private colleges.

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) expertise is necessary to sustain American competitiveness in the global economy. Technological innovation has been and will continue to be a primary driver of U.S. economic growth. Employment in STEM occupations is projected to expand faster than employment in non-STEM occupations (Lockard & Wolf 2012). In addition, employees in STEM occupations typically have higher average salaries and lower unemployment rates, a pattern that has persisted even during the recent economic recession (U.S. Department of Commerce 2011). However, despite the clear demand for STEM skills by employers, the U.S. is not producing enough people with expertise in STEM fields (Chen 2013). Too many students lack the interest or the ability to work in STEM fields or jobs that require either a bachelor's or an advanced degree in a STEM field.

Strengthening the STEM education pipeline has been raised to the center of the policy stage in the last decade, especially since the publication of *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (National Academy of Sciences et al. 2007). This report recommended increasing investment in STEM programs, enhancing the STEM teaching force, and enlarging the pool of students pursuing degrees and careers in STEM fields. Other government agencies and organizations also examined this issue and made similar policy recommendations (Government Accountability Office 2006; U.S. Department of Education 2006; National Science Board 2007; Business-Higher Education Forum 2010; U.S. Congress Joint Economic Committee 2012; and the President's Council of Advisors on Science and Technology 2012). In addition, the National Academy of Sciences' report argued for very large federal investments in universities to support the increase in production of STEM degree holders.

> **"Many small and mid-sized independent colleges are preparing postsecondary students for careers and graduate study in STEM fields more efficiently than public universities."**

The role of colleges and universities in preparing scientists and engineers has been highlighted in debates about the nation's need for a large STEM workforce. Many assume that research universities are the backbone of preparing postsecondary students in STEM fields and that they are effectively fulfilling this task. Much less well-known are the substantial contributions of small and mid-sized colleges in STEM education. This report demonstrates that many small and mid-sized independent colleges are preparing postsecondary students for careers and graduate study in STEM fields more efficiently than larger public universities.

By examining national postsecondary data collected by the U.S. Department of Education and the National Science Foundation, this report addresses the following four questions:

- How do small and mid-sized independent colleges and universities compare with other types of institutions in terms of students' persistence to an undergraduate STEM degree after entrance into a STEM field of study?

- How do bachelor's degree recipients from small and mid-sized independent colleges and universities compare with graduates from other types of institutions in their time-to-degree in the STEM fields?

- Upon receipt of a bachelor's degree in a STEM field, what are the plans of graduates of small and mid-sized institutions for future studies?

- How do small and mid-sized independent colleges and universities fare in preparing undergraduates who later earn doctoral degrees in STEM fields?

This report compares private nonprofit nondoctoral institutions (small and mid-sized independent colleges and universities) with three other types of four-year institutions: public nondoctoral, public doctoral, and private doctoral institutions.

Persistence to a STEM degree

The Beginning Postsecondary Students Longitudinal Study (BPS) conducted by the National Center for Education Statistics (NCES) follows cohorts of students who enroll in postsecondary education for the first time (Wine, Janson, Siegel, and Bennett 2013). The study collects data on student persistence in and completion of postsecondary education programs, their transition to employment, demographic characteristics, and other indicators. Members of the most recent cohort of BPS, with a sample size of nearly 16,700 students, were initially surveyed at the end of their first academic year (2003–2004) and then in follow-up surveys at the end of their third (2005–2006) and sixth (2008–2009) years after entry into postsecondary education. Therefore, BPS is a good data source to study the postsecondary education experiences of students, including their persistence patterns.

To analyze the persistence patterns of students in STEM fields, we examined all first-time students who enrolled in four-year institutions in 2003–2004 and entered into a STEM field within three years after initial enrollment (that is, students who declared a major in a STEM field in or before academic year 2005–2006). To understand better the effects of different types of institutions on the persistence patterns of students, we further limited our population to those who never transferred out of their first postsecondary institutions of study (about three-fourths of the students who enrolled in four-year institutions). Table 1 summarizes the spring 2009 status of the students who had entered into STEM fields by summer 2006.

As presented in Table 1, public nondoctoral institutions had the lowest persistence rate in STEM fields, 41 percent. In contrast, 62 percent of students who entered STEM fields at private nondoctoral institutions persisted in those fields after three or more years, a result comparable to rates at public and private doctoral institutions. Moreover, the percentage of students who obtained bachelor's degrees in STEM fields at private nondoctoral institutions was higher than that of public doctoral institutions (59 and 56 percent respectively). These statistics indicate that small and mid-sized private institutions performed better than public institutions in students' persistence and degree completion rates in STEM fields and they substantially outperformed public nondoctoral institutions.

Table 1. Persistence in and Completion of a STEM Degree of First-Time 2003–2004 Postsecondary Students (Who Entered STEM Field by 2006)

	Spring 2009 Status			
Institution Type	Left post-secondary education with no degree (%)	Changed to non-STEM field (%)	Stayed in STEM field *(including bachelor's degree recipients)* (%)	Obtained bachelor's degree in STEM field (%)
Public nondoctoral	19.7	39.3	41.0	31.1
Public doctoral	11.4	26.9	61.7	55.9
Private nonprofit nondoctoral	13.2	25.1	61.7	58.6
Private nonprofit doctoral	15.2	21.8	63.0	61.3

Source: U.S. Department of Education, National Center for Education Statistics, 2004–2009 Beginning Postsecondary Students Longitudinal Study (BPS:04/09).

Time-to-Bachelor's Degree in STEM Fields

To answer the second research question, we used data from the *Baccalaureate and Beyond Longitudinal Study* (B&B) conducted by NCES (Wine, Janson, and Wheeless 2011). The B&B study examines students' education and work experiences after completion of a bachelor's degree, including workforce participation, income and debt repayment, and entry into and persistence through graduate school programs, among other indicators. The most recent B&B cohort was drawn from bachelor's degree recipients in academic year 2007–2008 and has a sample size of approximately 19,000 students.

To analyze the time-to-degree (that is, time from initial enrollment to degree completion) for bachelor's degree recipients in STEM fields, we reviewed bachelor's degree recipients in all STEM fields, including computer and information sciences, engineering and engineering technology, biology, physical science, mathematics, chemistry, and agriculture. To focus on the effects of different types of institutions on graduates' time-to-degree, we limited our population to those who did not transfer out of their first postsecondary institutions. Table 2 displays the time-to-degree for 2007–2008 bachelor's degree recipients in the STEM fields.

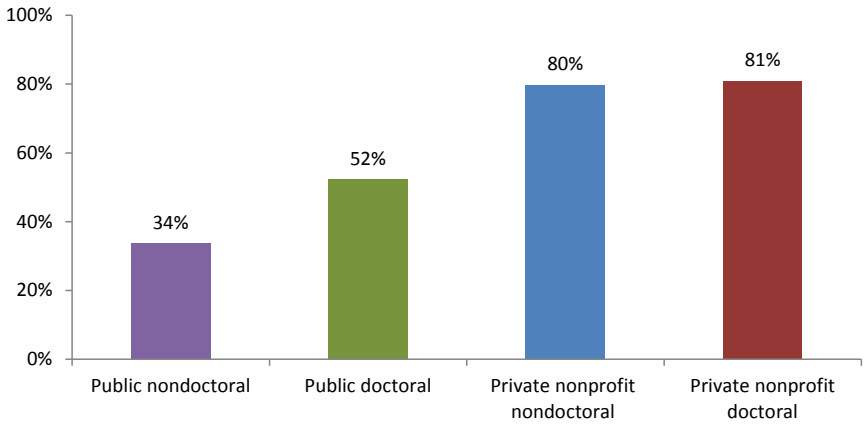
Table 2. Time to 2007–2008 Bachelor's Degree in STEM Fields by Bachelor's Degree Institution Type

	Number of Months to Bachelor's Degree[1]			
Institution Type	48 months or less (%)	49–60 months (%)	61–72 months (%)	>73 months (%)
Public nondoctoral	33.6	51.0	5.2	10.2
Public doctoral	52.2	31.7	8.9	7.2
Private nonprofit nondoctoral	79.7	11.1	2.0	7.2
Private nonprofit doctoral	80.8	11.0	3.0	5.2

Source: U.S. Department of Education, National Center for Education Statistics, 2008–2009 Baccalaureate and Beyond Longitudinal Study (B&B:08/09).

The findings here are stark. Small and mid-sized independent institutions produce bachelor-level graduates in the STEM fields more efficiently than their public peers. As illustrated by Figure 1, at small and mid-sized independent institutions, an overwhelming proportion (80 percent) of bachelor's degree recipients in STEM fields earned their degrees in four years or less, compared with 34 percent at public four-year nondoctoral institutions and 52 percent at public four-year doctoral institutions.

Figure 1. Percentage of Students Who Obtained Bachelor's Degrees in STEM Fields within Four Years or Fewer



Source: U.S. Department of Education, National Center for Education Statistics, 2008–2009 Baccalaureate and Beyond Longitudinal Study (B&B:08/09), 2007–2008 bachelor's degree recipients.

STEM Bachelor's Degree Recipients' Plans for Graduate Study

A policy goal of STEM education is to produce more graduates with advanced degrees in STEM fields. The B&B survey asked graduating college seniors about their plans for graduate study. Table 3 summarizes the plans for graduate study by the 2007–2008 bachelor's degree recipients in STEM fields.

As Table 3 indicates, a much larger proportion (57 percent) of graduates in STEM fields from small and mid-sized independent institutions planned to apply to graduate school upon receipt of their bachelor's degrees, compared with slightly more than 40 percent of graduates from public four-year institutions, where a considerable proportion of graduates (over 40 percent) were undecided about their plans for graduate study. This suggests that bachelor's degree recipients from small and mid-sized independent institutions are more committed to advancing their education in the STEM fields at the time of their graduation from college.

The 2009 follow-up to the B&B study collected information on the respondents' enrollment status in 2009. Table 4 summarizes this information by the respondents' bachelor's degree institution sector. The statistics show that about one-fifth (19 percent) of the bachelor's degree recipients in STEM fields from small and mid-sized independent institutions immediately enrolled in master's or doctoral degree programs after obtaining their bachelor's degrees, a comparable percentage with public four-year doctoral institutions (22 percent) and exceeding that of public four-year nondoctoral institutions (14 percent).

Table 3. Plans for Graduate School Application by Bachelor's Degree Recipients in STEM Fields in the Year of Graduation (as of 2007–2008)

	Plan to Apply to Graduate School in Future		
Bachelor's Degree Institution Sector	Did not plan to apply (%)	Planned to apply (%)	Maybe planned to apply (%)
Public nondoctoral	16.5	40.6	43.0
Public doctoral	15.8	43.1	41.1
Private nonprofit nondoctoral	15.0	56.6	28.4
Private nonprofit doctoral	6.1	56.5	37.4

Source: U.S. Department of Education, National Center for Education Statistics, 2008–2009 Baccalaureate and Beyond Longitudinal Study (B&B:08/09).

Table 4. 2009 Enrollment Status of 2007–2008 Bachelor's Degree Recipients in STEM Fields

	Enrollment in Degree Program in 2009[2]		
Bachelor's Degree Institution Sector	Master's degree (%)	Doctoral degree (%)	Not enrolled in degree program (%)
Public nondoctoral	10.4	3.9	85.7
Public doctoral	17.8	3.9	78.2
Private nonprofit nondoctoral	13.4	5.7	80.9
Private nonprofit doctoral	11.8	9.1	79.2

Source: U.S. Department of Education, National Center for Education Statistics, 2008–2009 Baccalaureate and Beyond Longitudinal Study (B&B:08/09).

Comparisons by Sector

To answer the final research question, we examined data from the National Science Foundation's Survey of Earned Doctorates (SED), an annual census of doctorate recipients from accredited colleges and universities in the U.S. (NSF 2014). According to SED, more than 130,000 doctoral degrees were awarded by U.S. academic institutions in STEM fields between 2006 and 2010 (the most recent five years for which data were available at the time of analysis).[3] Table 5 presents the distribution of institutions by type from which the 2006–2010 doctorate recipients in the STEM fields obtained their baccalaureate degrees.

The most noticeable category of the baccalaureate institutions of the STEM doctorate degree recipients is foreign institutions—40 percent of the 2006–2010 doctoral degree recipients in the U.S. obtained their bachelor's degrees from foreign institutions. This percentage is especially high in engineering, mathematics, and computer sciences,

Table 5. Distribution of Baccalaureate Institutions of STEM Doctorate Recipients by Field of Study, 2006–2010

Institution Type	Engineering (%)	Physical Sciences (%)	Geo-Sciences (%)	Math and Computer Sciences (%)	Life Science (%)	STEM Total (%)
Foreign Institutions	21,270 (56.0%)	7,831 (38.1%)	1,364 (32.2%)	7,433 (48.2%)	14,904 (27.8%)	52,802 (40.1%)
U.S. Four-Year Institutions *(see Table 6 for details)*	12,516 (32.9%)	9,842 (47.8%)	2,397 (56.6%)	5,970 (38.7%)	31,979 (59.8%)	62,704 (47.6%)
Other *(unknown, unclassified, or special focus)*	4,211 (11.1%)	2,902 (14.1%)	477 (11.2%)	2,021 (13.1%)	6,639 (12.4%)	16,250 (12.3%)
Total	37,997 (100.0%)	20,575 (100.0%)	4,238 (100.0%)	15,424 (100.0%)	53,522 (100.0%)	131,756 (100.0%)

Source: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

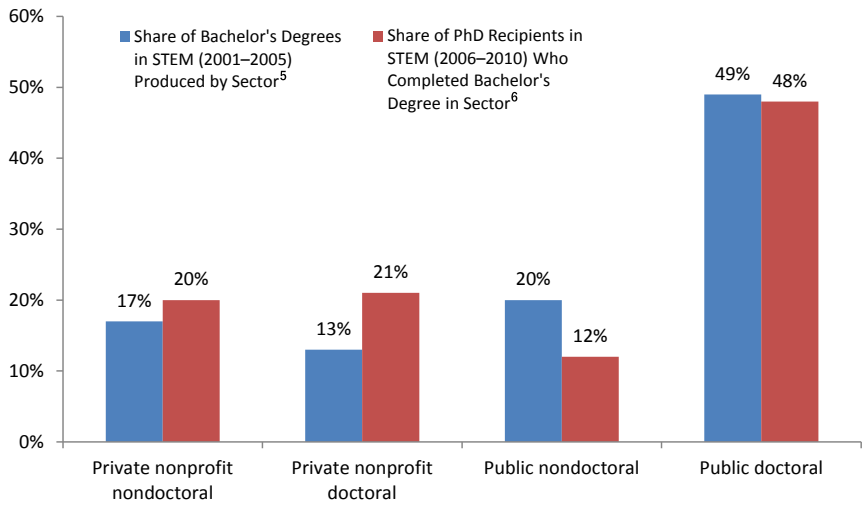
Table 6. Distribution of U.S. Baccalaureate Institutions of 2006–2010 STEM Doctorate Recipients by Field of Study

Institution Type	Engineering (%)	Physical Sciences (%)	Geo-Sciences (%)	Math and Computer Sciences (%)	Life Science (%)	STEM Total (%)
Public nondoctoral	833 (6.7%)	1,493 (15.1%)	291 (12.1%)	700 (11.7%)	4,083 (12.8%)	7,400 (11.8%)
Public doctoral	7,338 (58.6%)	3,834 (39.0%)	1,104 (46.1%)	2,491 (41.7%)	15,101 (47.2%)	29,868 (47.6%)
Private nonprofit nondoctoral	1,099 (8.8%)	2,608 (26.5%)	529 (22.1%)	1,168 (19.6%)	7,111 (22.2%)	12,515 (20.0%)
Private nonprofit doctoral	3,246 (25.9%)	1,907 (19.4%)	473 (19.7%)	1,611 (27.0%)	5,684 (17.8%)	12,921 (20.6%)
Total	12,516 (100.0%)	9,842 (100.0%)	2,397 (100.0%)	5,970 (100.0%)	31,979 (100.0%)	62,704 (100.0%)

Source: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

where about half of the doctoral recipients obtained their bachelor's degrees outside the U.S. This suggests that the United States still has a long way to go to produce more "home grown" scientists.

Figure 2. Share of Total Degrees by Sector



Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

A further look at 2006–2010 doctoral degree recipients in STEM fields who earned their bachelor's degrees from U.S. four-year institutions (excluding unknown, unclassified, or special-focus institutions; see Table 6) found that 20 percent of them earned their bachelor's degrees from small and mid-sized independent institutions, compared with 21 percent from private doctoral, 12 percent from public nondoctoral, and 48 percent from public doctoral institutions. As a reference, small and mid-sized independent colleges awarded only 17 percent of the total number of bachelor's degrees in STEM fields produced by all four-year institutions in the U.S. between 2001 and 2005, while private doctoral institutions accounted for 13 percent of the total bachelor's degrees in STEM fields, public nondoctoral institutions accounted for 20 percent, and public doctoral institutions accounted for 49 percent (see Figure 2).[4] This comparison suggests that STEM graduates of small and mid-sized colleges are more likely to complete doctoral degrees in STEM fields than are graduates of public four-year institutions.

Efficiency by Institution and Discipline

The productivity and efficiency of small and mid-sized independent colleges and universities can be further demonstrated by comparing specific institutions with select larger research universities.[7] When individual academic disciplines are examined, even some of the largest research universities do not produce more science majors who attain PhDs than do smaller colleges. Moreover, a number of smaller colleges produce a higher percentage of science majors who attain PhDs than many large research universities produce.[8] Below are a few examples:[9]

Chemistry: The number of students graduating from Allegheny College (Meadville, PA; 1,849 undergraduate enrollment)[10] who later received doctorates in chemistry between 2006 and 2010 was 25, an output comparable to that of two nearby research universities (see Table 7 on the next page; small and mid-sized independent colleges and universities are bolded in Tables 7–16).[11] Slightly more graduates (30) of the University of Pittsburgh (17,413 undergraduate enrollment) and a similar number of graduates (25) from Carnegie Mellon University (5,484 undergraduate enrollment) obtained doctorates in chemistry during that time. In addition, Furman University (Greenville, SC; 2,814 undergraduate enrollment) produced more future PhDs in chemistry (21) than nearby private research institution Clemson University (15 students; 13,813 undergraduate enrollment), while Butler University (Indianapolis, IN; 3,657 undergraduate enrollment) produced the same number of graduates in chemistry who would eventually complete PhDs in the field (17) as its neighboring state flagship institution, Indiana University (30,319 undergraduate enrollment).

Not only did these smaller private colleges produce more future chemists than local research institutions, they did so more efficiently. Table 8 indicates that a higher percentage of students who attained a baccalaureate degree in chemistry from Allegheny College between 2001 and 2005 subsequently completed a PhD in the discipline (36 percent) than did graduates from the University of Pittsburgh (13 percent) or Carnegie Mellon University (24 percent). Furthermore, Furman University out-produced Clemson University (18 percent vs. 12 percent) and Butler University out-produced Indiana University (12 percent vs. 10 percent) on this measure during that same period.

Table 7. Selected Institutions by Total Number of Graduates Who Completed PhD Degrees in Chemistry

National Rank by Total PhDs	Institution	Total Fall 2003 Undergraduate Enrollment	Total Baccalaureate Graduates in Chemistry, 2001–2005[12]	Number of Baccalaureate Graduates Who Attained a PhD in Chemistry, 2006–2010
1.	University of California–Berkeley	23,206	358	81
2.	Massachusetts Institute of Technology	4,112	140	57
3.	North Carolina State University at Raleigh	22,971	526	48
5.	University of Illinois at Urbana-Champaign	29,226	362	47
8.	Harvard University	9,714	141	43
15.	University of North Carolina at Chapel Hill	16,144	388	37
21.	Ohio State University–Main Campus	37,605	219	33
23.	University of Wisconsin–Madison	29,546	189	32
25.	University of Pittsburgh–Main Campus	17,413	239	30
28.	University of Virginia–Main Campus	13,829	453	28
34.	University of Texas at Austin	38,383	253	27
38.	**Allegheny College**	**1,849**	**70**	**25**
	Carnegie Mellon University	5,484	104	25
	University of Washington–Seattle Campus	27,962	310	25
46.	**College of Wooster**	**1,871**	**75**	**21**
	Furman University	**2,814**	**116**	**21**
	Georgia Institute of Technology–Main Campus	11,257	158	21
56.	**St. Olaf College**	**2,994**	**159**	**20**
61.	University of Kansas–Main Campus	20,447	110	19
64.	University of Maryland–College Park	25,446	97	18
71.	**Butler University**	**3,657**	**144**	**17**
	Indiana University at Bloomington	30,319	177	17
	University of Arizona	28,482	148	17
	University of Richmond	**3,613**	**68**	**17**
77.	**Haverford College**	**1,163**	**73**	**16**
	Kalamazoo College	**1,280**	**90**	**16**
	Stanford University	7,054	62	16
81.	Clemson University	13,813	123	15
	University of Georgia	25,415	109	15
	University of Oregon	15,983	83	15

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Table 8. Selected Institutions by Percentage of Baccalaureate Graduates Who Completed PhD Degrees in Chemistry

National Rank by Total PhDs	Institution	Total Baccalaureate Graduates in Chemistry, 2001–2005[13]	Number of Baccalaureate Graduates Who Attained a PhD in Chemistry, 2006–2010	Percentage of Baccalaureate Graduates in Chemistry (2001–2005) Who Attained a PhD in Chemistry (2006–2010)
2.	Massachusetts Institute of Technology	140	57	41%
38.	**Allegheny College**	**70**	**25**	**36%**
8.	Harvard University	141	43	30%
46.	**College of Wooster**	**75**	**21**	**28%**
77.	Stanford University	62	16	26%
71.	**University of Richmond**	**68**	**17**	**25%**
38.	Carnegie Mellon University	104	25	24%
1.	University of California–Berkeley	358	81	23%
77.	**Haverford College**	**73**	**16**	**22%**
64.	University of Maryland–College Park	97	18	19%
46.	**Furman University**	**116**	**21**	**18%**
81.	University of Oregon	83	15	18%
77.	**Kalamazoo College**	**90**	**16**	**18%**
61.	University of Kansas–Main Campus	110	19	17%
23.	University of Wisconsin–Madison	189	32	17%
21.	Ohio State University–Main Campus	219	33	15%
81.	University of Georgia	109	15	14%
46.	Georgia Institute of Technology–Main Campus	158	21	13%
5.	University of Illinois at Urbana-Champaign	362	47	13%
56.	**St. Olaf College**	**159**	**20**	**13%**
25.	University of Pittsburgh–Main Campus	239	30	13%
81.	Clemson University	123	15	12%
71.	**Butler University**	**144**	**17**	**12%**
71.	University of Arizona	148	17	11%
34.	University of Texas at Austin	253	27	11%
71.	Indiana University at Bloomington	177	17	10%
15.	University of North Carolina at Chapel Hill	388	37	10%
3.	North Carolina State University at Raleigh	526	48	9%
38.	University of Washington–Seattle Campus	310	25	8%
28.	University of Virginia–Main Campus	453	28	6%

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Biological Sciences: The number of students graduating from Oberlin College (Oberlin, OH; 2,907 undergraduate enrollment) who later received doctorates in biological sciences between 2006 and 2010 was 66 (see Table 9, above), exceeding the total of nearby private research university Case Western Reserve University (65 students; 3,587 undergraduate enrollment) and many nationally-recognized research universities that enrolled far more

Table 9. Selected Institutions by Total Number of Graduates Who Completed PhD Degrees in Biological Sciences

National Rank by Total PhDs	Institution	Total Fall 2003 Undergraduate Enrollment	Total Baccalaureate Graduates in Biological Sciences, 2001–2005[14]	Number of Baccalaureate Graduates Who Attained a PhD in Biological Sciences, 2006–2010
1.	University of California–Berkeley	23,206	3,612	477
2.	University of Wisconsin–Madison	29,546	2,934	356
6.	University of Illinois at Urbana-Champaign	29,226	2,374	282
7.	Pennsylvania State University–Main Campus	35,002	1,739	280
8.	University of Texas at Austin	38,383	2,854	233
10.	Harvard University	9,714	845	222
14.	Texas A&M University–College Station	36,066	2,811	201
17.	Stanford University	7,054	664	195
18.	Brown University	5,906	777	186
30.	Ohio State University–Main Campus	37,605	1,708	144
32.	Indiana University at Bloomington	30,319	1,653	138
41.	Iowa State University	22,230	1,147	120
49.	North Carolina State University at Raleigh	22,971	1,902	103
60.	University of Iowa	20,233	656	85
82.	**Oberlin College**	**2,907**	**268**	**66**
85.	Case Western Reserve University	3,587	405	65
	Swarthmore College	**1,500**	**222**	**65**
90.	Washington State University	18,746	815	59
92.	**Grinnell College**	**1,524**	**207**	**58**
	Kansas State University	19,083	873	58
97.	University of Tennessee at Knoxville	19,224	654	56
101.	**Allegheny College**	**1,849**	**286**	**54**
	University of Southern California	16,381	515	54
104.	Auburn University–Main Campus	19,251	801	53
	St. Olaf College	**2,994**	**444**	**53**
108.	**Haverford College**	**1,163**	**178**	**51**
	Mount Holyoke College	**2,147**	**316**	**51**
110.	Rochester Institute of Technology	12,383	479	50
118.	Georgia Institute of Technology–Main Campus	11,257	329	45
137.	Texas Tech University	23,595	675	38

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Table 10. Selected Institutions by Percentage of Baccalaureate Graduates Who Completed PhD Degrees in Biological Sciences

National Rank by Total PhDs	Institution	Total Baccalaureate Graduates in Biological Sciences, 2001–2005[15]	Number of Baccalaureate Graduates Who Attained a PhD in Biological Sciences, 2006–2010	Percentage of Baccalaureate Graduates in Biological Sciences (2001–2005) Who Attained a PhD in Biological Sciences (2006–2010)
17.	Stanford University	664	195	29%
85.	**Swarthmore College**	**222**	**65**	**29%**
108.	**Haverford College**	**178**	**51**	**29%**
92.	**Grinnell College**	**207**	**58**	**28%**
10.	Harvard University	845	222	26%
82.	**Oberlin College**	**268**	**66**	**25%**
18.	Brown University	777	186	24%
101.	**Allegheny College**	**286**	**54**	**19%**
108.	**Mount Holyoke College**	**316**	**51**	**16%**
7.	Pennsylvania State University–Main Campus	1,739	280	16%
85.	Case Western Reserve University	405	65	16%
118.	Georgia Institute of Technology–Main Campus	329	45	14%
1.	University of California–Berkeley	3,612	477	13%
60.	University of Iowa	656	85	13%
2.	University of Wisconsin–Madison	2,934	356	12%
104.	**St. Olaf College**	**444**	**53**	**12%**
6.	University of Illinois at Urbana-Champaign	2,374	282	12%
101.	University of Southern California	515	54	10%
41.	Iowa State University	1,147	120	10%
110.	Rochester Institute of Technology	479	50	10%
97.	University of Tennessee at Knoxville	654	56	9%
30.	Ohio State University–Main Campus	1,708	144	8%
32.	Indiana University at Bloomington	1,653	138	8%
8.	University of Texas at Austin	2,854	233	8%
90.	Washington State University	815	59	7%
14.	Texas A&M University–College Station	2,811	201	7%
92.	Kansas State University	873	58	7%
104.	Auburn University–Main Campus	801	53	7%
137.	Texas Tech University	675	38	6%
49.	North Carolina State University at Raleigh	1,902	103	5%

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

undergraduates: Washington State University (59 students; 18,746 undergraduate enrollment), Kansas State University (58 students; 19,083 undergraduate enrollment), the University of Tennessee (56 students; 19,224 undergraduate enrollment), the University of Southern California (54 students; 16,381 undergraduate enrollment), Auburn University (53 students; 19,251 undergraduate enrollment), Rochester Institute of Technology (50 students; 12,383 undergraduate enrollment), Georgia Tech (45 students; 11,257 undergraduate enrollment), and Texas Tech University (38 students; 23,595 undergraduate enrollment).

The superior efficiency of small and mid-sized independent colleges in preparing students for doctoral work in biological sciences is demonstrated by Table 10 (previous page), which re-orders these institutions by the percentage of their graduates who completed doctoral work. Approximately one out of every four graduates in biological sciences from Swarthmore College (Swarthmore, PA; 1,500 undergraduate enrollment), Haverford College (Haverford, PA; 1,163 undergraduate enrollment), Grinnell College (Grinnell, IA; 1,524 undergraduate enrollment), and Oberlin College (Oberlin, OH; 2,907 undergraduate enrollment) went on to complete a PhD, a rate higher than that of the large public research universities in their respective states: Pennsylvania State University (16 percent; 35,002 undergraduate enrollment), the University of Iowa (13 percent; 20,233 undergraduate enrollment), Iowa State University (10 percent; 22,230 undergraduate enrollment), and Ohio State University (8 percent; 37,605 undergraduate enrollment).

Computer Science: A number of smaller private colleges produced as many graduates who later completed PhD degrees in computer science as much larger research universities did (see Table 11). For the period 2006–2010, Swarthmore College (Swarthmore, PA; 1,500 undergraduate enrollment) produced the same number of graduates who later received doctorates in computer science (eight) as the University of Houston (27,048 undergraduate enrollment) and the University of Tennessee (19,224 undergraduate enrollment). Similarly, DePauw University (Greencastle, IN; 2,365 undergraduate enrollment) and Haverford College (Haverford, PA; 1,163 undergraduate enrollment) produced the same number of future PhDs in computer science (seven) as Tufts University (4,892 undergraduate enrollment) and Texas Tech University (23,595 undergraduate enrollment). In addition, the number of graduates from Bucknell University (Lewisburg, PA; 3,484 undergraduate enrollment), Hope College (Holland, MI; 3,068 undergraduate enrollment), Ithaca College (Ithaca, NY; 6,260 undergraduate enrollment), and Lewis & Clark College (Portland, OR; 1,792 undergraduate enrollment) who later received doctorates in computer science during that period (six) was the same as two much larger public research universities, the University of Georgia (25,415 undergraduate enrollment) and the University of North Carolina (16,144 undergraduate enrollment).

Many small and mid-sized independent colleges proved to be more efficient in producing future computer scientists than public research universities. For example, although it enrolled fewer than one-tenth of the undergraduate student body as its nearby public research university (3,484 vs. 35,002), computer science majors who graduated from Bucknell University were twice as likely to complete a doctoral degree as their peers who completed their undergraduate studies in computer science at Pennsylvania State University (6 percent vs. 3 percent, see Table 12). Likewise, graduates in computer science from DePauw University were twice as likely (4 percent vs. 2 percent) to complete a PhD degree than graduates of the in-state flagship university, Indiana University, even though it enrolled more than 12 times as many undergraduate students as the small private liberal arts college (30,319 vs. 2,365). Hope College (Holland, MI; 3,068 undergraduate enrollment) produced fewer eventual PhDs in computer science than the in-state flagship, the University of Michigan (24,517 undergraduate enrollment), yet its computer science graduates were more than twice as likely to complete their doctoral education in this discipline (9 percent vs. 4 percent).

Table 11. Selected Institutions by Total Number of Graduates Who Completed PhD Degrees in Computer Science

National Rank by Total PhDs	Institution	Total Fall 2003 Undergraduate Enrollment	Total Baccalaureate Graduates in Computer Science, 2001–2005[16]	Number of Baccalaureate Graduates Who Attained a PhD in Computer Science, 2006–2010
1.	Massachusetts Institute of Technology	4,112	831	91
2.	University of California–Berkeley	23,206	562	88
6.	University of Texas at Austin	38,383	1,678	43
8.	University of Illinois at Urbana-Champaign	29,226	979	40
13.	Pennsylvania State University–Main Campus	35,002	1,241	32
	University of Michigan–Ann Arbor	24,517	817	32
17.	Purdue University–Main Campus	32,377	1,534	26
	University of Washington–Seattle Campus	27,962	498	26
21.	Virginia Polytechnic Institute and State University	21,348	852	25
39.	Ohio State University–Main Campus	37,605	883	16
40.	Johns Hopkins University	5,723	325	15
	North Carolina State at Raleigh	22,971	983	15
47.	Florida State University	29,630	1315	13
59.	University of Oregon	15,983	352	11
63.	Indiana University at Bloomington	30,319	430	10
78.	Oregon State University	15,601	401	8
	Swarthmore College	**1,500**	**58**	**8**
	University of Houston	27,048	433	8
	University of Tennessee at Knoxville	19,224	195	8
88.	**DePauw University**	**2,365**	**168**	**7**
	Haverford College	**1,163**	**11**	**7**
	Texas Tech University	23,595	281	7
	Tufts University	4,892	209	7
108.	**Bucknell University**	**3,484**	**103**	**6**
	College of William and Mary	5,748	221	6
	Hope College	**3,068**	**70**	**6**
	Ithaca College	**6,260**	**101**	**6**
	Lewis & Clark College	**1,792**	**55**	**6**
	University of Chicago	4,355	71	6
	University of Georgia	25,415	296	6
	University of North Carolina at Chapel Hill	16,144	198	6

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Table 12. Selected Institutions by Percentage of Baccalaureate Graduates Who Completed PhD Degrees in Computer Science

National Rank by Total PhDs	Institution	Total Baccalaureate Graduates in Computer Science, 2001–2005[17]	Number of Baccalaureate Graduates Who Attained a PhD in Computer Science, 2006–2010	Percentage of Baccalaureate Graduates in Computer Science (2001–2005) Who Attained a PhD in Computer Science (2006–2010)
88.	**Haverford College**	**11**	**7**	**64%**
2.	University of California–Berkeley	562	88	16%
78.	**Swarthmore College**	**58**	**8**	**14%**
1.	Massachusetts Institute of Technology	831	91	11%
108.	**Lewis & Clark College**	**55**	**6**	**11%**
108.	**Hope College**	**70**	**6**	**9%**
108.	University of Chicago	71	6	8%
108.	**Ithaca College**	**101**	**6**	**6%**
108.	**Bucknell University**	**103**	**6**	**6%**
17.	University of Washington–Seattle Campus	498	26	5%
40.	Johns Hopkins University	325	15	5%
88.	**DePauw University**	**168**	**7**	**4%**
78.	University of Tennessee at Knoxville	195	8	4%
8.	University of Illinois at Urbana-Champaign	979	40	4%
13.	University of Michigan–Ann Arbor	817	32	4%
88.	Tufts University	209	7	3%
59.	University of Oregon	352	11	3%
108.	University of North Carolina at Chapel Hill	198	6	3%
21.	Virginia Polytechnic Institute and State University	852	25	3%
108.	College of William and Mary	221	6	3%
13.	Pennsylvania State University–Main Campus	1,241	32	3%
6.	University of Texas at Austin	1,678	43	3%
88.	Texas Tech University	281	7	2%
63.	Indiana University at Bloomington	430	10	2%
108.	University of Georgia	296	6	2%
78.	Oregon State University	401	8	2%
78.	University of Houston	433	8	2%
39.	Ohio State University–Main Campus	883	16	2%
17.	Purdue University–Main Campus	1,534	26	2%
40.	North Carolina State at Raleigh	983	15	2%
47.	Florida State University	1315	13	1%

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Physics: The number of students graduating from Colorado College (Colorado Springs, CO; 1,942 undergraduate enrollment) who later received doctorates in physics between 2006 and 2010 was eight (see Table 13), exceeding nearby public research university Colorado State University (seven students; 21,815 undergraduates). Similarly, Morehouse College (Atlanta, GA; 2,859 undergraduate enrollment) produced more baccalaureate graduates in physics who completed PhDs in this field (seven) than state flagship University of Georgia (five students; 25,415 undergraduate enrollment). Many private liberal arts colleges more efficiently produced future physicists than nearby research institutions. For example, baccalaureate graduates in physics from Mount Holyoke College (South Hadley, MA; 2,147 undergraduate enrollment) were more likely to complete a PhD in their discipline than graduates of the Massachusetts Institute of Technology (4,112 undergraduate enrollment) during this period (33 percent vs. 28 percent, see Table 14). Moreover, physics majors who graduated from Morehouse College (23 percent) were more likely to earn a PhD than graduates of the University of Georgia (17 percent), and graduates of the University of Puget Sound (28 percent; 2,516 undergraduate enrollment) were more likely to complete PhDs in physics than were graduates of the University of Washington (12 percent; 27,962 undergraduate enrollment).

Table 13. Selected Institutions by Total Number of Graduates Who Completed PhD Degrees in Physics

National Rank by Total PhDs	Institution	Total Fall 2003 Undergraduate Enrollment	Total Baccalaureate Graduates in Physics, 2001–2005[18]	Number of Baccalaureate Graduates Who Attained a PhD in Physics, 2006–2010
1.	University of California–Berkeley	23,206	224	92
2.	Massachusetts Institute of Technology	4,112	308	85
4.	Harvard University	9,714	281	61
8.	University of Washington–Seattle Campus	27,962	312	38
15.	University of California–Los Angeles	25,715	173	31
32.	Dartmouth College	4,097	62	21
45.	**Swarthmore College**	**1,500**	**38**	**17**
46.	Texas A&M University–Main Campus	36,066	66	16
48.	Ohio State University–Main Campus	37,605	92	15
63.	**University of Puget Sound**	**2,516**	**43**	**12**
83.	Duke University	6,248	55	9
	Grinnell College	**1,524**	**54**	**9**
	Gustavus Adolphus College	**2,593**	**73**	**9**
	Indiana University at Bloomington	30,319	56	9
93.	**Colorado College**	**1,942**	**63**	**8**
	Oberlin College	**2,907**	**48**	**8**
	University of North Carolina at Chapel Hill	16,144	59	8
	University of Oregon	15,983	60	8
103.	Colorado State University–Fort Collins	21,815	38	7
	Morehouse College	**2,859**	**31**	**7**
	Mount Holyoke College	**2,147**	**21**	**7**
	Texas Tech University	23,595	17	7
120.	University of Tennessee at Knoxville	19,224	24	6
144.	University of Georgia	25,415	30	5

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Mathematics and Statistics: Although it enrolls fewer than 5 percent of the total undergraduate enrollment of in-state flagship Pennsylvania State University (35,002 undergraduate enrollment), Swarthmore College (Swarthmore, PA; 1,500 undergraduate enrollment) produced the same number of baccalaureate graduates in mathematics and statistics who completed a PhD between 2006 and 2010 (14; see Table 15). Even more impressive, Swarthmore baccalaureate graduates in mathematics and statistics were more than six times as likely to complete their doctoral degrees (26 percent vs. 4 percent; see Table 16).

Similarly, the number of students graduating from St. Olaf College (Northfield, MN; 2,994 undergraduate enrollment) who later received doctorates in mathematics and statistics between 2006 and 2010 was 12, exceeding the in-state public flagship University of Minnesota (11 students; 32,474 undergraduate enrollment). Moreover, St.

Table 14. Selected Institutions by Percentage of Baccalaureate Graduates Who Completed PhD Degrees in Physics

National Rank by Total PhDs	Institution	Total Baccalaureate Graduates in Physics, 2001–2005[19]	Number of Baccalaureate Graduates Who Attained a PhD in Physics, 2006–2010	Percentage of Baccalaureate Graduates in Physics (2001–2005) Who Attained a PhD in Physics (2006–2010)
45.	**Swarthmore College**	**38**	**17**	**45%**
103.	Texas Tech University	17	7	41%
1.	University of California–Berkeley	224	92	41%
32.	Dartmouth College	62	21	34%
103.	**Mount Holyoke College**	**21**	**7**	**33%**
63.	**University of Puget Sound**	**43**	**12**	**28%**
2.	Massachusetts Institute of Technology	308	85	28%
120.	University of Tennessee at Knoxville	24	6	25%
46.	Texas A&M University–Main Campus	66	16	24%
103.	**Morehouse College**	**31**	**7**	**23%**
4.	Harvard University	281	61	22%
103.	Colorado State University–Fort Collins	38	7	18%
15.	University of California–Los Angeles	173	31	18%
83.	**Grinnell College**	**54**	**9**	**17%**
93.	**Oberlin College**	**48**	**8**	**17%**
144.	University of Georgia	30	5	17%
83.	Duke University	55	9	16%
48.	Ohio State University–Main Campus	92	15	16%
83.	Indiana University at Bloomington	56	9	16%
93.	University of North Carolina at Chapel Hill	59	8	14%
93.	University of Oregon	60	8	13%
93.	**Colorado College**	**63**	**8**	**13%**
83.	**Gustavus Adolphus College**	**73**	**9**	**12%**
8.	University of Washington–Seattle Campus	312	38	12%

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Olaf baccalaureate graduates in mathematics and statistics were twice as likely to complete a PhD in their field (6 percent vs. 3 percent). Finally, the University of Dallas (Dallas, TX; 1,250 undergraduate enrollment) produced the same number of future PhDs in mathematics and statistics (six) as Texas Tech University (23,595 undergraduate enrollment), but University of Dallas baccalaureate graduates in mathematics and statistics were seven times more likely to complete a PhD degree in their field (29 percent vs. 4 percent).

Table 15. Selected Institutions by Total Number of Graduates Who Completed PhD Degrees in Mathematics and Statistics

National Rank by Total PhDs	Institution	Total Fall 2003 Undergraduate Enrollment	Total Baccalaureate Graduates in Mathematics and Statistics, 2001–2005[20]	Number of Baccalaureate Graduates Who Attained a PhD in Mathematics and Statistics, 2006–2010
1.	University of California–Berkeley	23,206	942	74
2.	Harvard University	9,714	358	66
7.	University of Texas at Austin	38,383	816	40
9.	University of California–Los Angeles	25,715	1,108	37
12.	University of Wisconsin–Madison	29,546	360	29
19.	University of Washington–Seattle Campus	27,962	651	23
21.	Virginia Polytechnic Institute and State University	21,348	387	22
25.	Ohio State University–Main Campus	37,605	296	20
43.	Texas A&M University–College Station	36,066	958	15
47.	Pennsylvania State University–Main Campus	35,002	392	14
	Swarthmore College	**1,500**	**54**	**14**
52.	**St. Olaf College**	**2,994**	**216**	**12**
	University of Pittsburgh–Main Campus	17,413	206	12
56.	**Oberlin College**	**2,907**	**82**	**11**
	Purdue University–Main Campus	32,377	355	11
	University of Minnesota–Twin Cities	32,474	354	11
82.	Iowa State University	22,230	139	8
	University of Massachusetts at Amherst	18,718	189	8
96.	Colorado State University–Fort Collins	21,815	169	7
	Haverford College	**1,163**	**68**	**7**
114.	**Bucknell University**	**3,484**	**89**	**6**
	College of William and Mary	5,748	90	6
	Grinnell College	**1,524**	**76**	**6**
	Kenyon College	**1,613**	**35**	**6**
	Spelman College	**2,063**	**125**	**6**
	Texas Tech University	23,595	163	6
	University of Dallas	**1,250**	**21**	**6**
	University of Kentucky	18,108	101	6
	University of Puget Sound	**2,516**	**89**	**6**
145.	Florida State University	29,630	74	5

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Table 16. Selected Institutions by Percentage of Baccalaureate Graduates Who Completed PhD Degrees in Mathematics and Statistics

National Rank by Total PhDs	Institution	Total Baccalaureate Graduates in Mathematics and Statistics, 2001–2005[21]	Number of Baccalaureate Graduates Who Attained a PhD in Mathematics and Statistics, 2006–2010	Percentage of Baccalaureate Graduates in Mathematics and Statistics (2001–2005) Who Attained a PhD in Mathematics and Statistics (2006–2010)
114.	**University of Dallas**	**21**	**6**	**29%**
47.	**Swarthmore College**	**54**	**14**	**26%**
2.	Harvard University	358	66	18%
114.	**Kenyon College**	**35**	**6**	**17%**
56.	**Oberlin College**	**82**	**11**	**13%**
96.	**Haverford College**	**68**	**7**	**10%**
12.	University of Wisconsin–Madison	360	29	8%
114.	**Grinnell College**	**76**	**6**	**8%**
1.	University of California–Berkeley	942	74	8%
25.	Ohio State University–Main Campus	296	20	7%
145.	Florida State University	74	5	7%
114.	**Bucknell University**	**89**	**6**	**7%**
114.	**University of Puget Sound**	**89**	**6**	**7%**
114.	College of William and Mary	90	6	7%
114.	University of Kentucky	101	6	6%
52.	University of Pittsburgh–Main Campus	206	12	6%
82.	Iowa State University	139	8	6%
21.	Virginia Polytechnic Institute and State University	387	22	6%
52.	**St. Olaf College**	**216**	**12**	**6%**
7.	University of Texas at Austin	816	40	5%
114.	**Spelman College**	**125**	**6**	**5%**
82.	University of Massachusetts at Amherst	189	8	4%
96.	Colorado State University–Fort Collins	169	7	4%
114.	Texas Tech University	163	6	4%
47.	Pennsylvania State University–Main Campus	392	14	4%
19.	University of Washington–Seattle Campus	651	23	4%
9.	University of California–Los Angeles	1,108	37	3%
56.	University of Minnesota–Twin Cities	354	11	3%
56.	Purdue University–Main Campus	355	11	3%
43.	Texas A&M University–College Station	958	15	2%

Sources: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

CONCLUSION

The role that independent, smaller colleges and universities play in preparing the nation's scientists has often been overlooked. This report shows that small and mid-sized independent institutions have higher student persistence and degree completion rates in STEM fields and shorter time to the bachelor's degree. In addition, bachelor's degree recipients from small and mid-sized independent institutions in the STEM fields are more committed to advancing their education at the time of graduation, and many of them immediately enroll in graduate-level degree programs after obtaining their bachelor's degrees. Finally, graduates of small and mid-sized colleges are more likely to pursue doctoral degrees in STEM fields than graduates of public four-year institutions; in many individual academic disciplines, small and mid-sized colleges produce as many or more science majors who obtain PhDs than large research universities. Moreover, smaller private colleges are more efficient producers of graduates who go on to earn STEM doctorates than are public universities.

It is easy to understand the structural reasons why smaller institutions succeed in this arena. Overall, attrition at large state universities is much higher than at small colleges, and the gap between large universities and small colleges in attrition rates is even larger in science courses than it is in other fields. Students at small and mid-sized independent colleges and universities are usually more engaged in effective educational practices and reported making greater strides in their learning and development (CIC 2011). This may be attributed to the faculty's emphasis on teaching, smaller class sizes, mission-centered curricula, and the fostering of active forms of pedagogy that keep students connected to the process of learning in meaningful ways. In the sciences, these institutional hallmarks translate to more personal attention from faculty members in the classroom and in the laboratory, as well as opportunities for students to preview their future lives as scientists through open-ended, independent research projects that require a combination of technical expertise, critical thinking, and communication skills (Cech 1999). STEM fields are sequential and cumulative. A student who encounters academic difficulty is at risk of abandoning a major in a STEM field without help from a faculty member in getting back on track, a distinctive role of faculty members at small and mid-sized private colleges and universities.

> **"Small and mid-sized independent institutions have higher student persistence and degree completion rates in STEM fields and shorter time to the bachelor's degree."**

Policy Recommendations

At a time when federal and state officials have made a priority of increasing the number of Americans with advanced degrees in STEM fields and when state and federal spending is under increasing pressure, the educational effectiveness and cost effectiveness of small and mid-sized nonprofit independent colleges and universities in meeting national goals must not be overlooked. Indeed, the most cost-effective strategy for increasing the supply of STEM workers for the U.S. economy is to reduce college student attrition in STEM fields. In order to reap the full benefits of a strong

STEM workforce through higher education, policy makers should assist the sector of education in which colleges and universities have demonstrated that they can prepare many people for STEM careers effectively and efficiently—namely, small and mid-sized private colleges. Specifically, these policies might include:

Policy makers should assist the sector of education in which colleges and universities have demonstrated that they can prepare many people for STEM careers effectively and efficiently—namely, small and mid-sized private colleges.

- Provide additional federal funding to students who major in STEM fields at small and mid-sized private colleges to maximize efficient production of undergraduate degrees in STEM fields and of future scientists;
- Allow students who wish to major in a STEM field to receive at least as much state financial aid for use at private colleges that have demonstrated equivalent efficiency in degree production as their in-state flagship research university;
- Foster partnerships among high schools, businesses, and community organizations to identify promising students and encourage special programs and funding for both their STEM education at small and mid-sized private colleges and their future entry into the U.S. STEM workforce; and
- Create incentives through tax relief for businesses to provide specialized laboratory equipment to small and mid-sized private colleges to shorten transition time from the classroom to the workplace.

APPENDIX

Endnotes

1. As often is the case with nationally-representative longitudinal studies, cross-tabulations performed using the B&B study can yield parameter estimates with large standard errors when sub-groups with relatively small sample sizes are included in the analysis. The standard error represents more than 30 percent of the estimate for results reported in the following cells of Table 2: Public nondoctoral 61–72 months and >73 months; Private nonprofit nondoctoral 49–60 months, 61–72 months, and >73 months; Private nonprofit doctoral 61–72 months and >73 months.

2. See note for Table 2 above. The standard error represents more than 30 percent of the estimate for the result reported for graduates of public nondoctoral institutions who were enrolled in a doctoral degree program in 2009.

3. The National Science Foundation includes psychology and social sciences in "science and engineering" degrees. This report excludes these two fields in order to be consistent with previous analyses and traditional definitions of STEM fields.

4. Calculation based on IPEDS 2001–2005 data for all public and private nonprofit four-year institutions.

5. Baccalaureate completions in biological and biomedical sciences, computer and information sciences, engineering, mathematics and statistics, and physical sciences.

6. Doctoral completions in engineering, geosciences, life sciences, math and computer sciences, and physical sciences.

7. Researchers at Franklin & Marshall College (1998) conducted a series of studies that ranked the number of doctoral degrees awarded by academic discipline, undergraduate institution, and time period (1920–1995) among independent colleges and universities (nondoctoral and doctoral). Comparisons in these studies were not made with public institutions.

8. Analysis by Burrelli, Rapoport, and Lehming (2008) demonstrated the institutional productivity of 50 small, private liberal arts colleges (the "Oberlin 50") relative to private doctoral, private nondoctoral, public doctoral, and public nondoctoral institutions by calculating the number of baccalaureate recipients in science and engineering who completed doctorate degrees nine years later (i.e., the median time from bachelor's-to-doctorate receipt in science and engineering fields). Comparisons were made using overall totals in the broad fields of natural sciences, social and behavioral sciences, and engineering, rather than examining particular institutions in specific disciplines.

9. In order to compare institutional efficiency in producing future scientists, Tables 7–16 present data for the percentage of baccalaureate graduates who completed PhD degrees in various STEM fields. These calculations assume that students who attained their PhD degrees during the period 2006–2010 would have attained their baccalaureate degrees in the same discipline during the period 2001–2005. Incomplete data for particular institutions in specific disciplines prevented meaningful analysis for baccalaureate completions during the period 1997–2001, a more likely timeframe for bachelor's degree attainment for 2006–2010 STEM PhD graduates. The consistent methodology applied across institutions renders bias in percentage results unlikely.

10. All enrollment figures are based on fall 2003 IPEDS data.

11. All institutional PhD totals were calculated from data provided by the National Science Foundation's Survey of Earned Doctorates, accessed through the National Center for Science and Engineering Statistics WebCASPAR Integrated Science and Engineering Resources Data System.

12. Totals based on sum of first majors in Chemistry (IPEDS CIP code 40.05) during 2001–2005.

13. Totals based on sum of first majors in Chemistry (IPEDS CIP code 40.05) during 2001–2005.

14. Totals based on sum of first majors in Biological Sciences (IPEDS CIP code 26) during 2001–2005.

15. Totals based on sum of first majors in Biological Sciences (IPEDS CIP code 26) during 2001–2005.

16. Totals based on sum of first majors in Computer Sciences (IPEDS CIP code 11) during 2001–2005. Missing data for one year at one institution was imputed using the simple mean of the other four years.

17. Totals based on sum of first majors in Computer Sciences (IPEDS CIP code 11) during 2001–2005. Missing data for one year at one institution was imputed using the simple mean of the other four years.

18. Totals based on sum of first majors in Physics (IPEDS CIP code 40.08) during 2001–2005. Missing data for one year at one institution was imputed using the simple mean of the other four years.

19. Totals based on sum of first majors in Physics (IPEDS CIP code 40.08) during 2001–2005. Missing data for one year at one institution was imputed using the simple mean of the other four years.

20. Totals based on sum of first majors in Mathematics and Statistics (IPEDS CIP code 27) during 2001–2005.

21. Totals based on sum of first majors in Mathematics and Statistics (IPEDS CIP code 27) during 2001–2005.

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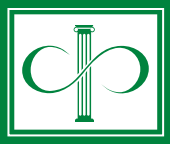

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