Chapter 2
Higher Education in Science and Engineering

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Highlights

Characteristics of the U.S. Higher Education System

Doctorate-granting institutions with very high research activity are the leading producers of S&E degrees at the bachelor's, master's, and doctoral levels, but other types of institutions are also important in the education of S&E graduates.

- ♦ In 2011, doctorate-granting institutions with very high research activity awarded 74% of doctoral degrees, 42% of master's degrees, and 38% of bachelor's degrees in S&E fields.
- ♦ Baccalaureate colleges are the source of relatively few S&E bachelor's degrees but are a prominent source of future S&E doctorate recipients.
- ♦ Master's colleges and universities awarded close to 30% of all S&E bachelor's degrees and 25% of all S&E master's degrees in 2011.
- ♦ Nearly one in five U.S. citizens or permanent residents who received a doctoral degree from 2007 to 2011 had earned some college credit from a community or 2-year college.

Higher education spending and revenue patterns and trends underwent substantial changes over the last two decades.

- ♦ Net student tuition more than doubled at public universities, whereas state and local appropriations fell by more than 25%.
- ♦ Although tuition remained lower at public very high research universities than at their private counterparts, average revenue from student tuition increased more rapidly at public institutions.
- ♦ In public very high research universities, revenues from federal appropriations, grants, and contracts per full-time equivalent (FTE) student nearly doubled between 1987 and 2010, and research expenditures grew by 79% in the same period. In private very high research universities, revenues from federal appropriations, grants, and contracts per FTE student grew by 61%, and research expenditures increased by 89%.
- ♦ Since 2007, expanding enrollment at community colleges, coupled with reductions in state and local appropriations, contributed to an 8% reduction in instructional spending per FTE student.

Over the past decade in the United States, tuition and fees for colleges and universities have grown faster than median household income.

- ♦ Undergraduate debt varies by type of institution and state. However, among recent graduates with S&E bachelor's degrees, the level of undergraduate debt does not vary by major.
- ♦ Levels of debt of doctorate recipients vary by field. In S&E fields, high levels of graduate debt were most common among doctorate recipients in social sciences, psychology, and medical or other health sciences.
- ♦ At the time of doctoral degree conferral, nearly half of 2011 S&E doctorate recipients had debt related to their undergraduate or graduate education.

Undergraduate Education, Enrollment, and Degrees

Undergraduate enrollment in U.S. higher education rose from 12.5 million to 18.3 million in the 15 years ending in 2011. The largest increases coincided with the two economic downturns, 2000–02 and 2008–10.

- ♦ Associate's colleges enroll the largest number of students, followed by master's colleges and universities and doctorate-granting institutions with very high research activity.
- ♦ Increased enrollment in higher education is projected to come mainly from minority groups, particularly Hispanics and Asians.

The number of S&E bachelor's degrees has risen steadily over the past 15 years, reaching a new peak of over half a million in 2011. The proportion of S&E bachelor's degrees has remained stable at about 32% during this period.

- ♦ All S&E fields experienced increases in the numbers of bachelor's degrees awarded in 2011, including computer sciences, which had declined sharply in the mid-2000s and had remained flat through 2009.
- ♦ Women have earned about 57% of all bachelor's degrees and half of all S&E bachelor's degrees since the late 1990s. Men earn the majority of bachelor's degrees in engineering, computer sciences, and physics. More women than men earn degrees in the biological, agricultural, and social sciences and in psychology.
- ♦ Between 2000 and 2011, the proportion of S&E bachelor's degrees awarded to women remained flat. During this period, it declined in computer sciences, mathematics, physics, engineering, and economics.

The racial and ethnic composition of those earning S&E bachelor's degrees is changing, reflecting both population changes and increases in college attendance by members of minority groups.

- ♦ For all racial and ethnic groups, the total number of bachelor's degrees earned, the number of S&E bachelor's degrees earned, and the number of bachelor's degrees in most S&E fields have increased since 2000.

The number of foreign undergraduate students in the United States increased substantially (18%) between fall 2011 and fall 2012.

- Most of the increase in undergraduate foreign enrollment was in non-S&E fields. Within S&E fields, the largest increases were in engineering and the social sciences.
- China, South Korea, and Saudi Arabia were the top countries sending undergraduates to the United States.

Graduate Education, Enrollment, and Degrees

Graduate enrollment in S&E increased from about 493,000 to more than 608,000 between 2000 and 2011.

- Graduate enrollment grew in most S&E fields, with particularly strong growth in engineering and in the biological and social sciences.
- Women continued to enroll at disproportionately low rates in engineering (23%), computer sciences (25%), physical sciences (33%), and economics (38%).
- In 2011, underrepresented minority students (blacks, Hispanics, and American Indians and Alaska Natives) made up 12% of students enrolled in graduate S&E programs, with Asians and Pacific Islanders representing 6% and whites 47%. Temporary residents accounted for most of the remainder of graduate S&E enrollment.

In 2011, the federal government was the primary source of financial support for 19% of full-time S&E graduate students. In recent years, this proportion has fluctuated between 18% and 20%.

- In 2009, the federal government funded 61% of S&E graduate students on traineeships, 51% of those with research assistantships, and 24% of those with fellowships.
- Graduate students in the biological sciences, the physical sciences, and engineering received relatively more federal financial support than those in computer sciences, mathematics, medical and other health sciences, psychology, and social sciences.

Between fall 2011 and fall 2012, the number of foreign graduate students increased by 3%, with all the increase occurring in non-S&E fields.

- Nearly 6 out of 10 foreign graduate students in the United States in fall 2012 were enrolled in S&E fields, compared with about 3 in 10 foreign undergraduates.
- The number of foreign graduate students enrolled in S&E fields between 2011 and 2012 was stable, with declines in the numbers of foreign students in computer sciences, biological sciences, and engineering offset by increases in mathematics, social sciences, and psychology.
- In fall 2012, about 60% of the foreign S&E graduate students in the United States came from China and India.

Master's degrees awarded in S&E fields increased from about 100,000 in 2000 to about 151,000 in 2011. In this period, the growth of S&E degrees at the master's level (57%) was higher than growth at the bachelor's (39%) and doctoral levels (38%).

- Increases occurred in most major S&E fields, with the largest in engineering, psychology, and political sciences and public administration.
- The number and percentage of master's degrees awarded to women in most major S&E fields have increased since 2000.
- The number of S&E master's degrees awarded increased for all racial and ethnic groups from 2000 to 2011. During this period, the proportion earned by blacks and Hispanics increased, that of Asians and Pacific Islanders and American Indians and Alaska Natives remained flat, and that of whites decreased.

In 2011, U.S. academic institutions awarded about 38,000 S&E doctorates.

- The number of S&E doctorates conferred annually by U.S. universities increased steeply from 2002 to 2007, then flattened and declined slightly in 2010, but increased again in 2011.
- Among fields that award large numbers of doctorates, the biggest increases in degrees awarded between 2000 and 2011 were in engineering (58%) and in the biological sciences (52%).

Students on temporary visas continue to earn high proportions of U.S. S&E doctorates, and these students dominated degrees in some fields. They also earned large shares of the master's degrees in S&E fields.

- In 2011, foreign students earned 56% of all engineering doctorates, 51% of all computer sciences doctorates, 44% of physics doctorates, and 60% of the economics doctorates. Their overall share of S&E degrees was about one-third.
- After steep growth from 2002 to 2008, the number of temporary residents earning S&E doctoral degrees declined through 2010, but it increased again in 2011.
- In 2011, temporary visa students earned 26% of S&E master's degrees, receiving 45% of those in computer sciences, 44% of those in economics, 42% of those in engineering, and 35% of those in physics.

International S&E Higher Education

In 2010, more than 5.5 million first university degrees were awarded in S&E worldwide. Students in China earned about 24%, those in the European Union (EU) earned about 17%, and those in the United States earned about 10% of these degrees.

- The number of S&E first university degrees awarded in China, Taiwan, Turkey, Germany, and Poland approximately doubled between 2000 and 2010. During this period, S&E first university degrees awarded in the United States and several other countries (e.g., Australia, Italy, the United Kingdom, Canada, and South Korea) increased between 23% and 56%, whereas those awarded in France, Japan, and Spain declined by 14%, 9%, and 4%, respectively.
- S&E degrees continue to account for about one-third of all bachelor's degrees awarded in the United States. In Japan, 6 out of 10 first degrees were awarded in S&E fields in 2010; in China, half.
- In the United States, about 5% of all bachelor's degrees awarded in 2010 were in engineering. This compares with about 18% throughout Asia and 31% in China specifically.

In 2010, the United States awarded the largest number of S&E doctoral degrees of any individual country, followed by China, Russia, Germany, and the United Kingdom.

- The numbers of S&E doctoral degrees awarded in China and the United States have risen substantially in recent years. S&E doctorates awarded in South Korea and in many European countries have risen more modestly. S&E doctorates awarded in Japan increased fairly steadily through 2006 but have declined since then.
- In 2007, China overtook the United States as the world leader in the number of doctoral degrees awarded in the natural sciences and engineering; in 2010, this number in China was stable.
- Women earned 41% of S&E doctoral degrees awarded in the United States in 2010, about the same as women's percentages in Australia, Canada, the EU, and Mexico and a higher proportion than in Malaysia, South Korea, and Taiwan.

International student mobility expanded over the past two decades, as countries are increasingly competing for foreign students.

- The United States remains the destination for the largest number of internationally mobile students worldwide (undergraduate and graduate), although its share decreased from 25% in 2000 to 19% in 2010. Among OECD countries, the U.S. share in natural sciences and engineering fields has declined during this period, but an increase in international students coming to the United States to study social and behavioral sciences has kept the overall S&E share stable.
- Some countries expanded recruitment of foreign students as their own populations of college-age students decreased.
- In addition to the United States, other countries that are among the top destinations for foreign students include the United Kingdom, Australia, Germany, and France.

Introduction

Chapter Overview

Higher education performs a number of societal functions, including developing human capital; building the knowledge base through research and knowledge development; and disseminating, using, and maintaining knowledge (Organisation for Economic Co-operation and Development [OECD] 2008). S&E higher education provides the advanced skills needed for a competitive workforce and, particularly in the case of graduate-level S&E education, the research capability necessary for innovation. This chapter focuses on the development of human capital through higher education.

Indicators presented in this chapter are discussed in the context of national and global developments, including changing demographics, increasing foreign student mobility, and global competition in higher education. The composition of the U.S. college-age population is becoming more diverse as the Asian and Hispanic shares of the population increase. During the latest economic downturn, public institutions of higher education faced unique pressures due to a combination of increasing enrollments and tight state budgets. Private institutions likewise experienced financial challenges stemming from declining incomes and the effects of stock market fluctuations on endowment growth. Technology has enabled very rapid growth in the delivery of online courses; the consequences of these changes remain to be seen.

Although the United States has historically been a world leader in providing broad access to higher education and in attracting foreign students, many other countries are providing expanded educational access to their own populations and attracting growing numbers of foreign students. Nevertheless, increases in foreign students contributed to most of the growth in overall S&E graduate enrollment in the United States in recent years. Following a decline in the number of foreign students coming to the United States after 11 September 2001, foreign student enrollment in S&E has recovered.

Chapter Organization

This chapter begins with an overview of the characteristics of U.S. higher education institutions providing instruction in S&E, followed by a discussion of characteristics of undergraduate and graduate education.[1] Trends are discussed by field and demographic group, with attention to the flow of foreign students into the United States by country. Various international higher education indicators are then presented, including comparative S&E degree production in several world regions and indicators that measure the growing dependence of industrialized countries on foreign S&E students.

The data in this chapter come from a variety of federal and nonfederal sources, primarily surveys conducted by the National Science Foundation's (NSF's) National Center for Science and Engineering Statistics (NCSES) and the National Center for Education Statistics (NCES) at the U.S. Department of Education. Data also come from international organizations, such as the OECD and the United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute of Statistics, as well as individual countries. Most of the data in the chapter are from censuses of the population—for example, all students receiving degrees from U.S. academic institutions—and are not subject to sampling variability.

The U.S. Higher Education System

Higher education in S&E produces an educated S&E workforce and an informed citizenry. It has also been receiving increased attention as an important component of U.S. economic competitiveness. In his 24 February 2009 address to a joint session of Congress, President Barack Obama called for every American to commit to at least 1 year of education or career training after completing high school. A 2012 report by the President's Council of Advisors on Science and Technology (PCAST 2012) notes that economic forecasts point to a need to increase the proportion of college graduates going into the natural sciences and engineering over the next decade. This section discusses the characteristics of U.S. higher education institutions providing S&E education and the financing of higher education.

Institutions Providing S&E Education

The U.S. higher education system consists of a large number of diverse academic institutions that vary in their missions, learning environments, selectivity levels, religious affiliations, types of students served, types of degrees offered, and sectors (public, private nonprofit, or private for-profit) (Aud et al. 2010). There were approximately 4,700 postsecondary degree-granting institutions in the United States in the 2011–12 academic year. Of these, 63% offered bachelor's or higher degrees, 30% offered only associate's degrees, and 7% offered degrees that were at least 2-year but less than 4-year as the highest degree awarded.[2] More than half of the 4-year institutions are private nonprofits, 23% are public, and 25% are private for-profits. The majority of 2-year degree-granting institutions are public (56%) or private for-profit (39%) (table 2-1) (NCES 2012). In 2011, U.S. academic institutions awarded nearly 3.5 million associate's, bachelor's, master's, and doctoral degrees; 23% of the degrees were in S&E (appendix table 2-1).[3]

Doctorate-granting institutions with very high research activity, though few in number, are the leading producers of S&E degrees at the bachelor's, master's, and doctoral levels. In 2011, these research institutions awarded 74% of doctoral degrees, 42% of master's degrees, and 38% of bachelor's degrees in S&E fields (appendix table 2-1). (See sidebar, "Carnegie Classification of Academic Institutions.") Master's colleges and universities awarded another 29% of S&E bachelor's degrees and 25% of S&E master's degrees in 2011.

Baccalaureate colleges were the source of relatively few S&E bachelor's degrees (12%) (appendix table 2-1), but they produce a larger proportion of future S&E doctorate recipients (15%) (NSF/NCSES 2013b). When adjusted by the number of bachelor's degrees awarded in all fields, baccalaureate colleges as a group yield more future S&E doctorates per 100 bachelor's degrees awarded than all other types of institutions except research universities.

High Hispanic enrollment institutions (HHEs) and historically black colleges and universities (HBCUs) play an important role in training Hispanic and black U.S. citizens and permanent residents for doctoral-level study in S&E fields.[4] Among Hispanic U.S. citizen and permanent resident S&E doctorate recipients who received their doctorates between 2007 and 2011, 29% had obtained their baccalaureate credential at an HHE (table 2-2). Similarly, among black U.S. citizen and permanent resident doctorate recipients who received their doctorates in S&E fields during the same period, 26% had obtained their baccalaureate degree at an HBCU (table 2-3). HBCUs are the second most important contributor of black S&E doctorate recipients after non-HBCU institutions with very high research activity (NSF/NCSES 2013b).

Table 2-1
Degree-granting institutions, by control and level of institution: 2011–12

Institution level	All degree-granting institutions	Public	Private nonprofit	Private for-profit
Total	4,706	1,649	1,653	1,404
2-year	1,738	967	100	671
4-year	2,968	682	1,553	733

SOURCE: U.S Department of Education, National Center for Education Statistics, *Digest of Education Statistics*, 2011, table 279, based on data from Integrated Postsecondary Education Data System Fall 2011 Institutional Characteristics component.

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Carnegie Classification of Academic Institutions

The Carnegie Classification of Institutions of Higher Education is widely used in higher education research to characterize and control for differences in academic institutions.

The 2010 classification update retains the structure adopted in 2005. It includes 4,634 institutions, 483 of which were added after the 2005 update. More than three-quarters of the new institutions (77%) are from the private for-profit sector, 19% from the private nonprofit sector, and 4% from the public sector.

The Carnegie Classification categorizes academic institutions primarily on the basis of highest degree conferred, level of degree production, and research activity.* In this report, several Carnegie categories have been aggregated for statistical purposes. The characteristics of those aggregated groups are as follows:

- *Doctorate-granting universities* include institutions that award at least 20 doctoral degrees per year. They include three subgroups based on level of research activity: very high research activity (108 institutions), high research activity (99 institutions), and doctoral/research universities (90 institutions). Because doctorate-granting institutions with very high research activity are central to S&E education and research, data on these institutions are reported separately.
- *Master's colleges and universities* include the 724 institutions that award at least 50 master's degrees and fewer than 20 doctoral degrees per year.
- *Baccalaureate colleges* include the 810 institutions at which baccalaureate degrees represent at least 10% of all undergraduate degrees and that award fewer than 50 master's degrees or 20 doctoral degrees per year.
- *Associate's colleges* include the 1,920 institutions at which all degrees awarded are associate's degrees or at which bachelor's degrees account for less than 10% of all undergraduate degrees.
- *Special-focus institutions* are the 851 institutions at which at least 75% of degrees are concentrated in a single field or a set of related fields (e.g., medical schools and medical centers, schools of engineering, and schools of business and management).
- *Tribal colleges* are the 32 colleges and universities that are members of the American Indian Higher Education Consortium.

*Research activity is based on two indexes (aggregate level of research and per capita research activity) derived from a principal components analysis of data on research and development expenditures, S&E research staff, and field of doctoral degree. See http://classifications.carnegiefoundation.org for more information on the classification system and on the methodology used in defining the categories.

Minority-serving academic institutions enroll a substantial fraction of minority undergraduates (NSF/NCSES 2013a).[5] In 2010, HBCUs awarded 19% of the 43,000 S&E bachelor's degrees earned by black U.S. citizens and permanent residents; HHEs awarded about 30% of the 46,000 S&E bachelor's degrees earned by Hispanic U.S. citizens and permanent residents. However, the percentages of blacks earning S&E bachelor's degrees from HBCUs and of Hispanics earning S&E bachelor's degrees from HHEs have declined since 2001. Tribal colleges, which mainly offer 2-year degrees, account for about 1% of S&E bachelor's degrees to American Indians; this proportion has been fairly stable over time.[6]

Community Colleges

Community colleges (also known as public 2-year colleges or associate's colleges) play a key role in increasing access to higher education for all citizens. These institutions serve diverse groups of students and offer a more affordable means of participating in postsecondary education. Community colleges are important in preparing students to enter the workforce with certificates or associate's

Table 2-2

U.S. citizen and permanent resident S&E doctorate recipients whose baccalaureate origin is a high Hispanic enrollment institution, by race and ethnicity: 2007–11

Race and ethnicity	All	Earned baccalaureate degree from a high Hispanic enrollment institution: Yes	No	Yes (%)
All races and ethnicities	101,216	3,773	97,443	3.7
American Indian or Alaska Native	376	21	355	5.6
Asian	10,258	178	10,080	1.7
Black or African American	4,958	181	4,777	3.7
Hispanic[a]	5,776	1,652	4,124	28.6
Native Hawaiian or Other Pacific Islander	218	15	203	6.9
White	75,973	1,601	74,372	2.1
More than one race	2,110	69	2,041	3.3
Unknown or unreported	1,547	56	1,491	3.6

[a] Hispanic may be any race. American Indian or Alaska Native, Asian, black or African American, Native Hawaiian or Other Pacific Islander, white, and more than one race refer to individuals who are not of Hispanic origin.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2013) of the Survey of Earned Doctorates, 2007–11.

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Table 2-3

U.S. citizen and permanent resident S&E doctorate recipients whose baccalaureate origin is an HBCU, by race and ethnicity: 2007–11

Race and ethnicity	All	Earned baccalaureate degree from an HBCU: Yes	No	Yes (%)
All races and ethnicities	101,216	1,480	99,736	1.5
American Indian or Alaska Native	376	D	D	D
Asian	10,258	9	10,249	0.1
Black or African American	4,958	1,304	3,654	26.3
Hispanic[a]	5,776	21	5,755	0.4
Native Hawaiian or Other Pacific Islander	218	D	D	D
White	75,973	88	75,885	0.1
More than one race	2,110	40	2,070	1.9
Unknown or unreported	1,547	D	D	D

[a] Hispanic may be any race. American Indian or Alaska Native, Asian, black or African American, Native Hawaiian or Other Pacific Islander, white, and more than one race refer to individuals who are not of Hispanic origin.

D = suppressed to avoid disclosure of confidential information.

HBCU = historically black college or university.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2013) of the Survey of Earned Doctorates, 2007–11.

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degrees or to transition to 4-year colleges or universities. Community colleges tend to be closely connected with local businesses, community organizations, and government, so they can be more responsive to local workforce needs (NRC and NAE 2012).

In the 2011–12 academic year, there were nearly 1,000 community colleges in the United States, enrolling more than 7 million students, or about a third of all postsecondary students (NCES 2012). Six out of 10 community college students were enrolled part time. With the economic recession, enrollment in community colleges increased by about 800,000 students between 2007 and 2009 but slowed down in 2010 and declined slightly in 2011 as the labor market improved (Knapp, Kelly-Reid, and Ginder 2009, 2011).

Community colleges play a significant role in the education of individuals who go on to acquire advanced S&E credentials. Among U.S. citizen and permanent resident S&E doctorate holders who received their doctorates between 2007 and 2011, nearly 20% indicated that they had earned college credit from a community or 2-year college (table 2-4). According to data from the National Survey of Recent College Graduates (NSRCG), the proportion of recent bachelor's S&E graduates who reported ever attending a community college has increased since the late 1990s (table 2-5). Nearly half of 2008 and 2009 S&E graduates said that they had attended a community college (49% of the bachelor's recipients and 36% of the master's recipients). Graduates in physical sciences, engineering, and computer and mathematical sciences were less likely than those in the biological and social sciences to have attended a community college. Between 2003 and 2010, the proportion of S&E graduates who attended community colleges remained stable in all broad fields (figure 2-1).

In 2010, female S&E bachelor's and master's degree recipients were more likely to have attended a community college than their male counterparts (table 2-6). Attendance was higher among U.S. citizens and permanent visa holders than among temporary visa holders. Attendance was

Table 2-4
U.S. citizen and permanent resident S&E doctorate recipients who reported earning college credit from a community or 2-year college, by race and ethnicity: 2007–11

		Earned college credit from a community or 2-year college		
Race and ethnicity	All	Yes	No	Yes (%)
All races and ethnicities	99,029	18,484	80,545	18.7
American Indian or Alaska Native	360	125	235	34.7
Asian	10,197	1,279	8,918	12.5
Black or African American	4,755	819	3,936	17.2
Hispanic[a]	5,517	1,236	4,281	22.4
Native Hawaiian or Other Pacific Islander	200	58	142	29.0
White	74,649	14,237	60,412	19.1
More than one race	2,076	461	1,615	22.2
Unknown or unreported	1,275	269	1,006	21.1

[a] Hispanic may be any race. American Indian or Alaska Native, Asian, black or African American, Native Hawaiian or Other Pacific Islander, white, and more than one race refer to individuals who are not of Hispanic origin.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2007–11.

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Table 2-5
Community college attendance among recent recipients of S&E bachelor's and master's degrees, by degree level and degree year: 1999–2010

	1999		2001		2003		2006		2008		2010	
Degree level	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All recent graduates	900,400	41	918,400	44	958,400	45	1,634,200	45	1,138,400	46	1,136,700	46
Bachelor's	743,400	43	758,300	46	794,400	47	1,343,000	47	934,300	49	916,500	49
Master's	157,000	35	160,100	34	164,000	34	291,200	34	204,100	35	220,300	36

NOTES: Recent graduates are those who earned degrees in the 2 academic years preceding the survey year or, for the 2006 survey year, in the 3 preceding academic years. For 2006, recent graduates are those who earned degrees between 1 July 2002 and 30 June 2005. Data are rounded to the nearest 100. Detail may not add to total because of rounding.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2013) of the National Survey of Recent College Graduates, 1999, 2001, 2003, 2006, 2008, and 2010.

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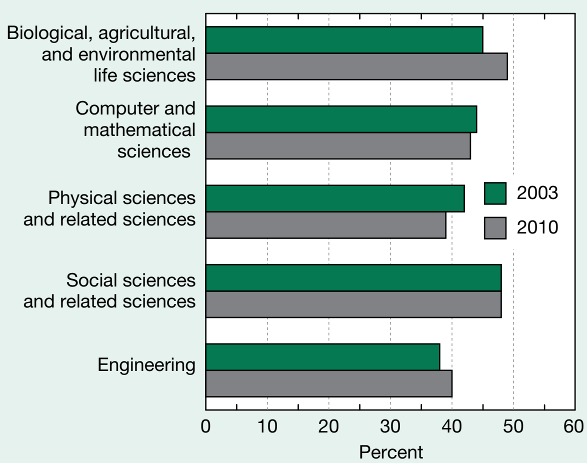
lower for Asian S&E graduates than for whites, blacks, or Hispanics. The likelihood of attending a community college before receiving an S&E bachelor's or master's degree was related to parental education level. Nearly 6 out of 10 of the S&E graduates who reported that their fathers or mothers had less than a high school diploma attended a community college, compared with about one-third of those whose fathers or mothers had a professional or a doctoral degree.

For-Profit Institutions

In 2011, about 3,400 higher education institutions in the United States operated on a for-profit basis. Nearly half of these institutions offer only less-than-2-year programs, and about 4 out of 10 are degree-granting institutions.[7] Two-year, for-profit institutions enroll considerably fewer students than community colleges. Over the last 12 years, however, the number of for-profit institutions has grown rapidly, and the number of degrees they award has more than tripled (NCES 2012; appendix table 2-2). A large part of that increase is accounted for by the growth of the University of Phoenix.

In 2011, for-profit academic institutions awarded between 2% and 6% of S&E degrees at the bachelor's, master's, and doctoral levels, as well as 33% of S&E degrees at the associate's level (appendix tables 2-1 and 2-2). Computer sciences accounted for 73% of the associate's degrees and 51% of the bachelor's degrees awarded by for-profit institutions in S&E fields in 2011 (appendix table 2-3). For-profit institutions awarded fewer S&E master's and doctoral degrees than associate's and bachelor's. At the master's level, S&E degrees were mainly in psychology, social sciences, and computer sciences; at the doctoral level, they were almost exclusively in psychology and social sciences. In 2011, degrees in psychology represented nearly half of the master's and three-quarters of the doctoral degrees awarded by for-profit institutions in S&E fields. Degrees in social science accounted for one-quarter of the master's and a similar proportion of the doctoral degrees awarded in S&E fields.

Figure 2-1
Community college attendance among recent recipients of S&E degrees, by field of most recent degree: 2003 and 2010



NOTE: Recent graduates are those who earned degrees in the 2 academic years preceding the survey year.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, National Survey of Recent College Graduates, 2003 and 2010.

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Table 2-6
Community college attendance among recent recipients of S&E degrees, by sex, race, ethnicity, and citizenship status: 2010

Characteristic	Number	Percent
All graduates	1,136,700	46
Sex		
Female	564,600	49
Male	572,100	43
Race, ethnicity		
American Indian or Alaska Native	1,900	39
Asian	155,300	39
Black or African American	72,000	46
Hispanic[a]	120,600	51
Native Hawaiian or Other Pacific Islander	4,900	64
White	746,400	46
More than one race	35,700	52
Citizenship status		
U.S. citizen	1,033,400	48
Permanent visa	27,200	42
Temporary visa	76,100	15
Father's education		
Less than high school	65,200	59
High school diploma or equivalent	210,300	52
Some college, vocational, or trade school	221,500	50
Bachelor's	292,100	45
Master's	175,500	43
Professional degree	86,300	31
Doctorate	64,600	34
Not applicable	21,100	47
Mother's education		
Less than high school	63,600	58
High school diploma or equivalent	226,600	53
Some college, vocational, or trade school	284,400	49
Bachelor's	313,400	41
Master's	175,200	42
Professional degree	34,700	36
Doctorate	27,900	33
Not applicable	10,900	37

[a] Hispanic may be any race. American Indian or Alaska Native, Asian, black or African American, Native Hawaiian or Other Pacific Islander, white, and more than one race refer to individuals who are not of Hispanic origin.

NOTES: Recent graduates are those who earned degrees between 1 July 2007 and 30 June 2009. Data are rounded to the nearest 100.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2013) of the National Survey of Recent College Graduates, 2010.

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Online and Distance Education

Online education and distance education enable institutions of higher education to reach a wider audience by expanding access for students in remote geographic locations and providing greater flexibility for students who face time constraints, physical impairments, responsibility to care for dependents, and similar challenges. Online education is a relatively new phenomenon, and online enrollment has grown substantially in recent years. In 2011–12, about 62% of 2- and 4-year Title IV institutions (i.e., institutions that participate in federal financial aid programs) offered some distance education opportunities to their students (table 2-7) (Ginder and Sykes 2013).[8] The vast majority of public institutions offered some distance education to their students, as did more than half of the private nonprofit and about 71% of the private for-profit 4-year institutions. In the United States, 30 Title IV institutions were exclusively distance education institutions; most of these institutions were private for-profits, and more than 90% of the degrees awarded were in non-S&E fields (Ginder and Sykes 2013).

More recently, changes in the online education landscape have accelerated with the appearance of massive open online courses (MOOCs). MOOCs can provide broad access to higher education. Through their online platforms, they also have the potential to collect massive amounts of information that can be used to conduct experimental research on how people learn and to identify online practices that improve learning (U.S. Department of Education 2013).

MOOCs originated when a Stanford professor, Sebastian Thrun, and the director of research at Google, Peter Norvig, opened admission to their course on artificial intelligence in fall 2011. Until then, enrollment was typically 200 students. When free online access was offered, 160,000 students from 190 countries registered for the class, and about 23,000 completed it. Previous efforts by academic institutions, such as the Open Learning Initiative at Carnegie Mellon University and OpenCourseWare at the Massachusetts Institute of Technology, had included online courses for public access; however, the Stanford class also allowed students to take quizzes, submit homework, and attend virtual office hours. In the wake of the popular response to this class, other selective universities have collaborated in joint ventures (e.g., Udacity, Coursera, edX) to offer free versions of their courses online, reaching large populations of students around the world. These companies are growing rapidly, adding new courses and students, and increasing the number of university partners in the United States and abroad (Lewin 2013). In fall 2012, edX and Udacity gave students the option of paying a small fee to take a proctored final exam that will validate their learning (Parry 2012). In February 2013, the American Council on Education approved five Coursera courses for college credit (Kolowich 2013). It is not clear whether colleges will generally be willing to grant credit for those courses.

Changing modes of online education are prompting questions about how the use of this technology will affect the higher education sector. In particular, it is not yet clear how many students can sustain commitment to learning in the absence of more personal contact and to what extent the growing access to higher education facilitated by MOOCs will translate into learning and, in the long run, to higher levels of educational achievement.

Trends in Higher Education Expenditures and Revenues

Higher education spending and revenue patterns changed substantially over the last two decades, in trends that intensified during the economic downturn of the late 2000s. Although all types of higher education institutions faced competing demands in a stringent budget environment, each type faced unique challenges. Increases in the number

Table 2-7
Title IV Institutions, by distance education status, control, and level of institution: 2011–12

Institutional control and level	All	No distance education	Some distance education	Exclusively distance education
All 2- and 4-year institutions	5,288	1,966	3,292	30
Public	1,755	138	1,616	1
2-year	1,072	74	998	0
4-year	683	64	618	1
Private nonprofit	1,751	823	921	7
2-year	185	149	36	0
4-year	1,566	674	885	7
Private for-profit	1,782	1,005	755	22
2-year	1,048	811	235	2
4-year	734	194	520	20

NOTES: Title IV institutions are those with a written agreement with the Secretary of Education that allows the institution to participate in any of the Title IV federal student financial assistance programs. Data are for institutions surveyed during 2011–12.

SOURCES: U.S. Department of Education, National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System, Fall 2011, Institutional Characteristics Component; NCES, 2013. *Characteristics of Exclusively Distance Education Institutions, by State: 2011–12*. NCES 2013-172. Washington DC. http://nces.ed.gov/pubs2013/2013172.pdf. Accessed 17 September 2013.

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of students seeking an affordable college education compounded the challenges created by tight budgets. This section shows trends in inflation-adjusted average spending and revenue per full-time equivalent (FTE) student from 1987 to 2010, based on data from the Delta Cost Project.[9]

Very High Research Universities—Public and Private Institutions

Net tuition and federal appropriations, grants, and contracts are the largest sources of revenues centrally involved with education for both public and private very high research institutions (appendix table 2-4).[10] For public institutions, state and local appropriations are also critical, supplying a similar amount of revenue as either of the other two sources (nearly $10,000 per FTE in 2010); in contrast, they are a small source of revenue for their private counterparts (about $400 per FTE in 2010). Much more important for private institutions are private and affiliated gifts, investment returns, and endowment income, which are usually the largest source of revenue.[11]

State and local appropriations for public very high research universities have declined since 1987, with a particularly steep drop between 2007 and 2010 (figure 2-2). This decline coincided with a compensating increase in net tuition. In 1987, average state appropriations per FTE at public very high research institutions were more than three times the amount of net tuition ($13,600 versus $4,000). By 2010, however, appropriations had dropped to $9,800 per FTE, whereas net tuition had increased from $4,000 to $9,600 per FTE (appendix table 2-4). This change represents a shift in tuition burden from state and local governments to individual students and their families. Starting at a higher level, net tuition at private very high research universities also increased during this period. But the increase, from $16,000 to $23,000, was proportionally much smaller.

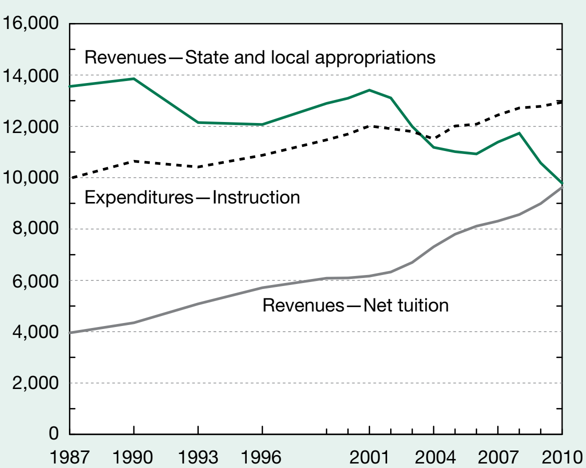
Revenue from federal appropriations, grants, and contracts, the source used for most research expenditures, is highest at the most research-intensive universities (appendix table 2-4). Between 1987 and 2010, these funds increased at both the public and the private very high research institutions. At the public very high research institutions, these funds per FTE almost doubled, reaching the same level as the state and local appropriations (about $10,000). At private very high research institutions, they increased somewhat less, by more than 60% in this 24-year period.

Research and instruction are the two largest core education expenditures at both public and private very high research universities. Between 1987 and 2010, research expenditures increased substantially at both types of institutions—by 89% at the private universities and by 79% at their public counterparts (figure 2-3; appendix table 2-5).[12]

Instructional spending per FTE followed a pattern similar to that of research expenditures. It was much higher at private very high research institutions than at their public counterparts, and it also increased at a higher rate. In the late 1980s and early 1990s, instructional spending at private very high research universities was slightly more than double that of the public ones. By the mid-2000s, it was more than triple (figure 2-4).

Most other expenditures also increased at both types of very high research institutions; however, at the public ones, spending on plant operation and maintenance declined from 2007 to 2010, with a sharp drop in 2010 (appendix table 2-5).

Figure 2-2
Selected average revenues and expenditures at public very high research universities: 1987–2010
2010 dollars



NOTE: Data are per full-time equivalent student.

SOURCE: IPEDS Analytics: Delta Cost Project Database, 1987–2010, special tabulations (2013).

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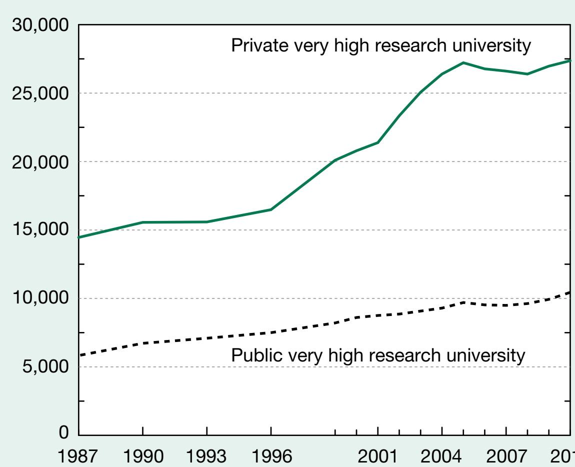
Figure 2-3
Average expenditures per FTE on research at public and private very high research universities: 1987–2010
2010 dollars



FTE = full-time equivalent student.

SOURCE: IPEDS Analytics: Delta Cost Project Database, 1987–2010, special tabulations (2013).

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Four-Year and Other Graduate Public Institutions

From 1987 to 2010, state and local appropriations and net student tuition were the largest sources of revenues centrally involved with education at other public institutions offering 4-year and graduate degrees (appendix table 2-4).[13] At these institutions, total revenues from these two sources were lower than those at public very high research universities and higher than those at community colleges. Overall, the percentage drop in revenue per FTE from state and local appropriations was similar to that experienced at the public very high research institutions. In 2010, net student tuition replaced state and local appropriations as the largest source of revenue in the public 4-year institutions. Average state appropriations per FTE in 1987 ($8,400) were three times higher than the corresponding amount of tuition revenue ($2,800). By 2010, average revenues from net student tuition, at $6,600 per FTE, exceeded average revenues from state appropriations per FTE by more than $500 (figure 2-5).

Spending on instruction at these institutions has been at least three times as high as almost all the other standard expense categories. It increased from an average of $5,800 per FTE in 1987 to $6,800 per FTE in 2010 (appendix table 2-5). Other expenditures represented much smaller shares of total spending; most of these expenditures increased. Spending on plant operation and maintenance fell by 4% over the 24-year period, with a large decline from 2007 to 2010 (18%).

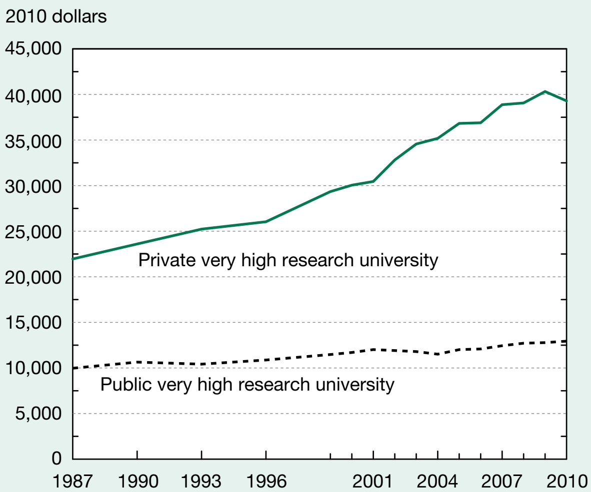
Community Colleges

Both revenues and expenditures are much lower for community colleges than for other public institutions of higher education.[14] As in these other institutions, the main sources of revenue at community colleges are state and local appropriations and net student tuition (appendix table 2-4). In 2010, average revenues from state and local appropriations at community colleges were about $5,600 per FTE, compared with $9,800 at public very high research institutions; average revenues from net tuition were $3,300 per FTE, compared with $9,600 at public very high research institutions.

Between 1987 and 2010, revenues from state and local appropriations at community colleges decreased from an average of $6,800 per FTE to $5,600 per FTE, with a steep drop from 2007 to 2010 (figure 2-6). During this 24-year period, as state support declined, revenues from net tuition more than doubled. In 1987, revenues from state and local appropriations represented 64% of total revenues at community colleges, and tuition accounted for 15%. By 2010, state and local appropriations had dropped to 46% of total revenues, whereas the proportion of revenues from tuition nearly doubled, to 27%.

At community colleges, instruction is by far the largest expenditure (appendix table 2-5). In 1987, spending on instruction was $4,700 per FTE, about 43% of total expenditures. In 2010, average instructional spending per FTE ($4,800) was nearly identical to the 1987 level. Overall, these expenditures had increased somewhat through 2008 but dropped by 10% between 2008 and 2010 (figure 2-6). Expenditures on student services, institutional and academic

Figure 2-4
Average expenditures per FTE on instruction at public and private very high research universities: 1987–2010



FTE = full-time equivalent student.

SOURCE: IPEDS Analytics: Delta Cost Project Database, 1987–2010, special tabulations (2013).

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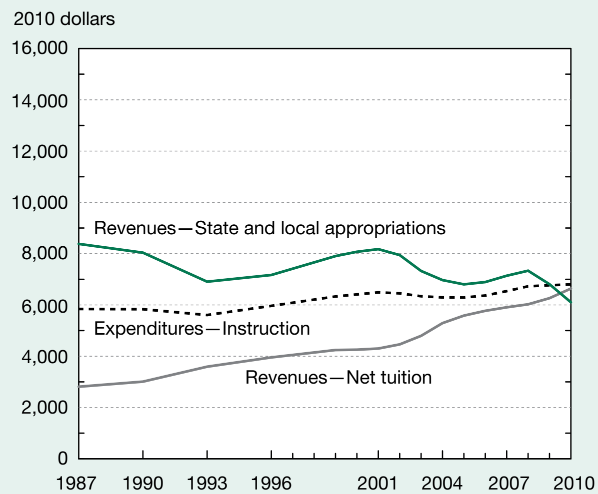
Figure 2-5
Selected average revenues and expenditures at public 4-year and other postsecondary institutions: 1987–2010



NOTES: Average expenditures and revenues are per full-time equivalent. Four-year and other postsecondary institutions include doctorate-granting universities/high research activity, doctoral/research universities, master's colleges/universities, and baccalaureate colleges, according to the 2005 Carnegie Classification of Institutions.

SOURCE: IPEDS Analytics: Delta Cost Project Database, 1987–2010, special tabulations (2013).

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support, and plant operation and maintenance also declined between 2007 and 2010.

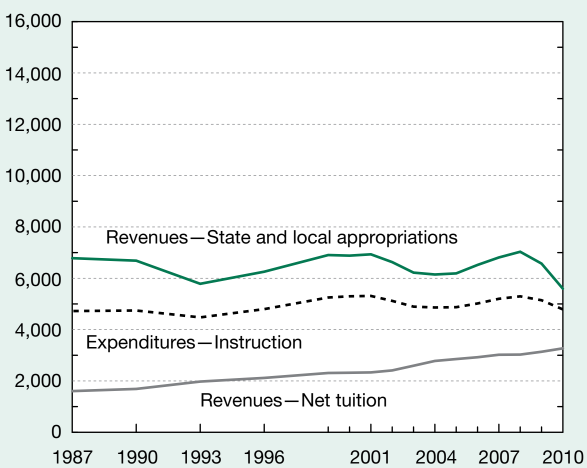
Public Institutions Comparison

Between 1987 and 2010, revenues from state and local appropriations and net tuition, the main two revenue sources at public institutions, grew less at community colleges than at the other two types of public institutions. In community colleges, these two revenue sources combined increased by 6% during this period, lower than the comparable increases at the public 4-year and other graduate institutions (14%) and the very high research institutions (11%). However, trends in these individual revenue sources were substantially different. States and localities cut funding for all three categories of institutions, but the reduction was smaller in the community colleges (18%) than in the very high research public institutions (28%) and the 4-year and other graduate public institutions (27%). Unlike the community colleges, though, the other two types of public institutions were able to increase revenues from net tuition. FTE net tuition revenues increased by 143% at the public very high research universities and by 136% at the 4-year and other graduate public institutions, compared with 104% at community colleges (appendix table 2-4).

Expenditures for instruction followed a different pattern. They rose most rapidly at the very high research institutions (30%), where there was pressure to keep faculty salaries (a major component of instructional expenses) competitive with those of their private counterparts, which spent more on instruction to begin with and were increasing these expenses at an even more rapid rate (79%) (appendix table 2-5). At community colleges, FTE instructional expenses were essentially the same at the end of the period as they were at the beginning;[15] in 4-year and other graduate institutions, they fell somewhere in between. Overall, during this period, community colleges had more limited resources and less flexibility to draw on alternate revenue sources to support their instructional expenses, which were growing because of large increases in enrollment (see section "Undergraduate Enrollment in the United States").

In recent years, universities have been under pressure to improve the way they monitor and manage their performance and are attempting to contain costs without compromising quality or accessibility. In May 2012, the National Research Council released a report titled "Improving Measurement of Productivity in Higher Education" (NRC 2012a), which examined key issues regarding the measurement of productivity (for a summary of the panel's conclusions and recommendations, see sidebar, "Improving Measurement of Productivity in Higher Education").

Figure 2-6
Selected average revenues and expenditures at community colleges: 1987–2010
2010 dollars



NOTES: Revenues and expenditures are per full-time equivalent. Community colleges are public associate's colleges in the 2005 Carnegie Classification of Institutions.

SOURCE: IPEDS Analytics: Delta Cost Project Database, 1987–2010, special tabulations (2013).

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Financing Higher Education

Cost of Higher Education

Affordability and access to U.S. higher education institutions are continuing concerns (NCPPHE 2008; NRC 2012a). Estimated average net tuition and fees (i.e., the published prices minus grant aid and tax benefits) paid by full-time undergraduate students in public 4-year colleges declined from 2007–08 to 2009–10 and in their private counterparts from 2007–08 to 2010–11 because of unusually large increases in grant aid and tax credits. However, since then, net tuition and fees have increased at both public and private nonprofit institutions. At public 2-year colleges, net tuition and fees followed a similar pattern, but since 2008–09, the average student enrolled full time has received enough funding through federal tax benefits and grant aid from all sources to cover other expenses, in addition to tuition and fees (–$1,220 net tuition in 2012–13) (table 2-8) (College Board 2012a).[16]

For at least the past 10 years, tuition and fees for colleges and universities in the United States have grown rapidly (see section "Trends in Higher Education Expenditures and Revenues"), whereas real median household income declined 8.9% between 1999 and 2011 (DeNavas-Walt, Proctor, and Smith 2012). Some evidence suggests that increases in net tuition and fees, however, have fallen disproportionately on households at higher levels in the income distribution, where financial aid is less readily available (College Board 2012a).[17]

Undergraduate Financial Support Patterns and Debt

Financial Support for Undergraduate Education. With rising tuition, students increasingly rely on financial aid (particularly loans) to finance their education. Financial aid for undergraduate students comes mainly in the form of grants, student loans, and work-study. A financial aid package may contain one or more of these kinds of support. In the 2011–12 academic year, federal loans constituted 38% of the $185 billion in student aid that undergraduate students received, followed by federal grants (26%), institutional grants (18%), state grants (5%), private employer grants (4%), and federal work-study programs (1%) (College Board 2012b). According to the latest data available from the NCES National Postsecondary Student Aid Study, a higher proportion of undergraduates in private for-profit institutions (96%) and in private nonprofit 4-year institutions (85%) than those in public 4-year (71%) or public 2-year (48%) institutions received some type of financial aid (Wei et al. 2009).

Undergraduate Debt. Among recent graduates with S&E bachelor's degrees, the level of undergraduate debt does not vary much by undergraduate major (NSF/NCSES 2010); however, levels of debt vary by type of institution and state. Levels of undergraduate debt for students from public colleges and universities are almost as high as those for students from private colleges and universities. Nearly 6

Improving Measurement of Productivity in Higher Education

An expert panel convened by the National Research Council produced a report on measuring productivity in higher education (NRC 2012a). The panel defined productivity as a ratio of outputs (degrees completed, credit hours passed, or other indicators of successful completion) to inputs (labor and nonlabor factors of production).

The panel identified the many complexities characteristic of higher education processes that complicate the measurement of productivity in this sector. Among them are the following:

- The need to disentangle the joint production of outputs (e.g., educated citizens, research findings, athletic events, hospital services) and inputs (e.g., labor, public service)
- The high variability in the quality and characteristics of inputs (e.g., teachers and students) and outputs (e.g., degrees)
- The difficulty of making meaningful comparisons across institutions, given that the diversity of its institutions is in itself one of the system's main strengths
- The need to account for the differences in students' preparedness for college and to measure the academic value added in terms of student achievement of learning outcomes and competencies

The panel made several recommendations to develop the data infrastructure necessary to measure productivity and to improve data collection across the federal statistical system, in particular by the National Center for Education Statistics (NCES) and the Bureau of Labor Statistics (BLS). The panel noted that, at the moment, the graduation rates produced by the NCES Integrated Postsecondary Education Data System (IPEDS) survey restrict the denominator to first-time, full-time students, so graduation rates are not meaningful productivity indicators for institutions that enroll more part-time students or in instances in which students transfer to a different institution. More accurate productivity measurement will require the development of comprehensive longitudinal student databases to be able to calculate more precise graduation rates, follow students through their college years and into their careers, and compile detailed reports on which colleges produce the most successful graduates. To do that, the panel recommended that the BLS facilitate multistate links of unemployment insurance records and education data. That step will enable research on issues such as return on investment from postsecondary training or placement rates in different occupations. Given the importance of higher education, the panel also advocated efforts to include colleges and universities in the U.S. Economic Census, as was the case in 1977.

Table 2-8
Net tuition and fees for full-time undergraduate students by institutional control: 2007–08 through 2012–13
(2012 U.S. dollars)

Institutional control	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13[a]
Public 2-year	10	-450	-890	-1,460	-1,350	-1,220
Public 4-year	2,470	2,340	1,950	2,120	2,620	2,910
Private, nonprofit 4-year	13,870	13,440	12,650	12,540	12,600	13,380

[a] Estimated value.

NOTES: Prices have been rounded to the nearest $10. Net tuition and fees equal published tuition and fees minus total grant aid and tax benefits.

SOURCE: The College Board, *Annual Survey of Colleges, Trends in College Pricing* (2012).

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out of 10 students who earned bachelor's degrees in 2010–11 from the public 4-year colleges where they began their studies graduated with debt, and their average total debt was $23,800. Among students who earned their bachelor's from the private 4-year institutions where they began their studies, two-thirds graduated with debt, and their average total debt was $29,900. Students who attend private for-profit institutions are more likely to borrow, and to borrow larger amounts, than those who attend public and private nonprofit institutions (College Board 2012b).

Levels of debt varied widely by state. Average debt for 2011 graduates of public 4-year colleges and universities ranged from $16,317 in Utah to $32,385 in New Hampshire. Average debt for graduates of private nonprofit colleges and universities ranged from $18,614 in Utah to $34,017 in Connecticut (Reid and Cochrane 2012). Cost of living may account for some of the differences by state.

Graduate Financial Support Patterns and Debt

Financial Support for S&E Graduate Education. More than one-third of all S&E graduate students are primarily self-supporting; that is, they rely primarily on loans, their own funds, or family funds for financial support. The other approximately two-thirds receive primary financial support from a variety of sources, including the federal government, university sources, employers, nonprofit organizations, and foreign governments.

Support mechanisms include research assistantships (RAs), teaching assistantships (TAs), fellowships, and traineeships. Sources of funding include federal agency support, nonfederal support, and self-support. Nonfederal support includes state funds, particularly in the large public university systems; these funds are affected by the condition of overall state budgets. Most graduate students, especially those who pursue doctoral degrees, are supported by more than one source or mechanism during their time in graduate school, and some receive support from several different sources and mechanisms in any given academic year.

Other than self-support, over time RAs have been the most prevalent primary mechanism of financial support for full-time S&E graduate students (appendix table 2-6). In 2011, 27% of full-time S&E graduate students were supported primarily by RAs, 18% primarily through TAs, and 12% primarily by fellowships or traineeships (table 2-9).

Primary mechanisms of support differ widely by S&E field of study (figure 2-7; appendix table 2-7). For example, in fall 2011, full-time students in physical sciences were financially supported mainly through RAs (40%) and TAs (38%). RAs also were important in agricultural sciences (51%); earth, atmospheric, and ocean sciences (39%); biological sciences (38%); and engineering (38%, and in particular in materials and chemical engineering). In mathematics, nearly half (49%) of full-time students were supported primarily through TAs and another quarter were self-supported. Full-time students in computer sciences and the social and behavioral sciences were mainly self-supporting (49% and 48%, respectively) or received TAs (14% and 20%, respectively). Students in medical and other health sciences were mainly self-supporting (59%).

The federal government plays a substantial role in supporting S&E graduate students in some fields but a smaller role in others. Federal financial support for graduate education reaches a larger proportion of students in the biological sciences; the physical sciences; the earth, atmospheric, and ocean sciences; and engineering. Lower proportions of students in computer sciences, mathematics, medical and other health sciences, psychology, and social sciences receive federal support (figure 2-8). Appendix table 2-8 provides detailed information by field and mechanism.

Table 2-9
Full-time S&E graduate students, by source and mechanism of primary support: 2011

Source	All	Research assistantship	Fellowship	Traineeship	Teaching assistantship	Other	Self-support[a]
All sources (number)	444,991	121,010	40,583	12,557	80,719	29,799	160,323
Federal	84,816	61,799	9,766	7,600	1,091	4,560	NA
Nonfederal	199,852	59,211	30,817	4,957	79,628	25,239	NA
All sources (%)	100.0	27.2	9.1	2.8	18.2	6.7	36.1
Federal	100.0	72.9	11.5	9.0	1.3	5.4	NA
Nonfederal	100.0	29.6	15.4	2.5	39.8	12.6	NA

NA = not available; self-support is not included in federal or nonfederal counts.

[a] Includes any loans (including federal) and support from personal or family financial contributions.

NOTES: S&E includes health fields (i.e., medical sciences and other health sciences). These fields are reported separately in data from the National Science Foundation's Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS). S&E excludes fields that are collected by the GSS (architecture, communication, and family and consumer sciences/human sciences) that are not included in other tables in this report from other data sources. Percentages may not add to 100% because of rounding.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Graduate Students and Postdoctorates in Science and Engineering, 2011.

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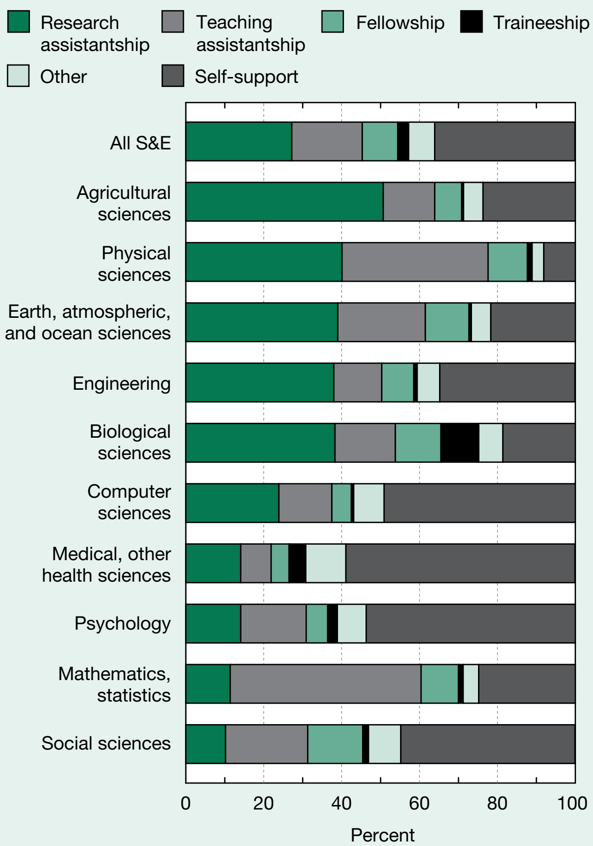
The federal government was the primary source of financial support for 19% of full-time S&E graduate students in 2011, whereas 45% were supported by nonfederal sources (institutional, state or local government, other U.S. sources, or other non-U.S. sources) and 36% were self-supported (appendix table 2-6). The number of full-time S&E graduate students supported by the federal government increased between 1998 and 2004 but has been fairly stable since then, whereas the number of students supported by nonfederal sources or through self-support has gradually increased between 1997 and 2011 (figure 2-9).

For some mechanisms of support, the federal role is fairly large. In 2011, the federal government funded 61% of S&E graduate students who were on traineeships, 51% of those with RAs, and 24% of those with fellowships (appendix table 2-8).

Figure 2-7
Full-time S&E graduate students, by field and mechanism of primary support: 2011



NOTE: Self-support includes any loans (including federal) and support from personal or family financial contributions.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Graduate Students and Postdoctorates in Science and Engineering, 2011.

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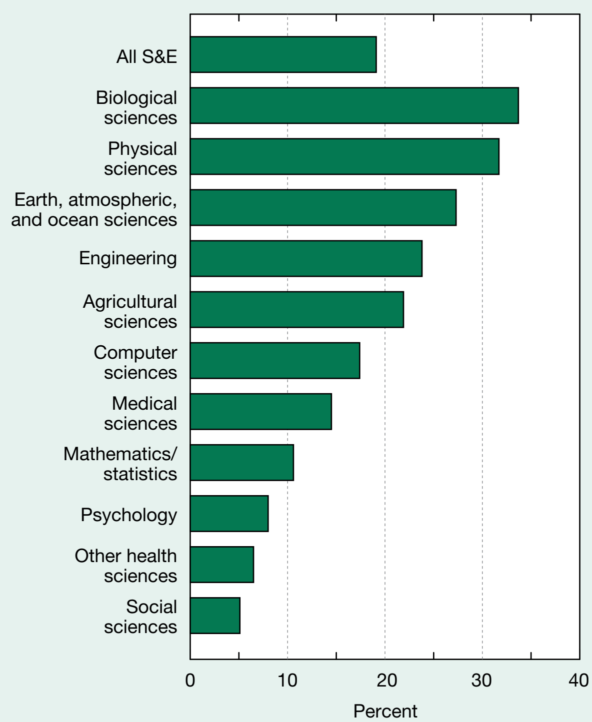
Most federal financial support for graduate education is in the form of RAs funded through grants to universities for academic research. RAs are the primary mechanism of support for 73% of federally supported full-time S&E graduate students. Fellowships and traineeships are the means of funding for 21% of the federally funded full-time S&E graduate students. For students supported through nonfederal sources in 2011, TAs were the most prominent mechanism (40%), followed by RAs (30%) (table 2-9; appendix table 2-6).

The National Institutes of Health (NIH) and NSF support most of the full-time S&E graduate students whose primary support comes from the federal government, followed by the U.S. Department of Defense (DOD) (appendix table 2-9). In 2011, NIH supported about 26,000 students, NSF about 24,000, and DOD about 9,000. Trends in federal agency support of graduate students show considerable increases from 1997 to 2011 in the proportion of students funded by NSF, from 21% to 29% (appendix table 2-9). NSF supported nearly 60% of students in computer sciences or mathematics whose primary support comes from the federal government; 50% of those in earth, atmospheric, and ocean sciences; 39% of those in the physical sciences; and 34% of those in engineering overall (about 43% of those in chemical and electrical engineering) (appendix table 2-10). The proportion

Figure 2-8
Full-time S&E graduate students with primary support from federal government, by field: 2011



SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Graduate Students and Postdoctorates in Science and Engineering, 2011.

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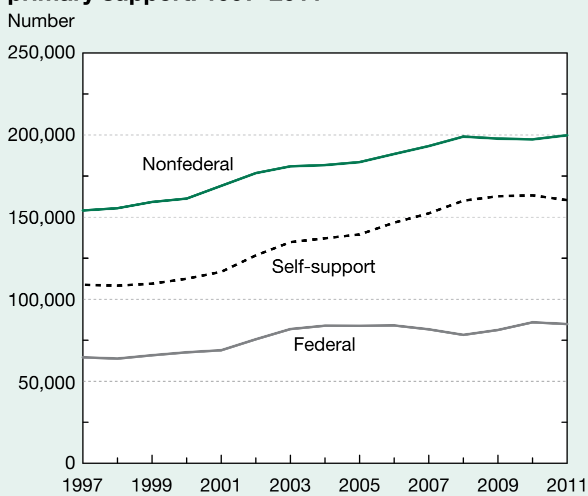
of students funded by NIH increased from 28% to 33% between 1997 and 2008 but since then has decreased to 30%. In 2011, NIH funded about 71% of such students in the biological sciences, 53% of those in the medical sciences, and 43% of those in psychology. The proportion of graduate students supported by DOD decreased slightly between 1997 and 2011. In 2011, DOD supported almost half of the S&E graduate students in aerospace engineering, about one-third of those in industrial and electrical engineering, and close to one-quarter of those in mechanical engineering and in computer sciences.

For doctoral degree students, notable differences exist in primary support mechanisms by type of doctorate-granting institution (table 2-10). In 2011, RAs were the primary support mechanism for S&E doctorate recipients from research universities (i.e., doctorate-granting institutions with very high research activity, which receive the most federal funding, as well as those with high research activity). For those from medical schools, which are heavily funded by NIH, fellowships or traineeships accounted for the main source of support. Students at less research-intensive universities relied mostly on personal funds. These differences by type of institution hold for all S&E fields (NSF/NCSES 2000; NSB 2010).

Figure 2-9
Full-time S&E graduate students, by source of primary support: 1997–2011



NOTES: Self support includes any loans (including federal) and support from personal or family financial contributions. In 2007, the survey was redesigned to improve reporting. In this figure, "2007" shows data as collected in 2007. Because of methodological changes, counts should be used with caution for trend analysis. See http://www.nsf.gov/statistics/nsf10307/ for more detail. S&E excludes fields that were collected in this survey starting in 2007 (architecture, communication, and consumer sciences/human sciences) that are not included in other tables in this report.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Graduate Students and Postdoctorates in Science and Engineering, 2011.

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Notable differences also exist in primary support mechanisms for doctoral degree students by sex, race or ethnicity, and citizenship (appendix table 2-11). In 2011, among U.S. citizens and permanent residents, men were more likely than women to be supported by RAs (31% compared with 22%). Women were more likely than men to be supported by fellowships or traineeships (29% compared with 24%) and to support themselves from personal sources (18% compared with 12%). Also, among U.S. citizens and permanent residents, whites and Asians were more likely than other racial or ethnic groups to receive primary support from RAs (28% and 32%, respectively), whereas underrepresented minorities depended more on fellowships or traineeships (35%). The primary source of support for doctoral degree students with temporary visas was an RA (50%).

To some extent, the sex, citizenship, and racial and ethnic differences in types of support mechanisms are related to differences in field of study. White and Asian men, as well as foreign doctoral degree students, are more likely than white and Asian women and underrepresented minority doctoral degree students of both sexes to receive doctorates in engineering and physical sciences, fields largely supported by RAs. Women and underrepresented minorities are more likely than other groups to receive doctorates in social sciences and psychology, fields in which self-support is prevalent. However, differences in type of support by sex, race or ethnicity, or citizenship remain, even after accounting for doctoral field (NSF/NCSES 2000, NSB 2010).

Graduate Debt. At the time of doctoral degree conferral, 45% of S&E doctorate recipients have debt related to their undergraduate or graduate education. In 2011, 28% of S&E doctorate recipients reported having undergraduate debt, and 32% reported having graduate debt. For some, debt levels were high, especially for graduate debt: 5% reported more than $40,000 of undergraduate debt, and 7% reported more than $70,000 of graduate debt (appendix table 2-12).

Levels of debt vary widely by doctoral field. A higher percentage of doctorate recipients in non-S&E fields (49%) than those in S&E fields (32%) reported graduate debt. In 2011, within S&E, high levels of graduate debt were most common among doctorate recipients in social sciences, psychology, and medical and other health sciences. The proportion of doctorate recipients in these fields who reported graduate debt has increased since 2001. Psychology doctorate recipients were most likely to report having graduate debt and also high levels of debt.[18] In 2011, 24% of psychology doctoral degree recipients reported graduate debt of more than $70,000 (appendix table 2-12). Doctorate recipients in mathematics and computer sciences were the least likely to report graduate debt. Since 2001, the proportion of doctorate recipients reporting graduate debt higher than $30,000 has increased in all broad fields except engineering and mathematics (appendix table 2-13).

Men and women differed little in level of undergraduate debt, but women were more likely to have accumulated more graduate debt. U.S. citizens and permanent residents accumulated more debt than temporary visa holders. Blacks, Hispanics, and American Indian and Alaska Natives had higher levels of graduate debt than whites, even accounting for differences in field of doctorate (NSF/NCSES 2012).

Undergraduate Education, Enrollment, and Degrees in the United States

Undergraduate education in S&E courses prepares students majoring in S&E for the workforce. It also prepares nonmajors to become knowledgeable citizens with a basic understanding of science and mathematics concepts. This section includes indicators related to enrollment by type of institution, field, and demographic characteristics; intentions to major in S&E fields; and recent trends in the number of earned S&E degrees.

Undergraduate Enrollment in the United States

Overall Undergraduate Enrollment

Over the last 15 years, enrollment in U.S. institutions of higher education at all levels rose from 14.5 million students in fall 1996 to 21.3 million in fall 2011, with two main periods of high growth—between 2000 and 2002 and between 2007 and 2010, the two most recent recessionary periods. Undergraduate enrollment typically represents about 86% of all postsecondary enrollment (appendix table 2-14).

In 2011, for the first time since 1996, undergraduate enrollment declined slightly. As in previous years, the types of institutions enrolling the largest numbers of students at the undergraduate level were associate's colleges (8.2 million, 45% of all students enrolled), master's colleges/universities (3.8 million, 21%), and doctorate-granting universities with very high research activity (2.0 million, 11%). Between 1996 and 2011, undergraduate enrollment nearly doubled at doctoral/research universities and increased by 56% at associate's colleges, 47% at master's colleges, and 39% at baccalaureate colleges (appendix table 2-14). (See sidebar, "Carnegie Classification of Academic Institutions," for definitions of the types of academic institutions.)

According to the latest Census Bureau projections, the number of college-age individuals (ages 20–24) is expected to decline from 22.6 million in 2015 to 21.6 million in 2025 but increase in the longer term (to 25.3 million by 2060) (appendix table 2-15). The short-term decline in this segment of the population is mostly due to a drop in the number of whites who are not Hispanic, which is projected overall to continue to fall through 2060, and a decline in the population of blacks who are not Hispanic between 2015 and 2035. The populations of 20–24-year-old Hispanics and of Asians who are not Hispanic are expected to increase continuously between 2015 and 2060. The proportion of Hispanics in this age group is expected to grow from 22% in 2015 to 36% in 2060, and the proportion of Asians in this age group is expected to increase from 5% to 7%. Increased enrollment in higher education is projected to come mainly from minority groups, particularly Hispanics.[19]

Undergraduate Enrollment in S&E

Freshmen's Intentions to Major in S&E. Since 1971, the annual The American Freshman: National Norms survey, administered by the Higher Education Research Institute at

Table 2-10
Primary support mechanisms for S&E doctorate recipients, by 2010 Carnegie classification of doctorate-granting institution: 2011

Mechanism	All institutions	Research universities (very high research activity)	Research universities (high research activity)	Doctoral/ research universities	Medical schools and medical centers	Other/not classified
Doctorate recipients (*n*)	36,654	27,641	5,773	1,219	1,197	824
All mechanisms	100.0	100.0	100.0	100.0	100.0	100.0
Fellowship or traineeship	20.9	22.6	13.2	11.7	35.2	12.5
Grant	6.4	6.8	3.2	2.5	18.0	3.2
Teaching assistantship	16.1	16.3	21.2	7.7	1.3	7.3
Research assistantship	32.7	35.8	28.6	7.9	20.2	14.1
Other assistantship	0.5	0.4	1.1	1.1	D	D
Personal	9.6	6.3	17.3	34.8	9.4	30.0
Other	3.3	2.8	4.4	7.1	D	D
Unknown	10.4	8.9	11.1	27.2	12.2	28.5

D = suppressed to avoid disclosure of confidential information.

NOTES: Personal support mechanisms include personal savings, other personal earnings, other family earnings or savings, and loans. Traineeships include internships and residencies. Other support mechanisms include employer reimbursement or assistance, foreign support, and other sources. Percentages may not add to 100% because of rounding.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012), of the 2011 Survey of Earned Doctorates.

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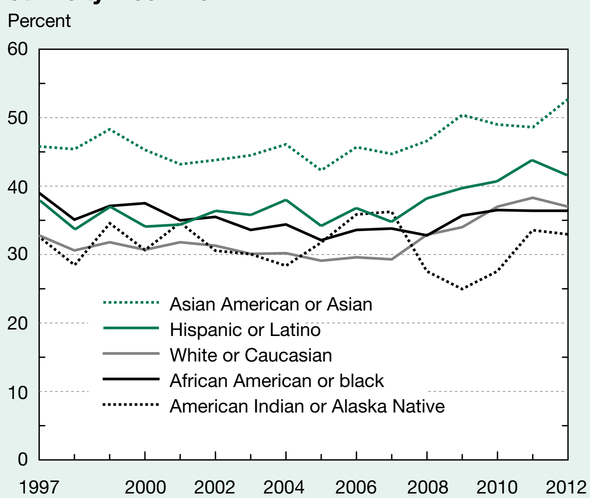
the University of California–Los Angeles, has asked freshmen at a large number of universities and colleges about their intended majors.[20] The data have proven to be a broadly accurate picture of trends in degree fields several years later.[21] Data show that up until 2007, about one-third of all freshmen planned to study S&E; this proportion gradually rose to 39% by 2012. Increases in the proportion of freshmen planning to major in biological and agricultural sciences account for most of this growth. In 2012, about 13% of freshmen intended to major in the biological and agricultural sciences and about 10% each in the social and behavioral sciences and engineering. About 3% each intended to major in physical sciences and mathematics, statistics, or computer sciences (appendix table 2-16).

In 2012, more than half of Asian American or Asian freshmen reported that they intended to major in S&E; proportions were lower for Hispanic or Latino freshmen (42%) and lower still for white (37%), black (36%), and American Indian or Alaska Native (33%) freshmen (figure 2-10). The proportions planning to major in S&E were higher for men than for women in every racial and ethnic group (appendix table 2-16). For most racial and ethnic groups, about 10% planned to major in social and behavioral sciences; about 8%–10% in engineering; about 12% in biological and agricultural sciences; 3% in mathematics, statistics, or computer sciences; and 2% in physical sciences. Higher proportions of Asian American or Asian freshmen than of those from other racial and ethnic groups planned to major in engineering; biological and agricultural sciences; and mathematics, statistics, or computer sciences. Higher proportions of blacks and Hispanics or Latinos intended to major in the social and behavioral sciences. The percentage of all freshmen intending to major in mathematics, statistics, or computer sciences has dropped since the late 1990s, whereas the percentages of students intending to major in biological and agricultural sciences, engineering, and the social and behavioral sciences have increased.

Generally, the percentages of students earning bachelor's degrees in specific S&E fields are similar to the percentages planning to major in those fields, with the exception of engineering and social and behavioral sciences (see "S&E Bachelor's Degrees" section and appendix tables 2-17 and 2-23 for trends in bachelor's degrees; see section on "Persistence and Retention in Undergraduate Education [S&E versus Non-S&E Fields]" in NSB 2012 for a discussion of longitudinal data on undergraduate attrition in S&E). For both sexes and all racial and ethnic groups, the percentage of students earning bachelor's degrees in engineering is smaller than the percentage planning to major in it (figures 2-11 and 2-12). The percentage earning bachelor's degrees in social and behavioral sciences in 2011 (16%) (appendix table 2-17) is larger than the percentage that planned to major in those fields as freshmen 6 years earlier (10%) (appendix table 2-16). For women, blacks, and Hispanics—unlike for men, whites, and Asians—the proportion earning bachelor's degrees in the natural sciences is smaller than the proportion who begin college planning to major in these fields (figures 2-13 and 2-14).

Figure 2-10
Freshmen intending S&E major, by race and ethnicity: 1997–2012



NOTE: In 2001, Native Hawaiian or Pacific Islander was added as a category under Asian American or Asian.

SOURCE: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2013).

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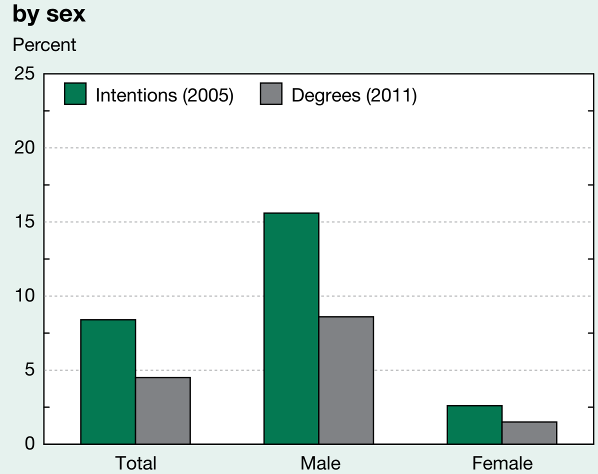
Figure 2-11
Engineering: Freshmen intentions and degrees, by sex



NOTES: Degrees do not reflect the same student cohort.

SOURCES: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2013); National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2011; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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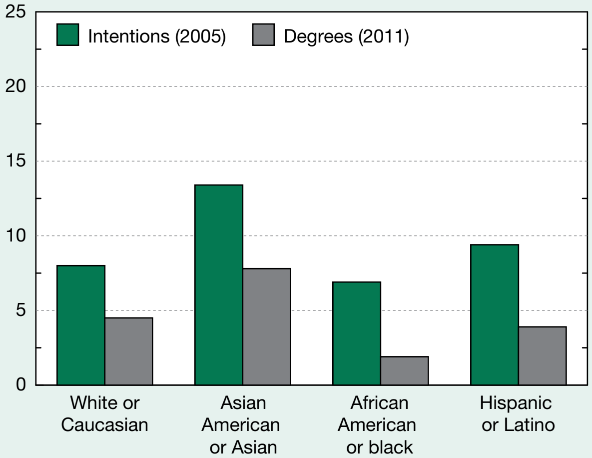
Figure 2-12
Engineering: Freshmen intentions and degrees, by race and ethnicity



NOTES: Degrees do not reflect the same student cohort. Asian American or Asian includes Native Hawaiian or Pacific Islander.

SOURCES: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2013); National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2011; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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Figure 2-13
Natural sciences: Freshmen intentions and degrees, by sex

NOTE: Degrees do not reflect the same student cohort.

SOURCES: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2013); National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2011; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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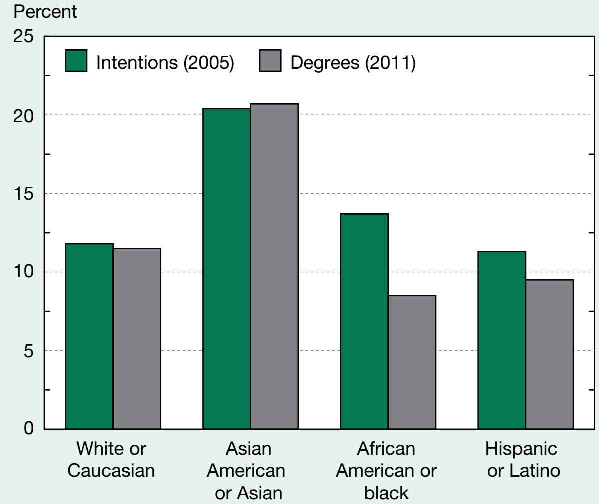
According to the 2012 PCAST report on science, technology, engineering, and mathematics (STEM) education (PCAST 2012), to retain the U.S. historical preeminence in S&E, the United States will need to increase the proportion of students who receive undergraduate degrees in STEM (or the natural sciences and engineering) fields considerably over current rates. Persistent historic patterns suggest that generating such an increase may be challenging because the following have been true for at least 15 years:

- The proportion of freshmen intending to major in the different S&E fields changed little for most fields, except for biological and agricultural sciences, and even declined for mathematics, statistics, and computer sciences (appendix table 2-16).
- The proportion of bachelor's degrees in the natural sciences and engineering combined has remained 15%–17% (appendix table 2-17 and NSB 2010).[22]
- The patterns of net undergraduate migration into S&E majors and attrition out of them have been stable (see section on "Persistence and Retention in Undergraduate Education [S&E versus Non-S&E Fields]" in NSB 2008 and NSB 2012).

One strategy to increase retention of students in STEM fields, however, is to improve student learning by improving the quality of undergraduate education in S&E. The 2012

Figure 2-14
Natural sciences: Freshmen intentions and degrees, by race and ethnicity



NOTES: Degrees do not reflect the same student cohort. Asian American or Asian includes Native Hawaiian or Pacific Islander.

SOURCES: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2013); National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2011; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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National Academies report, "Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering" (NRC 2012b), examines available research on current teaching practices that have been shown to be more effective than the traditional lecture (see sidebar, "Discipline-Based Education Research").

The demographic profile of students planning to major in S&E has become more diverse over time. The proportion of white students declined from about three-quarters in 1998 to about two-thirds in 2012. On the other hand, in the same period, the proportion of Asian American or Asian students doubled to 16%, and the proportion of Hispanic students nearly tripled, also to 16%, in 2012. American Indian or Alaska Native and black students accounted for roughly 2% and 11%, respectively, of freshmen intending to major in S&E in both 1998 and 2012 (appendix table 2-18).

Discipline-Based Education Research

The purpose of discipline-based education research (DBER) is to improve teaching and learning in S&E by bringing together general findings and perspectives from the science of learning and expert knowledge of specific S&E disciplines. DBER seeks to understand how people learn the concepts, practices, and thinking of S&E fields. It focuses on a group of related research fields (physics, chemistry, engineering, biology, the geosciences, and astronomy).

In 2012, at the request of the National Science Foundation, the National Research Council (NRC) examined the status, contributions, and future directions of DBER in undergraduate education. It found that across the different disciplines, students have incorrect understandings of basic concepts, in particular those involving time or space scales that are very large or very small. The NRC also concluded that students find important aspects of the fields that seem easy or obvious to experts to be challenging and to pose barriers to further learning, especially when instructors are unaware of the challenges for the novice.

DBER has shown that actively involving undergraduate students in the learning process improves understanding more than listening to a traditional lecture. Effective instruction strategies can promote conceptual change. Such strategies include, for example, making lectures more interactive, having students work in groups, and incorporating authentic activities and open-ended problems into teaching (e.g., learning in laboratories or learning in a field setting). Students can be taught more expert-like problem-solving skills and strategies to improve their understanding of concepts by instructional practices that provide steps and prompts to guide them, use multiple ways to represent those concepts, and help them to make their own thinking visible.

Foreign Undergraduate Enrollment.[23] In recent years, foreign undergraduate enrollment has been on the rise. In the 2011–12 academic year, the number of foreign students enrolled in bachelor's degree programs in U.S. academic institutions rose 11% from the previous year, to approximately 245,000 (IIE 2012). This rise continues a 5-year trend following the decline seen after 9/11. The number of foreign undergraduates enrolled in 2011–12 was 18% above the peak in 2001–02. New enrollments of foreign undergraduates in 2011–12 increased by 8% over the previous year. The countries that accounted for the largest numbers of foreign undergraduates enrolled in a U.S. institution in 2011–12 were China (75,000), South Korea (38,000), Saudi Arabia (14,000), India (13,000), Canada (13,000), and Vietnam (11,000). The numbers of Chinese and Saudi Arabian undergraduates each increased by 31% over the previous year. The numbers of South Korean undergraduates increased by 1%, whereas the numbers of Indian undergraduates decreased by 7%. In 2011–12, among all foreign students (undergraduate and graduate), the number of those studying mathematics and computer sciences increased 11% over the preceding year, and the number of those studying engineering, physical and life sciences, and social sciences also grew, each by 4% (IIE 2012).

More recent data from the Student and Exchange Visitor Information System (SEVIS) at the Department of Homeland Security show a substantial increase in foreign undergraduate enrollment in the United States between November 2011 and November 2012 (table 2-11; appendix table 2-19).[24] Most of the increase in foreign enrollment was in non-S&E fields, but within S&E the largest increases were in engineering and the social sciences. The top 10 countries sending foreign undergraduates in fall 2012 were similar to those in the preceding year (figure 2-15; appendix table 2-19). One-third of all foreign students in undergraduate programs at U.S. institutions are enrolled in S&E fields; in 2012, the proportion of undergraduate students enrolled in S&E fields was 50% or higher among students from Malaysia, Kuwait, India, and Nigeria.[25] Between 2008 and 2011, undergraduate foreign enrollment in S&E increased each year by about 6%–10%, with the growth rate more than doubling in 2012 (21%). At the undergraduate level, growth in non-S&E fields was between 1% and 3% each year between 2008 and 2011 but climbed to 16% in 2012 (table 2-11). About 50% of the growth in foreign undergraduate enrollment in the last year, both in S&E and non-S&E fields, is accounted for by the increase in the number of students from China.

Engineering Enrollment. For the most part, students do not declare majors until their sophomore year. Because of this, undergraduate enrollment data for domestic students are not available by field. However, engineering is an exception. Engineering programs generally require students to declare a major or an intent to major in the first year of college, so engineering enrollment data can serve as an early indicator of both future undergraduate engineering degrees and student interest in engineering careers. The Engineering Workforce Commission administers an annual fall survey that tracks enrollment in undergraduate and graduate engineering programs (EWC 2012).

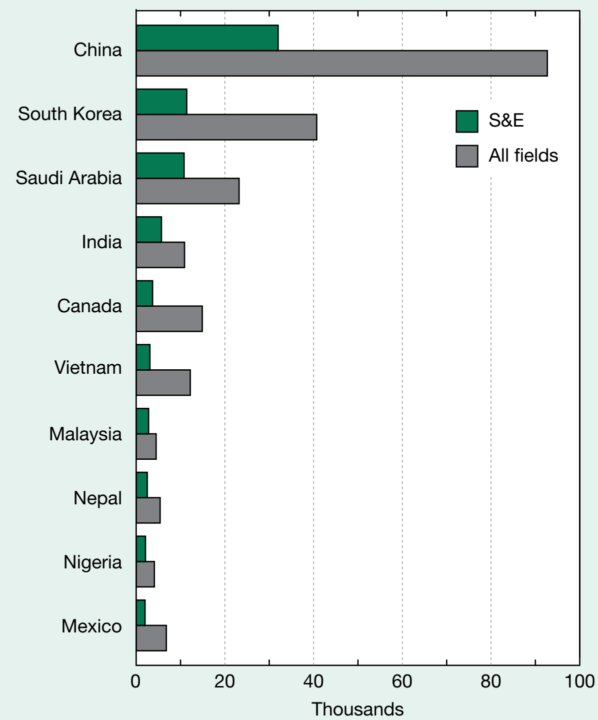
Undergraduate engineering enrollment was flat in the late 1990s, increased from 2000 to 2003, declined slightly through 2006, and has risen steadily since then to a peak of 511,000 in 2011 (figure 2-16; appendix table 2-20). The number of undergraduate engineering students increased by 26% between 2006 and 2011. Full-time freshman enrollment followed a similar pattern, reaching 122,000 in 2011—the highest since 1982. These trends correspond with declines in the college-age population through the mid-1990s, particularly the drop in white 20–24-year-olds, who account for the majority of engineering students (NSF/NCSES 2013a).

Enrollment by Disability Status. According to the most recent available estimates, 11% of undergraduate students reported a disability in 2008. Nearly half of them were enrolled in 2-year institutions, 41% in 4-year institutions, 3% in less-than-2-year institutions, and 8% in more than one institution. About one in five undergraduates with a disability was in an S&E field (NSF/NCSES 2013a).

Undergraduate Degree Awards

The number of undergraduate degrees awarded by U.S. academic institutions has been increasing over the past two decades in both S&E and non-S&E fields. These trends are expected to continue at least through 2021 (Hussar and Bailey 2013).

Figure 2-15
Foreign undergraduate student enrollment in U.S. universities, by top 10 places of origin and field: November 2012



NOTES: Data include active foreign national students on F-1 visas and exclude those on optional practical training. Undergraduate enrollment includes associate's and bachelor's degrees.

SOURCE: Bureau of Citizenship and Immigration Services, Student and Exchange Visitor Information System database, special tabulations (2013).

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Table 2-11
Foreign students enrolled in U.S. higher education institutions, by broad field and academic level: 2008–12

Field and level	2008	2009	2010	2011	2012
All fields					
All levels	526,570	525,680	537,650	574,360	635,650
Undergraduate	266,320	272,980	284,770	297,950	351,030
Graduate	260,260	252,710	252,890	276,400	284,620
S&E fields					
All levels	229,010	229,230	235,990	260,280	280,020
Undergraduate	76,780	81,110	87,590	96,400	116,640
Graduate	152,230	148,120	148,400	163,880	163,390
Non-S&E fields					
All levels	297,560	296,460	301,670	314,080	355,630
Undergraduate	189,530	191,870	197,180	201,560	234,390
Graduate	108,030	104,590	104,490	112,520	121,240

NOTES: Data include active foreign national students on F-1 visas and exclude those on optional practical training. Undergraduate level includes associate's and bachelor's degrees; graduate level includes master's and doctoral degrees. Numbers are rounded to the nearest 10. Detail may not add to total because of rounding.

SOURCE: U.S. Department of Homeland Security, U.S. Immigration and Customs Enforcement, Student and Exchange Visitor Information System database, special tabulations (2013).

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S&E Associate's Degrees

Community colleges often are an important and relatively inexpensive gateway for students entering higher education. Associate's degrees, largely offered by 2-year programs at community colleges, are the terminal degree for some, but others continue their education at 4-year colleges or universities and subsequently earn higher degrees.[26] Many who transfer to baccalaureate-granting institutions do not earn associate's degrees before transferring. Combined, associate's degrees in S&E and in engineering technologies accounted for about 12% of all associate's degrees in 2011 (appendix table 2-21).

S&E associate's degrees from all types of academic institutions have been rising continuously since 2007, after a steep decline between 2003 and 2007. The overall trend mirrors the pattern of computer sciences, which also peaked in 2003, declined through 2007, and increased through 2011. Associate's degrees earned in engineering technologies (not included in S&E degree totals because of their applied focus) declined from about 40,000 in 2000 to about 30,000 in 2006, but they have been rising since then to about 38,000 in 2011 (appendix table 2-21).[27]

In 2011, women earned 62% of all associate's degrees, up from 60% in 2000, and 43% of S&E associate's degrees, down from 48% in 2000. Most of the decline is attributable to a decrease in women's share of computer sciences degrees, which dropped from 42% in 2000 to 23% in 2011 (appendix table 2-21).

Students from underrepresented minority groups (blacks, Hispanics, and American Indians and Alaska Natives) earn a higher proportion of associate's degrees than of bachelor's or more advanced degrees, both in S&E fields and in all fields.[28] (See the "S&E Bachelor's Degrees by Race and Ethnicity" and "Doctoral Degrees by Race and Ethnicity" sections.) In 2011, underrepresented minorities earned 27% of S&E associate's degrees—more than one-third of all associate's degrees in social and behavioral sciences and more than one-quarter of all associate's degrees in biological sciences, physical sciences, and mathematics (appendix table 2-22). Since 2000, the number of S&E associate's degrees earned by these students grew faster than the overall national increase.

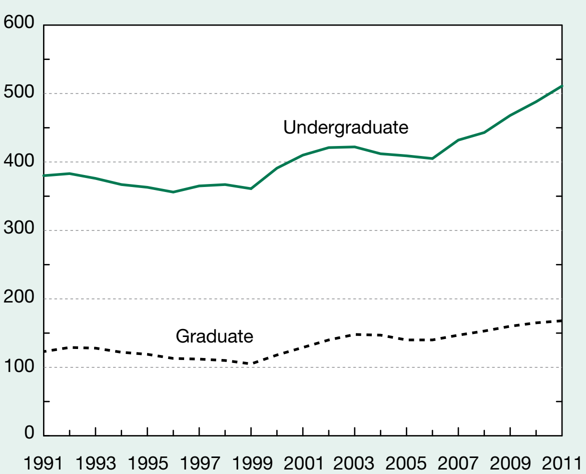
S&E Bachelor's Degrees

The baccalaureate is the most prevalent S&E degree, accounting for nearly 70% of all S&E degrees awarded. S&E bachelor's degrees have consistently accounted for roughly one-third of all bachelor's degrees for at least the past 10 years. The number of S&E bachelor's degrees awarded rose steadily from about 400,000 in 2000 to more than 550,000 in 2011 (appendix table 2-17).[29]

In the last decade, the number of bachelor's degrees awarded increased fairly consistently, although to different extents, in all S&E fields. The exception was computer sciences, where the number increased sharply from 2000 to 2004, dropped as sharply through 2009, but increased again in 2010 and 2011 (figure 2-17; appendix table 2-17).

S&E Bachelor's Degrees by Sex. Since 1982, women have outnumbered men in undergraduate education. They have earned relatively constant fractions of all bachelor's and S&E bachelor's degrees for several years. Since the

Figure 2-16
U.S. engineering enrollment, by level: 1991–2011



NOTE: Enrollment data include full- and part-time students.

SOURCE: American Association of Engineering Societies, Engineering Workforce Commission, Engineering & Technology Enrollments (various years).

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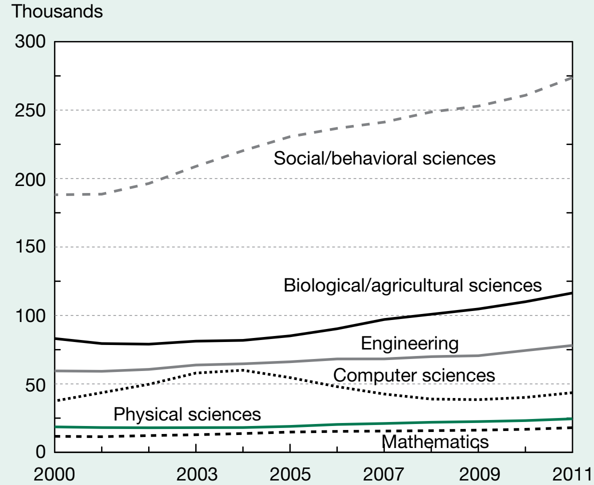
Figure 2-17
S&E bachelor's degrees, by field: 2000–11



NOTE: Physical sciences include earth, atmospheric, and ocean sciences.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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late 1990s, women have earned about 57% of all bachelor's degrees and about half of all S&E bachelor's degrees. Among U.S. citizens and permanent residents, women also earn about half of all S&E bachelor's degrees (NSF/NCSES 2013a).

Within S&E, men and women tend to study different fields; these tendencies are also observed at the master's and doctoral levels, as will be seen below and in the workforce data in chapter 3. In 2011, men earned the vast majority of bachelor's degrees awarded in engineering, computer sciences, and physics. Women earned half or more of the bachelor's degrees in psychology, biological sciences, agricultural sciences, and all the broad fields within social sciences except for economics (appendix table 2-17).

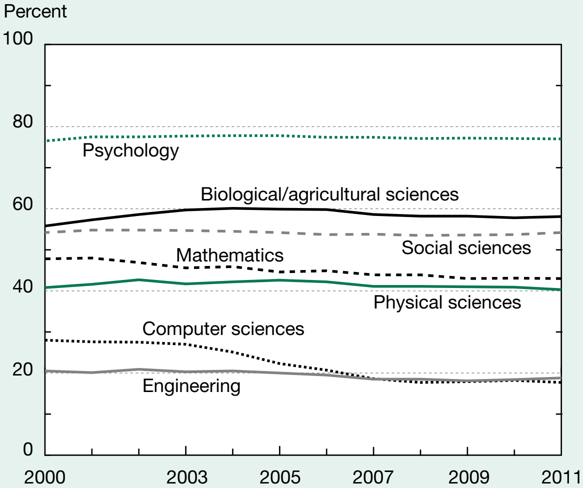
Since 2000, changes have not followed a consistent pattern. The share of bachelor's degrees awarded to women declined in computer sciences (by 10%), mathematics (by 5%), physics (by 2%), and engineering (by 2%) (figure 2-18; appendix table 2-17). Fields in which the proportion of bachelor's degrees awarded to women grew during this period include atmospheric sciences (by 9%), agricultural sciences (by 6%), astronomy (by 3%), chemistry (by 2%), anthropology (by 3%), and political science and public administration (by 1%) (appendix table 2-17).

The number of bachelor's degrees awarded to men and women in S&E and in all fields increased in similar proportions between 2000 and 2011.[30]

S&E Bachelor's Degrees by Race and Ethnicity. The racial and ethnic composition of the cohort of S&E bachelor's degree recipients has changed over time, reflecting both population changes and increasing rates of college attendance by members of minority groups.[31] Between 2000 and 2011, the share of S&E degrees awarded to white students among U.S. citizens and permanent residents declined from 71% to 63%, although the number of S&E bachelor's degrees earned by white students increased during that time (figure 2-19; appendix table 2-23). The share awarded to Hispanic students increased from 7% to 10% and to Asians and Pacific Islanders from 9% to 10%. The shares to black and American Indian or Alaska Native students have remained flat since 2000, at 9% and 1%, respectively. The number of S&E bachelor's degrees earned by students of unknown race or ethnicity nearly tripled in this period, to about 42,000.

Despite considerable progress over the past two decades for underrepresented minority groups earning bachelor's degrees in any field, the gap in educational attainment between young minorities and whites continues to be wide. In 2011, the percentage of the population ages 25–29 with bachelor's or higher degrees was 20% for blacks, 13% for Hispanics, and 39% for whites. These figures changed from the 1980 shares of 12%, 8%, and 25%, respectively (Aud et al. 2012). Differences in completion of bachelor's degrees in S&E by

Figure 2-18
Women's share of S&E bachelor's degrees, by field: 2000–11



NOTE: Physical sciences include earth, atmospheric, and ocean sciences.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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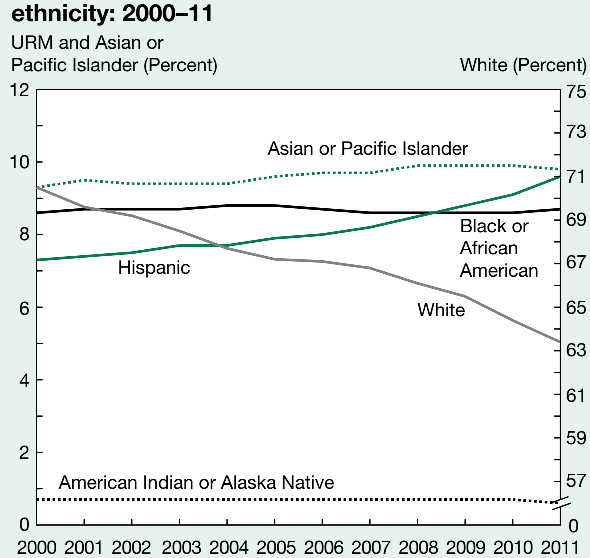
Figure 2-19
Share of S&E bachelor's degrees among U.S. citizens and permanent residents, by race and ethnicity: 2000–11



URM = underrepresented minorities (black, Hispanic, and American Indian or Alaska Native).

NOTES: Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific Islander, black or African American, and white refer to individuals who are not of Hispanic origin. Percentages do not sum to 100 because data do not include individuals who did not report their race and ethnicity.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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race or ethnicity reflect differences in high school completion rates, college enrollment rates, and college persistence and attainment rates. In general, blacks, Hispanics, and American Indians and Alaska Natives are less likely than whites and Asians or Pacific Islanders to graduate from high school, to enroll in college, and to graduate from college. (For information on immediate post-high school college enrollment rates, see the “Transition to Higher Education” section in chapter 1.) Among those who do enroll in or graduate from college, blacks, Hispanics, and American Indians and Alaska Natives are about as likely as whites to choose S&E fields; Asians or Pacific Islanders are more likely than members of other racial and ethnic groups to choose these fields. For Asians and Pacific Islanders, almost half of all bachelor’s degrees received are in S&E, compared with close to one-third of all bachelor’s degrees earned by each of the other racial and ethnic groups. However, the proportion of Asians and Pacific Islanders earning degrees in the social sciences is similar to that of other racial and ethnic groups (appendix table 2-23).

The contrast in field distribution among whites, blacks, Hispanics, and American Indians and Alaska Natives on the one hand and Asians and Pacific Islanders on the other is apparent within S&E fields as well. White, black, Hispanic, and American Indian and Alaska Native S&E baccalaureate recipients share a similar distribution across broad S&E fields. In 2011, between 9% and 11% of all baccalaureate recipients in each of these racial and ethnic groups earned their degrees in the natural sciences, 2%–4% in engineering, and 15%–18% in the social and behavioral sciences. Asian and Pacific Islander baccalaureate recipients earned 21% of their bachelor’s degrees in natural sciences and 8% in engineering (appendix table 2-23).

Since 2000, the total number of bachelor’s degrees and the number of S&E bachelor’s degrees rose for all racial and ethnic groups. The number of bachelor’s degrees in all broad S&E fields except computer sciences also rose for most racial and ethnic groups (appendix table 2-23). In all racial and ethnic groups, the number of degrees in computer sciences followed the pattern for the general population: it increased considerably through 2003–04 and then sharply declined through 2008–09. In the last 2 or 3 years, the numbers started to increase, and in the case of Hispanics, the number of earned bachelor’s degrees in computer sciences in 2011 was close to the peak reached in 2004.

Bachelor’s Degrees by Citizenship. Students on temporary visas in the United States have consistently earned a small share (3%–4%) of S&E degrees at the bachelor’s level. In 2011, these students earned a larger share of bachelor’s degrees awarded in economics and in chemical, electrical, and industrial engineering (about 10%). The number of S&E bachelor’s degrees awarded to students on temporary visas increased from about 15,000 in 2000 to about 19,000 in 2004, then declined to 17,000 by 2008, but it increased through 2011, peaking at almost 21,000 (appendix table 2-23).

Graduate Education, Enrollment, and Degrees in the United States

Graduate education in S&E contributes to global competitiveness, producing the highly skilled workers of the future and the research needed for a knowledge-based economy. This section includes indicators related to graduate enrollment; recent trends in the number of earned degrees in S&E fields; and participation by women, minorities, and foreign students in graduate education in U.S. academic institutions.

Graduate Enrollment by Field

S&E graduate enrollment in the United States increased between 2000 and 2011 to more than 600,000 (appendix table 2-24).[32] Graduate enrollment grew considerably in most S&E fields, particularly in engineering and in the biological and the social sciences (where most of the growth is accounted for by the increase of graduate enrollment in political science and public administration). Graduate enrollment in computer sciences grew rapidly in the early 2000s, then decreased through 2006, but it has generally increased since then.

Graduate enrollment in engineering grew between 2000 and 2011. Although the rate of growth slowed somewhat in 2011, the number of full-time engineering students reached a new peak in that year (appendix table 2-25).

The number of full-time students enrolled for the first time in S&E graduate departments is an indicator of developing trends. Despite some drops in first-time, full-time enrollment in engineering and computer sciences in the early to mid-2000s, this indicator has increased fairly steadily in most broad S&E fields, particularly between 2008 and 2011. In 2011, the number of first-time, full-time S&E graduate students reached a new peak in most S&E fields (appendix table 2-26).

First-time, full-time graduate enrollment, particularly in engineering and to some extent in computer sciences, often follows trends in employment opportunities. When employment opportunities are plentiful, recent graduates often forgo graduate school, but when employment opportunities are scarce, further training in graduate school may be perceived as a better option. Figure 2-20 shows trends in unemployment rates and trends in first-time, full-time graduate enrollment in engineering and computer sciences. Enrollment in S&E fields that offer fewer employment opportunities at the bachelor’s level (e.g., biological sciences) does not follow this trend. According to data from the NSRCG, the proportion of recent S&E bachelor’s recipients who were taking classes or enrolled full-time in a degree program after obtaining their degree increased to about 30% among those who graduated in 2008 and 2009, up from about 25% among those who graduated earlier in the decade.[33]

Graduate Enrollment by Sex

In 2011, 46% of the S&E graduate students enrolled in the United States were women (appendix table 2-24). The proportions of women graduate students enrolled in S&E differed considerably by field, with the lowest proportions in engineering, computer sciences, and physical sciences. Women constituted the majority of graduate students in psychology, medical and other health sciences, biological sciences, and social sciences, and they were half or close to half of graduate students in agricultural sciences and earth, atmospheric, and ocean sciences. Among the social sciences, economics has an unusually low proportion of women. Except for computer sciences and physical sciences, in most of these broad fields, the proportion of women enrolled increased between 2000 and 2005–07, but it has remained fairly stable since then. The proportion of women enrolled in graduate programs in computer sciences peaked in 2000 and has decreased since then. In the physical sciences, the proportion of women increased gradually in the last two decades, from 25% in 1991 to 33% in 2011 (for earlier data, see NSB 2008).

Graduate Enrollment of Underrepresented Groups

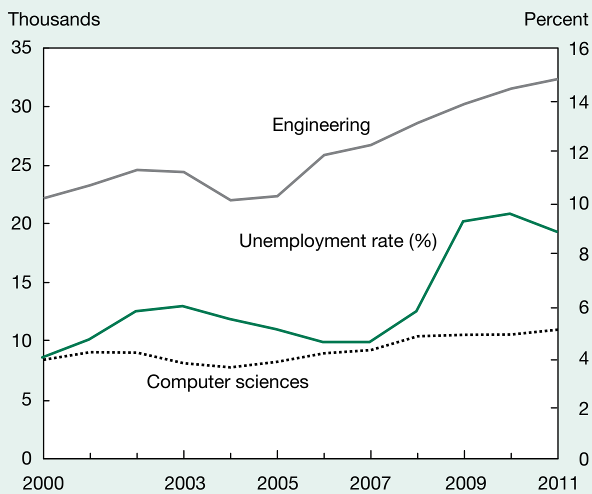
In 2011, among U.S. citizens and permanent residents, underrepresented minority students (blacks, Hispanics, and American Indians and Alaska Natives) accounted for 17% of students enrolled in graduate S&E programs (appendix table 2-27). The proportion of underrepresented minorities was highest in psychology and the social sciences (23%), medical and other health sciences (19%), and computer sciences (15%); it was lowest in the earth, atmospheric, and ocean sciences (9%) and the physical sciences (10%). Between 2000 and 2011, the proportion of underrepresented minorities enrolled has increased in all broad S&E fields, in particular in psychology and computer sciences.

In 2011, whites accounted for about 65% of S&E graduate enrollment among U.S. citizens and permanent residents. They constituted a larger proportion of graduate students enrolled in agricultural sciences and in earth, atmospheric, and ocean sciences (about 80%) and a smaller proportion of those enrolled in computer sciences and social sciences (about 60%). The proportions of whites in other fields fell in between. Over time, however, the proportion of whites among graduates enrolled in S&E has declined in all broad S&E fields except for computer sciences, where the proportion of whites increased slightly, from 58% in 2000 to 60% in 2011.

Asians and Pacific Islanders accounted for 9% of S&E graduate enrollment among U.S. citizens and permanent residents in 2011, with larger proportions in computer sciences (14%), engineering (13%), the biological and medical sciences (about 12% and 11%, respectively) and a lower proportion in the agricultural sciences (3%); earth, atmospheric, and ocean sciences (4%); psychology (5%); and the social sciences (6%). Between 2000 and 2011, the proportion of Asians and Pacific Islanders enrolled increased slightly in most broad fields, but it declined in computer sciences (from 21% in 2000 to 14% in 2011).

About 20% of graduate students reporting a disability were enrolled in S&E fields. Nearly two-thirds of those in S&E fields were men; nearly 90% were 24 years old or older (NSF/NCSES 2013a).

Figure 2-20
First-time, full-time graduate enrollment in engineering and computer sciences and unemployment rate of all workers: 2000–11



SOURCES: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Graduate Students and Postdoctorates in Science and Engineering, 2011. Unemployment rates are from the Bureau of Labor Statistics, Current Population Survey, table 1, employment status of the civilian noninstitutional population, 1942 to date, http://www.bls.gov/cps/cpsaat01.htm, accessed 4 February 2013.

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Foreign Graduate Enrollment

In 2011, nearly 174,000 foreign students on temporary visas were enrolled in S&E graduate programs (appendix table 2-27). The concentration of foreign enrollment was highest in computer sciences, engineering, physical sciences, mathematics/statistics, chemistry, and economics.[34]

Following a post-9/11 decline, the numbers of first-time, full-time foreign graduates enrolled increased more or less consistently in most broad fields through 2011 (appendix table 2-26). Declines and subsequent increases were concentrated in engineering and computer sciences, the fields heavily favored by foreign students. However, between 2000 and 2011, foreign students' share of first-time, full-time S&E graduate enrollment dropped in other broad fields, particularly in the physical sciences (from 43% to 40%) and the social sciences (from 29% to 24%).

According to data collected by the Institute of International Education (IIE), the overall number of foreign graduate students in all fields increased by 1% from academic year 2010–11 to 2011–12 (IIE 2012). The number of new foreign graduate students increased by 3%. India, China, South Korea, Taiwan, and Canada were the top originating locations for foreign graduate students, similar to the leading foreign sources for undergraduate enrollment.

More recent data from SEVIS show an overall 3% increase in foreign graduate students from November 2011 to November 2012 in all fields (appendix table 2-28, table 2-11).[35] In 2012, nearly 60% of all foreign students in graduate programs at U.S. institutions were enrolled in S&E fields. Between fall 2011 and fall 2012, the number of foreign graduate students enrolled in S&E fields was stable, with declines in the numbers of foreign students in computer sciences (5%), biological sciences (4%), and engineering (2%) offset by increases in mathematics (11%), social sciences (7%), and psychology (4%). China and India continued to account for about 61% of the foreign S&E graduates in the United States in November 2012; however, between fall 2011 and fall 2012, the number of S&E foreign students from China increased, whereas the number of foreign students from India declined. South Korea, Taiwan, and Canada also sent large numbers of S&E graduate students, although these economies sent larger numbers of graduate students in non-S&E fields, primarily business and the humanities.

S&E Master's Degrees

In some fields, such as engineering and geosciences, a master's degree can be a terminal degree that fully prepares students for an established career track. In other fields, master's degrees primarily mark a step toward doctoral degrees. Master's degrees awarded in S&E fields increased from about 96,000 in 2000 to about 151,000 in 2011, with growth concentrated in two periods, 2002–04 and 2007–11 (appendix table 2-29).[36] Increases occurred in all major science fields. Master's degrees awarded in engineering and computer sciences declined between 2004 and 2007, but they have since increased. The number of master's degrees awarded in engineering in 2011 was the highest in the last 12 years; in the case of computer sciences, the number of master's degrees awarded in 2011 was near its peak in 2004 (figure 2-21). During this 12-year period, growth was particularly high in engineering, psychology, and political science and public administration (appendix table 2-29). Both students and institutions are concerned that success rates in completing master's degrees are too low (see sidebar, "Master's Completion and Attrition in S&E").

In 2012, the Commission on Pathways through Graduate School and into Careers, a 14-member commission composed of industry leaders and university executives, led a research effort to understand the different career paths students may take and to modernize graduate education by emphasizing skills that align more closely with workforce needs (Wendler et al. 2012).[37] Professional science master's degree programs, which stress interdisciplinary training, are part of this relatively new direction in graduate education (for details, see sidebar, "Professional Science Master's Degrees").

Master's Degrees by Sex

The number of S&E master's degrees earned by both men and women rose between 2000 and 2011 (figure 2-22). In 2000, women earned 43% of all S&E master's degrees; by 2011, they earned 45% (appendix table 2-29). Among U.S. citizens and permanent residents, women earned nearly half of all S&E master's degrees; among temporary residents, women earned about one-third of all S&E master's degrees (NSF/NCSES 2013a).

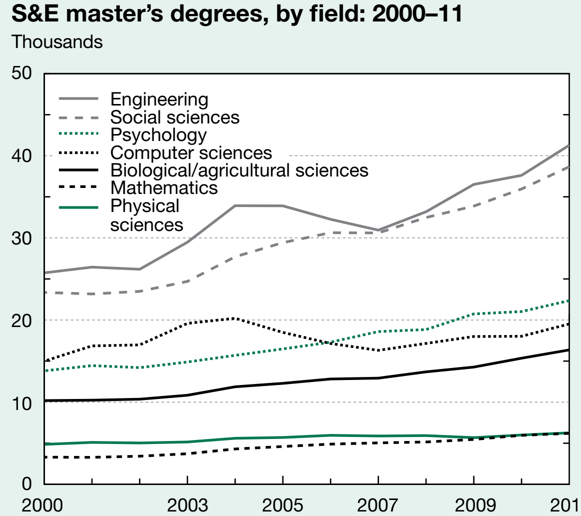
Women's share of S&E master's degrees varies by field. As with bachelor's degrees, in 2011, women earned a majority of master's degrees in psychology, biological sciences, agricultural sciences, and most social sciences except economics, but low proportions of master's degrees in engineering, computer sciences, and physics. Women's share of master's degrees in engineering in 2011, however, was slightly higher than their share in 2000 (appendix table 2-29). The number of master's degrees awarded to women in most major S&E fields increased fairly consistently throughout the last decade. In computer sciences, the numbers increased through 2004, then declined sharply through 2007, but they have increased consistently since then.

Master's Degrees by Race and Ethnicity

The number of S&E master's degrees awarded to U.S. citizens and permanent residents increased for all racial and ethnic groups between 2000 and 2011 (figure 2-23; appendix table 2-30).[38]

The proportion of master's degrees in S&E fields earned by U.S. citizens and permanent residents from underrepresented racial and ethnic minorities increased slightly between

Figure 2-21
S&E master's degrees, by field: 2000–11



NOTE: Physical sciences include earth, atmospheric, and ocean sciences.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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2000 and 2011. The trends are not very different from those found in the data on bachelor's degree awards among racial and ethnic groups. Blacks accounted for 10% of S&E master's degree recipients in 2011, up from 8% in 2000; Hispanics accounted for 8%, up from 5%; and American Indians and Alaska Natives accounted for 0.5%, similar to the proportion in 2000. The proportion of Asian and Pacific Islander S&E recipients also remained flat in this period.

The percentage of S&E master's degrees earned by white students fell from 70% in 2000 to 61% in 2011, whereas the percentage of degrees earned by blacks, Hispanics, and temporary residents increased. The proportion of S&E master's degrees recipients of other or unknown race doubled between 2000 and 2011, to 12% (appendix table 2-30).

Master's Completion and Attrition in S&E

Trends in master's education have attracted considerable attention in recent years, but little is known about the extent to which master's students succeed in completing their programs. A study by the Council of Graduate Schools (CGS 2013) collected data on master's completion and attrition trends in master's programs from the 2003–04 to the 2006–07 academic years from five academic institutions in five broad S&E fields (biological and agricultural sciences, engineering, mathematics and computer sciences, physical and earth sciences, social and behavioral sciences) and in business. Although the data from this study are not nationally representative and cannot be generalized to S&E graduate programs as a whole, they come from a range of fields and institutions and are suggestive of factors affecting master's degree completion.

In surveys, graduating S&E master's students said that the most important factor contributing to the successful completion of a master's program was their motivation and determination, followed by nonfinancial family support, being a full-time student, quality of teaching, and supportive faculty.

S&E master's students who left their programs reported that the most important factors preventing them from earning a master's degree were interference from employment, program structure, lack of adequate financial support, and lack of support from faculty. Among students who reported having concerns about their ability to complete their master's in S&E, the most frequently reported challenge was finding the time to manage school, work, and family commitments.

In the institutions studied, 41% of the S&E master's students completed their program within 2 years, 60% within 3 years, and 66% within 4 years. Completion rates within 4 years varied little by S&E field, but rates within 2 years were lowest for students in physical and earth sciences. Women, Asians and Pacific Islanders, temporary residents, and younger cohorts of students completed their master's degrees at higher rates.

About 10% of students in S&E fields left their programs within 6 months, 17% within 1 year, and 23% within 2 years. The median time to degree for students in S&E fields was 23 months, and the median time to attrition was 8 months.

Professional Science Master's Degrees

Professional science master's (PSM) degrees provide advanced training in an S&E field beyond the bachelor's degree level while also developing administrative and business skills that are valued by employers, including leadership, project management, teamwork, and communication. Starting from a handful of PSM programs in 1997, there are now almost 300 such programs in more than 100 institutions in 32 states and the District of Columbia, as well as some international programs in Canada, Australia, and the United Kingdom.

Total enrollment in PSM programs in the United States reached nearly 5,800 students in 2012, about one-third of whom were first-time enrollees (Allum, Gonzales, and Remington 2013). More than half of the enrollees were men (55%) and, among U.S. citizens and permanent residents, one-quarter were underrepresented minorities. The majority of the students were enrolled in one of four fields of study: computational sciences (21%), biotechnology (16%), environmental sciences and natural resources (14%), and mathematics and statistics (14%).

Nearly 1,800 PSM degrees were awarded in 2012. More than one in five of them were in biotechnology, and a similar proportion was in computer or information sciences. Men earned the majority of the PSM degrees awarded in chemistry, geosciences and geographic information systems, bioinformatics and computational biology, and mathematics and statistics. Women earned the majority of the degrees granted in medical-related sciences and environmental sciences and natural resources.

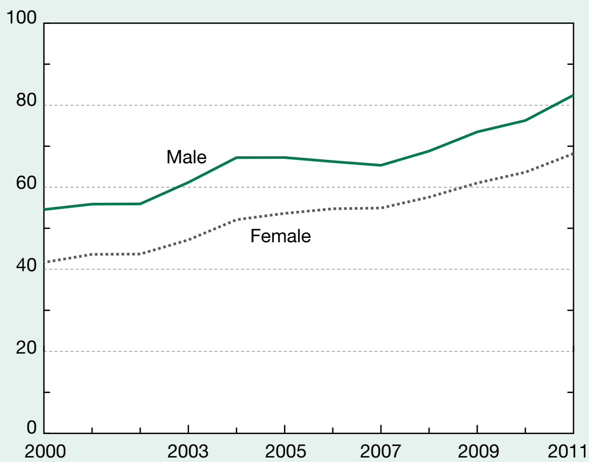
PSM programs have not yet been subject to a systematic, formal evaluation. However, according to the Outcomes for PSM Alumni: 2010/11 survey conducted by the Council of Graduate Schools (Bell and Allum 2011), more than 8 in 10 PSM program graduates were working in the summer of 2011, the vast majority of them in jobs closely related to their fields of study. More than half of those working full-time reported salaries of $50,000 or higher. Similar findings are reported by individual PSM programs that track student outcomes (Carpenter 2012).

Master's Degrees by Citizenship

Foreign students make up a much higher proportion of S&E master's degree recipients than of bachelor's or associate's degree recipients. In 2011, foreign students earned more than one-quarter of S&E master's degrees. Their degrees were heavily concentrated in computer sciences, economics, and engineering, where they received more than 4 out of 10 of all master's degrees awarded in 2011 (appendix table 2-30). Within engineering, students on temporary visas earned more than half of the master's degrees in electrical and chemical engineering.

The number of S&E master's degrees awarded to students on temporary visas reached its highest point in a decade in 2011 (39,000), after a sharp decline between 2004 and 2007. Most of the drop during this period was accounted for by decreasing numbers of temporary residents in the computer sciences and engineering fields, but in both fields numbers rebounded in both fields by about one-third in the following years.

Figure 2-22
S&E master's degrees, by sex of recipient: 2000–11



SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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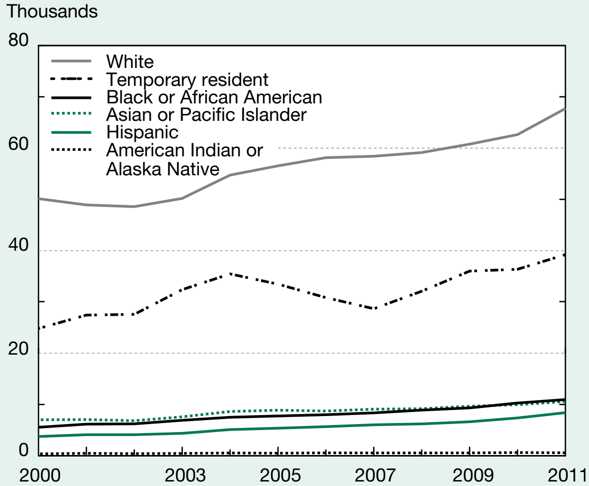
Figure 2-23
S&E master's degrees, by race, ethnicity, and citizenship of recipient: 2000–11



NOTES: Data on race and ethnicity include U.S. citizens and permanent residents. Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific islander, black or African American, and white refer to individuals who are not of Hispanic origin.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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S&E Doctoral Degrees

Doctoral education in the United States generates new knowledge important for the society as a whole and for U.S. competitiveness in a global knowledge-based economy. It prepares a new generation of researchers in academia, industry, and government, as well as a highly skilled workforce for other sectors of the economy.

The number of S&E doctorates (excluding those in other health sciences) conferred annually by U.S. universities increased steadily between 2002 and 2008, then decreased in 2009 and 2010.[39] The number rose by nearly 5% in 2011, to more than 38,000 (appendix table 2-31).[40] The growth in the number of S&E doctorates between 2000 and 2012 occurred among U.S. citizens and permanent residents as well as temporary residents. The largest increases were in engineering and the biological sciences (figure 2-24).

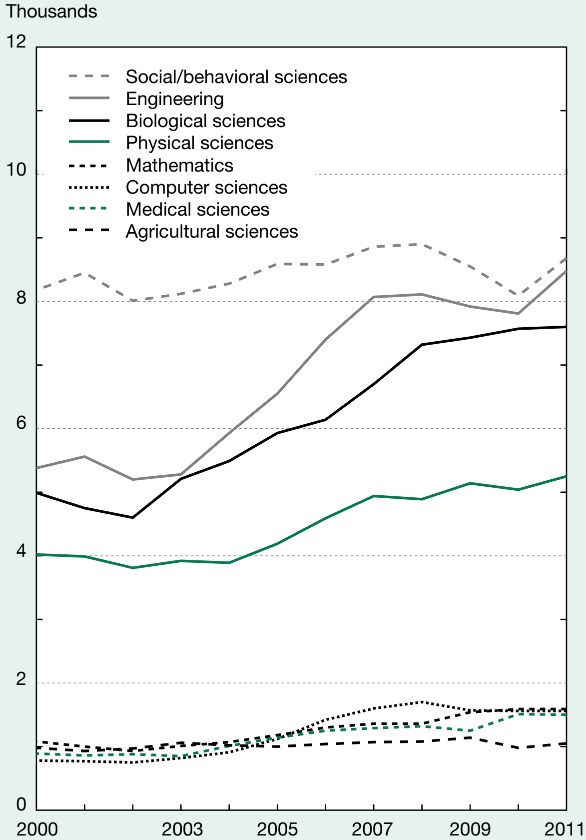
Time to Doctoral Degree Completion

The time required to earn a doctoral degree and the success rates of those entering doctoral programs are concerns for those pursuing a degree, the universities awarding the degree, and the agencies and organizations funding graduate study. Longer times to degree mean lost earnings and a higher risk of attrition. Time to degree (as measured by time from graduate school entry to doctorate receipt) increased through the mid-1990s but has since decreased in all S&E fields from 7.7 to 7.0 years (appendix table 2-32). The physical sciences and mathematics had the shortest time to degree, whereas the social sciences and medical and other health sciences had the longest.

Between 1997 and 2011, time to degree for doctorate recipients decreased in each of the Carnegie types of academic institutions awarding doctoral degrees (see sidebar, "Carnegie Classification of Academic Institutions"). Time to degree was shortest at research universities with very high research activity (6.9 years in 2011, down from 7.2 years in 1997). Doctorate recipients at medical schools also finished quickly (6.7 years in 2011). Time to degree was longer at universities that were less strongly oriented toward research (table 2-12).

The median time to degree varies somewhat by demographics, but these variations tend to reflect differences among broad fields of study. In 2011, across all doctorate recipients, women have a longer time to degree than men (7.9 versus 7.4 years, respectively) (NSF/NCSES 2012). However, these differences were very small or nonexistent when men and women were compared within broad fields.[41] Time to degree for men and women was similar in most broad S&E fields except for engineering, where it was slightly shorter for women (6.5 versus 6.9 for men). Within broad S&E fields, time to degree was longer for temporary visa holders than for U.S. citizens and permanent residents, and, in most broad fields, it was shorter for whites than for any other racial or ethnic group. In the life sciences, time to degree of Hispanic doctorate recipients was as short as that of whites (6.7).

Figure 2-24
S&E doctoral degrees earned in U.S. universities, by field: 2000–11



NOTES: Physical sciences include earth, atmospheric, and ocean sciences. Data differ from doctoral degree data in other tables and figures in this report that are based on the National Science Foundation Survey of Earned Doctorates and that refer to research doctorates only. Greatest differences are in psychology and medical sciences.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov.

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Doctoral Degrees by Sex

Among U.S. citizens and permanent residents, the proportion of S&E doctoral degrees (excluding those in other health sciences; see endnote 39) earned by women grew from 43% in 2000 to 47% in 2011 (appendix table 2-31). During this decade, women made gains in most major fields, but considerable disparities continued in certain fields. In 2011, women earned half or more of doctorates in non-S&E fields, in most social and behavioral sciences except for economics, in the biological sciences, and in medical and other health sciences. They earned fewer than one-third of the doctorates awarded in physical sciences, mathematics and computer sciences, and engineering (appendix table 2-31). Although the percentages of degrees earned by women in physical sciences and engineering are low, they are higher than they were in 2000.

The number of S&E doctoral degrees earned by women grew faster than that earned by men. The number of U.S. citizen and permanent resident women earning doctorates in S&E increased from nearly 8,000 in 2000 to nearly 11,000 in 2011, while the number earned by men increased from about 10,000 to nearly 12,000 in the same time interval (appendix table 2-31). The increase in the number of S&E doctorates earned by women occurred in most major S&E fields. For example, the number of engineering doctorates earned by U.S. citizen and permanent resident women increased from approximately 500 in 2000 to 900 in 2011, biological sciences doctorates from 1,700 to 2,900, and physical sciences doctorates from 600 to nearly 900. A decrease in the number of doctorates earned by U.S. citizen and permanent resident men in the early years of the decade occurred in non-S&E fields and in many S&E fields. However, since 2005, the number of doctorates earned by men has increased in all major S&E fields except for agricultural sciences, and psychology.

Doctoral Degrees by Disability Status

In 2011, 3% of doctorate recipients reported having a disability. Compared with persons without disabilities, those with disabilities were less likely to earn doctorates in engineering fields (9% versus 17%) and more likely to earn doctorates in the social and behavioral sciences (21% versus 17%). Nearly one-third of the S&E doctorate recipients with disabilities reported a learning disability, 17% reported being blind or visually impaired, 13% reported a physical or orthopedic disability, 12% indicated being deaf or hard of hearing, 4% reported a vocal or speech disability, and 21% cited other or unspecified disabilities (NSF/NCSES 2013a).

Doctoral Degrees by Race and Ethnicity

The number and proportion of doctoral degrees in S&E fields earned by underrepresented minorities increased between 2000 and 2011. In 2011, blacks earned 1,233 S&E doctorates, Hispanics earned 1,326, and American Indians and Alaska Natives earned 113—accounting for 8% of S&E

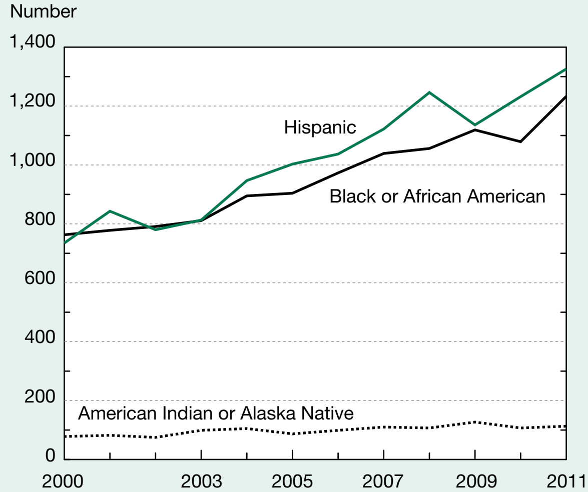
doctoral degrees (excluding doctorates in other health sciences; see endnote 39) earned that year, up from 6% in 2000 (appendix table 2-33).[42] Their share of the S&E doctorates earned by U.S. citizens and permanent residents rose from 9% to 12% in the same period. Gains by all groups contributed to this rise, although the number of S&E degrees earned by blacks and Hispanics rose considerably more than the number earned by American Indians and Alaska Natives (figure 2-25). Asian and Pacific Islander U.S. citizens and permanent residents earned 6% of all S&E doctorates in 2011, similar to 2000.

Although the number of S&E doctorates earned by white U.S. citizens and permanent residents increased between 2000 and 2011 (figure 2-26), the number of S&E doctorates awarded to minorities and temporary residents increased at a faster pace. As a result, the proportion of S&E doctoral degrees earned by white U.S. citizens and permanent residents decreased from 53% in 2000 to 43% in 2011 (appendix table 2-33).

Foreign S&E Doctorate Recipients

Temporary residents earned nearly 13,000 S&E doctorates in 2011, up from about 8,000 in 2000. Foreign students on temporary visas earned a larger proportion of doctoral degrees than master's, bachelor's, or associate's degrees (appendix tables 2-33, 2-30, 2-23, and 2-22, respectively). The temporary residents' share of S&E doctorates rose from 31% in 2000 to 36% in 2011. In some fields, these students earned even larger shares of doctoral degrees. In 2011, they earned half or more of doctoral degrees awarded in engineering, computer sciences, and economics. They earned considerably lower proportions of doctoral degrees in other S&E fields—for example, 27% in biological sciences, 26%

Figure 2-25
S&E doctoral degrees earned by U.S. citizen and permanent resident underrepresented minorities, by race and ethnicity: 2000–11



NOTES: Data differ from doctoral degree data in other tables and figures in this report that are based on the National Science Foundation Survey of Earned Doctorates and that refer to research doctorates only. Greatest differences are in psychology and medical/other health sciences. S&E excludes other health sciences. Hispanic may be any race. American Indian or Alaska Native and black or African American refer to individuals who are not of Hispanic origin.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov. See appendix table 2-33.

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Table 2-12
Median number of years from entering graduate school to receipt of S&E doctorate, by 2010 Carnegie classification of doctorate-granting institution: 1997–2011

Year	All institutions	Research universities (very high research activity)	Research universities (high research activity)	Doctoral/research universities	Medical schools and medical centers	Other/not classified
1997	7.7	7.2	8.2	9.7	7.7	8.2
1998	7.3	7.2	8.2	9.2	6.9	7.7
1999	7.2	7.2	7.9	9.0	6.7	7.7
2000	7.5	7.2	8.2	9.2	7.2	7.9
2001	7.2	7.2	8.2	9.7	6.9	7.7
2002	7.5	7.2	8.2	9.9	6.9	7.9
2003	7.6	7.2	8.2	9.7	6.9	8.7
2004	7.2	7.0	8.0	9.3	6.9	7.7
2005	7.3	7.2	7.9	9.3	7.0	7.9
2006	7.2	7.0	7.9	9.0	6.9	7.7
2007	7.0	6.9	7.7	8.9	6.9	7.7
2008	7.0	6.9	7.7	8.9	6.7	7.6
2009	7.0	6.9	7.7	9.2	6.8	7.7
2010	7.0	6.9	7.7	8.9	6.7	7.4
2011	7.0	6.9	7.7	8.7	6.7	7.7

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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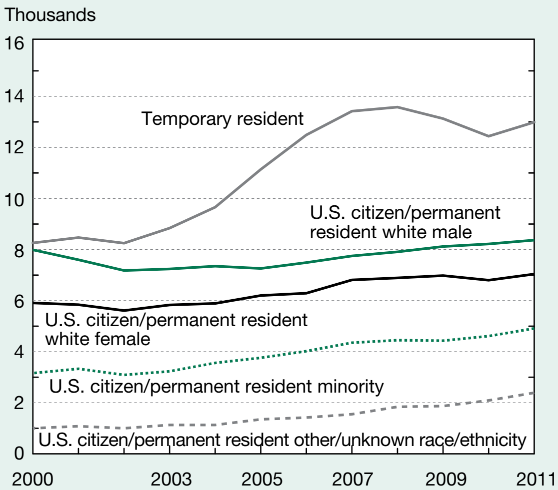
in medical sciences, 7% in psychology, and between 11% and 38% in most social sciences (except economics) (appendix table 2-33).

Countries and Economies of Origin

The top 10 countries and economies of origin of foreign S&E doctorate recipients (both permanent and temporary residents) together accounted for 68% of all foreign recipients of U.S. S&E doctoral degrees from 1991 to 2011 (table 2-13). Six out of those top 10 locations are in Asia.

Asia. From 1991 to 2011, students from four Asian countries and economies (China, India, South Korea, and Taiwan, in descending order) earned more than half of U.S. S&E doctoral degrees awarded to foreign students (131,000 of 236,000)—more than three times more than students from Europe (41,000). China accounted for almost half of these (63,000), followed by India (28,000), South Korea (22,000), and Taiwan (17,000). Most of these degrees were awarded in engineering, biological sciences, and physical sciences (table 2-14). About one in five of the doctorates awarded to South Korean and Taiwanese recipients in this period was in a non-S&E field.

Figure 2-26
S&E doctoral degrees, by sex, race, ethnicity, and citizenship: 2000–11



NOTES: Minority includes American Indian or Alaska Native, Asian or Pacific Islander, black or African American, and Hispanic. Data differ from doctoral degree data in other tables and figures in this report that are based on the National Science Foundation Survey of Earned Doctorates and that refer to research doctorates only. Greatest differences are in psychology and medical/other health sciences. S&E excludes other health sciences.

SOURCES: National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov. See appendix tables 2-31 and 2-33.

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The number of S&E doctorates earned by students from China declined in the late 1990s, increased through 2007, and dropped 16% in the following 3 years, but it rose 4% in 2011 (figure 2-27). Over the 20-year period, however, despite these fluctuations, the number of S&E doctorates earned by Chinese nationals more than doubled. The number of S&E doctorates earned by students from India also declined in the late 1990s, but it has increased almost every year since 2002; over the last two decades it nearly tripled. South Korea followed a similar trend but with a less dramatic increase. The number of S&E doctoral degrees earned by South Korean students also dipped in the late 1990s and then rose in the mid-2000s. In contrast, Taiwan experienced a substantially different trajectory. In 1991, its students earned more U.S. S&E doctoral degrees than those from India or South Korea.[43] However, as universities in Taiwan increased their capacity for advanced S&E education in the 1990s, the number of students from Taiwan earning S&E doctorates from U.S. universities declined. Since 2004, however, the number of Taiwanese doctorate recipients in the United States has been slowly going up again.

Europe. European students earned far fewer U.S. S&E doctorates than Asian students between 1991 and 2011, and they tended to focus less on engineering than did their Asian counterparts (tables 2-14 and 2-15). European countries whose students earned the largest number of U.S. S&E doctorates from 1991 to 2011 were Germany, Russia, the United Kingdom, Greece, Italy, Romania, and France, in that order. Trends in doctorate recipients from individual Western European countries vary (figure 2-28). The number of Central and Eastern European students earning S&E doctorates at U.S. universities quintupled between 1991 and 2011, to 553. Although their numbers almost reached the Western Europe total between 2005 and 2007, they have declined

Table 2-13
Foreign recipients of U.S. S&E doctorates, by country/economy of origin: 1991–2011

Country/economy	Number	Percent
All foreign recipients	235,582	100.0
Top 10 total	160,082	68.0
China	63,341	26.9
India	27,787	11.8
South Korea	22,400	9.5
Taiwan	16,997	7.2
Canada	7,511	3.2
Turkey	6,138	2.6
Thailand	4,232	1.8
Germany	3,985	1.7
Japan	3,974	1.7
Mexico	3,717	1.6
All others	75,500	32.0

NOTE: Foreign doctorate recipients include permanent and temporary residents.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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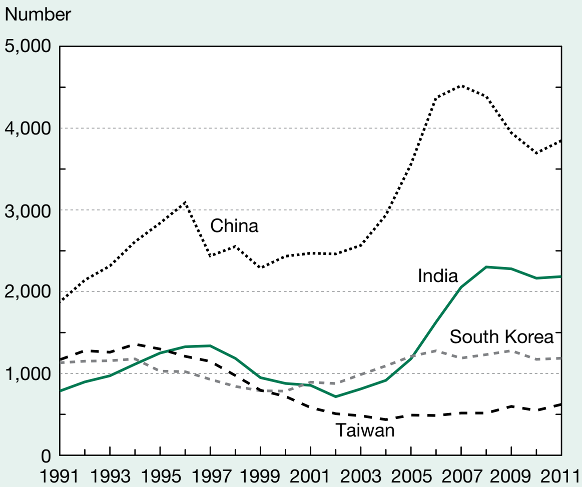
since then (figure 2-29). A higher proportion of doctorate recipients from Russia, Romania, and Greece than from the United Kingdom, France, Italy, and Germany earned their doctorates in S&E. Russian and Romanian doctorate recipients were more likely than those from Western European countries to earn their doctorates in mathematics and physical sciences, and Greeks were more likely to earn doctoral degrees in engineering (table 2-15).

The Americas. Despite the proximity of Canada and Mexico to the United States, the shares of U.S. S&E doctoral degrees awarded to residents of these countries were small compared with those awarded to students from Asia and Europe. The number of U.S. doctoral S&E degrees earned by students from Canada increased from about 320 in 1991 to nearly 500 in 2009, but it has declined in the last 2 years. The overall number of doctoral degree recipients from

Figure 2-27
U.S. S&E doctoral degree recipients, by selected Asian country/economy of origin: 1991–2011



NOTE: Degree recipients include permanent and temporary residents.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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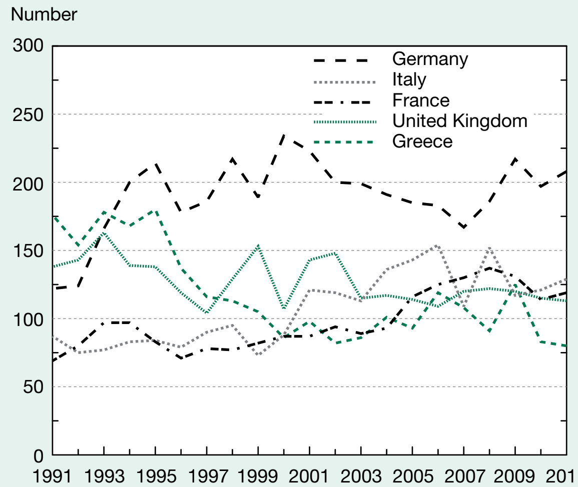
Figure 2-28
U.S. S&E doctoral degree recipients, by selected Western European country: 1991–2011



NOTE: Degree recipients include permanent and temporary residents.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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Table 2-14
Asian recipients of U.S. S&E doctorates, by field and country/economy of origin: 1991–2011

Field	Asia	China	India	South Korea	Taiwan
All fields	174,538	68,104	30,985	28,898	21,307
S&E	150,963	63,341	27,787	22,400	16,997
Engineering	54,831	20,823	12,144	8,779	7,294
Science	96,132	42,518	15,643	13,621	9,703
Agricultural sciences	5,296	1,804	727	831	630
Biological sciences	27,276	14,326	4,760	2,746	2,753
Computer sciences	8,400	3,312	2,346	1,017	855
Earth, atmospheric, and ocean sciences	3,063	1,737	324	377	286
Mathematics	7,356	4,068	782	1,017	639
Medical/other health sciences	5,226	1,342	1,232	654	936
Physical sciences	22,155	11,947	3,145	2,561	1,684
Psychology	2,213	485	320	462	350
Social sciences	15,147	3,497	2,007	3,956	1,570
Non-S&E	23,575	4,763	3,198	6,498	4,310

NOTES: Data include permanent and temporary residents. Asia includes Afghanistan, Armenia, Azerbaijan, Bangladesh, Bhutan, Brunei, Burma/Myanmar, Cambodia, China, Georgia, Hong Kong, India, Indonesia, Japan, Kazakhstan, Kyrgyzstan, Laos, Macau, Malaysia, Maldives, Mongolia, Nepal, Pakistan, Philippines, Singapore, South Korea, Spratly Islands, Sri Lanka, Taiwan, Tajikistan, Thailand, Turkmenistan, Uzbekistan, and Vietnam.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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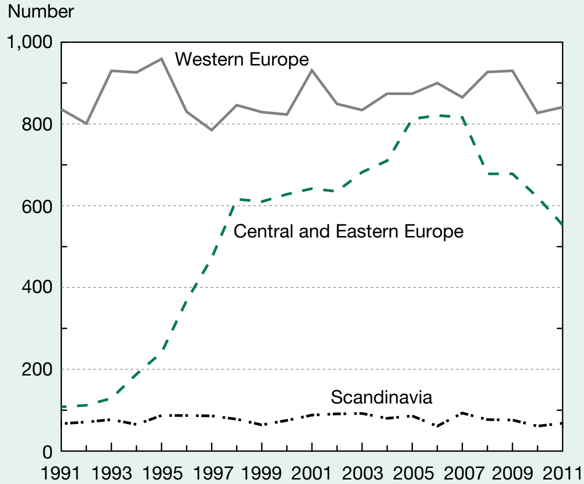
Figure 2-29
U.S. S&E doctoral degree recipients from Europe, by region: 1991–2011



NOTES: Degree recipients include permanent and temporary residents. Western Europe includes Andorra, Austria, Belgium, France, Germany, Greece, Ireland, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Portugal, San Marino, Spain, Switzerland, and United Kingdom. Central and Eastern Europe includes Albania, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kosovo, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, and Ukraine. Scandinavia includes Denmark, Finland, Iceland, Norway, and Sweden.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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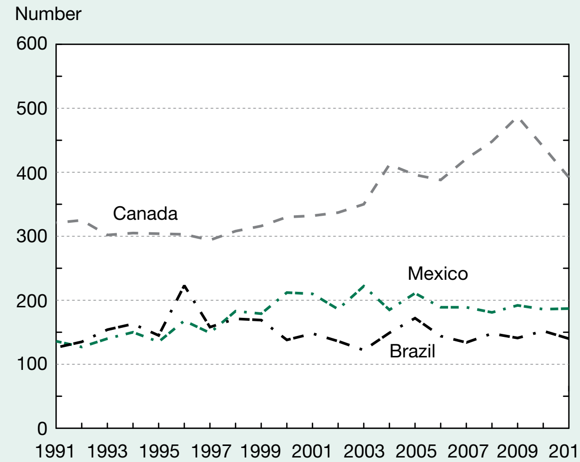
Mexico and Brazil peaked earlier (2003 and 1996, respectively) and declined in recent years (figure 2-30).

A higher proportion of Mexican and Brazilian students earned U.S. doctorates in S&E fields than the comparable proportion for Canadians (table 2-16). In particular, higher proportions of Mexican and Brazilian students than Canadian students received U.S. doctoral degrees in engineering and agricultural sciences.

Figure 2-30
U.S. S&E doctoral degree recipients from Canada, Mexico, and Brazil: 1991–2011



NOTE: Degree recipients include permanent and temporary residents.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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Table 2-15
European recipients of U.S. S&E doctorates, by field and region/country of origin: 1991–2011

Field	All European countries	Germany	Russia	United Kingdom	Greece	Italy	Romania	France
All fields	40,529	5,442	3,505	4,035	2,821	2,963	2,414	2,767
S&E	31,479	3,986	3,115	2,669	2,479	2,245	2,144	2,056
Engineering	6,142	610	464	281	888	465	346	646
Science	25,337	3,376	2,651	2,388	1,591	1,780	1,798	1,410
Agricultural sciences	827	113	27	68	61	60	23	62
Biological sciences	4,912	700	445	548	264	229	264	297
Computer sciences	1,803	238	141	66	249	93	263	78
Earth, atmospheric, and ocean sciences	1,154	189	113	153	40	90	43	91
Mathematics	3,015	300	407	178	168	217	398	83
Medical/other health sciences	752	105	16	128	62	33	21	36
Physical sciences	6,190	749	1,088	462	375	384	554	412
Psychology	1,174	228	54	216	56	66	37	37
Social sciences	5,510	754	360	569	316	608	195	314
Non-S&E	9,050	1,456	390	1,366	342	718	270	711

NOTE: Data include permanent and temporary residents.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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The Middle East. Between 1991 and 2011, Middle Eastern students earned far fewer U.S. S&E doctorates (about 20,000) than did students from Asia, Europe, or the Americas (tables 2-14, 2-15, and 2-16). Students from Turkey earned the largest number of U.S. S&E doctorates in this region, followed by those from Iran and Jordan. A larger proportion of doctorate recipients from Iran earned their doctorates in engineering (55%) than recipients from any other country above. More than one-third of doctorate recipients from Turkey and Jordan earned their doctorates in engineering, a proportion similar to that from Asian countries.

International S&E Higher Education

In the 1990s, many countries expanded their higher education systems and increased access to higher education. At the same time, flows of students worldwide increased. More recently, a number of countries have adopted policies to encourage the return of students who studied abroad, to attract foreign students, or both. As the world becomes more interconnected, students who enroll in tertiary (post-high school) institutions outside their own countries have opportunities to expand their knowledge of other societies and languages and improve their employability in globalized labor markets.

Higher Education Expenditures

Increasingly, governments around the world have come to regard movement toward a knowledge-based economy as key to economic progress. Realizing that this requires a well-trained workforce, they have invested in upgrading and expanding their higher education systems and broadening participation in them. In most instances, government spending underwrites these initiatives. Recent investments by several governments to send large numbers of their students to study abroad are a strategy for workforce and economic development. Examples include the Brazilian Scientific Mobility Program (also known as “Science without Borders”), launched officially in July 2011, whose goal is to enable 75,000 Brazilian students to study in foreign countries (Knobel 2012). Similarly, the government of Saudi Arabia has invested considerably in a scholarship program launched in 2005 that has supported study abroad for more than 100,000 Saudi students throughout the world, at an estimated cost of at least $5 billion since the program’s inception (Knickmeyer 2012).

One indicator of the importance of higher education is the percentage of a nation’s resources devoted to it, as measured by the ratio of expenditures on tertiary education to gross domestic product (GDP). Between 2005 and 2009, this indicator declined for the United States and Canada, even though

Table 2-16
North American, South American, and Middle Eastern recipients of U.S. S&E doctorates, by field and region/country of origin: 1991–2011

	North and South America[a]				Middle East[b]			
Field	All countries	Canada	Mexico	Brazil	All countries	Turkey	Iran	Jordan
All fields	28,759	11,329	4,458	3,904	19,660	7,257	3,290	2,012
S&E	21,634	7,511	3,717	3,168	16,169	6,138	3,079	1,737
Engineering	4,331	1,098	866	750	7,118	2,728	1,800	783
Science	17,303	6,413	2,851	2,418	9,051	3,410	1,279	954
Agricultural sciences	2,037	263	578	422	627	256	68	84
Biological sciences	4,114	1,614	593	543	1,603	511	300	173
Computer sciences	733	253	112	174	924	348	120	91
Earth/atmospheric/ocean sciences	780	254	140	133	264	109	29	14
Mathematics	1,058	342	204	164	741	299	138	83
Medical/other health sciences	1,030	556	98	172	563	55	66	148
Physical sciences	2,058	903	315	162	1,482	592	322	187
Psychology	1,270	897	84	80	442	123	38	8
Social sciences	4,223	1,331	727	568	2,405	1,117	198	166
Non-S&E	7,125	3,818	741	736	3,491	1,119	211	275

[a] North America includes Bermuda, Canada, and Mexico; South America includes Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela.
[b] Middle East includes Bahrain, Gaza Strip, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, West Bank, and Yemen.

NOTE: Data include permanent and temporary residents.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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of all OECD countries, these countries and South Korea spent the highest percentage of GDP on higher education. Between 1995 and 2005, U.S. expenditures on tertiary education as a percentage of GDP were about double the OECD average; by 2009, this proportion had decreased to about 60% above the OECD average. Between 2005 and 2009, expenditures on tertiary education as a percentage of GDP rose in most other OECD countries; they remained stable in the United Kingdom (appendix table 2-34). As a result of the global recession and fiscal crisis, some European governments have cut investments on higher education. The effects of these cuts are not yet evident in the most recent data.

Higher education funding data are not always comparable across different nations. They can vary between countries for reasons unrelated to actual expenditures, such as differences in measurement, prevalence of public versus private institutions,[44] types and levels of government funding included, and types and levels of education included.

Educational Attainment

Higher education in the United States expanded greatly after World War II. As a result, the U.S. population led the world in educational attainment for several decades. Because of this, the United States offered clear advantages for firms whose work would benefit from the availability of a highly educated workforce. In the 1990s, however, many countries in Europe and Asia began to expand their higher education systems. Some of them have now surpassed the United States in the attainment of degrees from tertiary-type A (see "Glossary") and advanced research programs in their younger cohorts. Over time, the expansion of higher education elsewhere has substantially diminished the U.S. educational advantage and its related economic advantages.

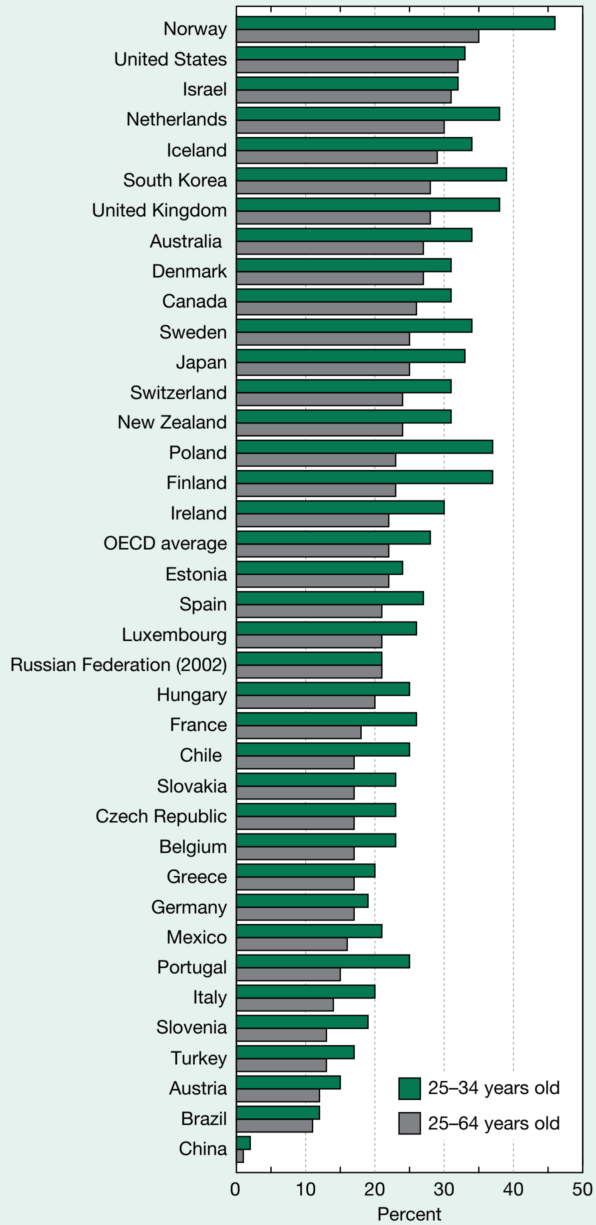
Although the United States continues to be among those countries with the highest percentage of the population ages 25–64 with a bachelor's degree or higher, several other countries have surpassed the United States in the percentage of the younger population (ages 25–34) with a bachelor's degree or higher (figure 2-31; appendix table 2-35).

China has lower tertiary education attainment than all OECD countries. China's tertiary attainment rates are also lower than those of Brazil and Russia, the two non-OECD, G20 countries for which data are available. As in most OECD countries, attainment among the younger population (ages 25–34) in China is higher than in the older population.[45]

First University Degrees in S&E Fields

Almost 17 million students worldwide earned first university degrees in 2010, with about 5.5 million of these in S&E fields (appendix table 2-36). These worldwide totals include only countries for which relatively recent data are available (primarily countries in Asia, Europe, and the Americas) and are therefore underestimates. Asian universities accounted for nearly 2.5 million of the world's S&E first university degrees in 2010, close to half of them in engineering. Students

Figure 2-31
Attainment of tertiary-type A and advanced research programs, by country and age group: 2010



OECD = Organisation for Economic Co-operation and Development.

NOTES: International Standard Classification of Education (ISCED) tertiary-type A programs, ISCED 5A, are largely theory-based and designed to provide sufficient qualifications for entry to advanced research programs and professions with high skill requirements such as medicine, dentistry, or architecture and have a minimum duration of 3 years' full-time equivalent, although they typically last 4 years or longer. In the United States, they correspond to bachelor's and master's degrees. Advanced research programs are tertiary programs leading directly to award of an advanced research qualification (e.g., doctorate).

SOURCE: OECD, *Education at a Glance 2012: OECD Indicators* (2012).

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across Europe (including Eastern Europe and Russia) earned more than 1.5 million first university S&E degrees (nearly 40% of them in engineering), and students in North America earned more than 700,000 such degrees in 2010 (22% in engineering).

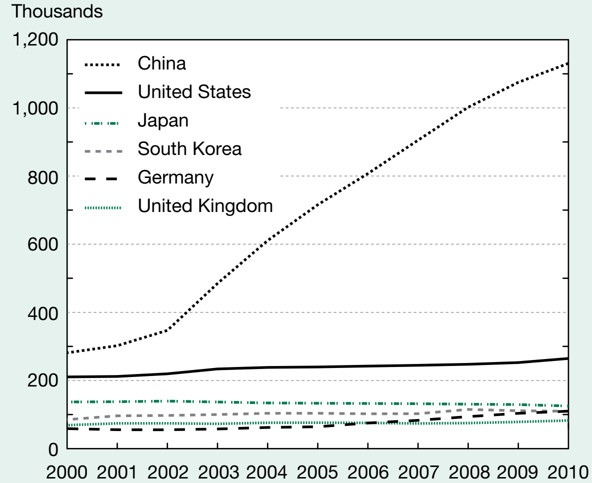
In several countries and economies around the world, the proportion of first university degrees in S&E fields was higher than in the United States. Half or more of all first university degrees in Japan and China were in S&E fields, compared with about one-third in the United States. National differences in engineering degrees largely account for overall differences in the proportion of S&E degrees, given that the disparity was especially large in engineering. However, differences in the taxonomies and quality of engineering programs and level of reporting detail across countries make comparisons problematic. For example, according to Wadhwa et al. (2007), in China in the mid-2000s, the term "engineer" had no standard definition and did not translate well into different dialects, so the reports sent to the Ministry of Education from different Chinese provinces did not count degrees consistently. In the late 1990s, the Chinese government implemented top-down policy changes to increase enrollment in engineering. However, the total number of technical schools and the corresponding teachers and staff declined, which meant that degree awards were achieved by increasing class sizes and student-to-teacher ratios.

China has traditionally awarded a large proportion of its first university degrees in engineering, although the percentage declined from 43% in 2000 to 31% in 2011 (appendix table 2-37). Other places with a high proportion of engineering degrees are Singapore, Iran, South Korea, and Taiwan (appendix table 2-36). In the United States, about 5% of all bachelor's degrees are in engineering. About 11% of all bachelor's degrees awarded in the United States and worldwide are in natural sciences (physical, biological, computer, and agricultural sciences, as well as mathematics).

The number of S&E first university degrees awarded in China, Taiwan, Turkey, Germany, and Poland more than doubled or nearly doubled between 2000 and 2010. During this period, S&E first university degrees awarded in the United States and several other countries (i.e., Australia, Italy, the United Kingdom, Canada, and South Korea) increased between 23% and 56%, whereas those awarded in France, Japan, and Spain declined by 14%, 9%, and 4%, respectively (appendix table 2-37).

Natural sciences and engineering degrees account for most of the increase in S&E first university degrees in China. The number of natural sciences and engineering first university degrees in China grew by more than 300% between 2000 and 2010 (figure 2-32). The number awarded in Germany grew by nearly 90%, and the number awarded in South Korea, the United States, and the United Kingdom increased between 20% and 29%; in Japan, it declined by 9%.

Figure 2-32
First university natural sciences and engineering degrees, by selected country: 2000–10



NOTE: Natural sciences include agricultural sciences; biological sciences; computer sciences; earth, atmospheric, and ocean sciences; and mathematics.

SOURCES: China—National Bureau of Statistics of China, China Statistical Yearbook, annual series (Beijing) various years; Germany and South Korea—Organisation for Economic Co-operation and Development, Education Online Database, http://stats.oecd.org/Index.aspx; Japan—Government of Japan, Ministry of Education, Culture, Sports,Science and Technology, Higher Education Bureau, Monbusho Survey of Education; United Kingdom—Higher Education Statistics Agency; and United States—National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

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In 1999, 29 European countries, through the Bologna Declaration, initiated a system of reforms in higher education throughout Europe. The goal of the Bologna Process was to harmonize certain aspects of higher education within participating countries so that degrees were comparable; credits were transferable; and students, teachers, and researchers could move freely from institution to institution across national borders. Ten years later, the European Higher Education Area was launched, and higher education reform in Europe was extended to 47 participating countries. In recent years, countries have made considerable changes: they have modified higher education structures by implementing three degree cycles (bachelor's, master's, and doctorate), developed quality assurance systems, and established mechanisms to facilitate mobility (EACEA 2012). In 2009, for the first time, the Bologna Process established a quantitative target for student mobility. By 2020, at least 20% of those graduating in the Area should have spent time studying abroad. For details on student mobility in Europe, see sidebar, "Mapping Mobility in European Higher Education."

S&E First University Degrees by Sex

Women earned half or more of first university degrees in S&E in many countries around the world in 2010, including the United States and a number of smaller countries. Most large countries in Europe are not far behind, with more than 40% of first university S&E degrees earned by women. In the Middle East, women earned nearly half or more of the S&E first university degrees in most countries in the region, except for Iraq, Turkey, Iran, and Jordan. In several Asian and African countries, women generally earn about one-third or fewer of the first university degrees awarded in S&E fields (appendix table 2-38).

In Canada, Japan, the United States, and many smaller countries, more than half of the S&E first university degrees earned by women were in the social and behavioral sciences. In South Korea and Singapore, nearly half of the S&E first university degrees earned by women were in engineering, a much higher proportion than in the United States or in any countries in Europe.

Mapping Mobility in European Higher Education

A 2011 study produced for the European Commission's Directorate-General for Education and Culture examines degree mobility and credit mobility into, out of, and between 32 European countries (the European Union [EU]-27, European Free Trade Association [EFTA]-4, and Turkey, also called the "Europe 32 [EU 32] area") (Teichler et al. 2011).

The report distinguishes between two types of student mobility. Degree or diploma mobility includes students who travel abroad to obtain a degree, whereas credit mobility refers to students who study abroad on a more temporary basis. Data for degree mobility come from United Nations Educational, Scientific and Cultural Organization, Organisation for Economic Co-operation and Development, and Eurostat data. For credit mobility, however, there is no comprehensive data set, so the study examines data on participation in ERASMUS, an EU study-abroad program that enables students at higher education institutions in Europe to study in another participating country for a period between 3 months and 1 year.* Although ERASMUS is one of the largest programs of its kind in this region, it supports only a portion of total credit mobility in Europe, so its figures are an underestimation.

Average degree mobility levels in the EU 32 region are high by global standards and increased considerably between 1998–99 and 2006–07. In 2006–07, 1.5 million foreign students, representing 51% of the global student market, were enrolled in a degree program in the EU 32. In addition, despite growing competition worldwide, EU 32 countries have increased their global share of foreign students since 1998–99. The strong growth in foreign enrollment was fueled primarily by students from non-EU 32 nations. These students accounted for 58% of all foreign students in 2006–07, compared with 38% of nationals from EU 32 countries (in the case of 4% of foreign students, the nationality was unknown).

Degree mobility levels differed considerably across countries. Almost two-thirds of all foreign students pursuing a degree in the EU 32 zone were enrolled in one of three countries: the United Kingdom, Germany, and France. In all other countries of the EU 32, regional mobility levels are considerably lower. The proportion of EU 32 students in a degree program in a foreign country grew by nearly 40% between 1998–99 and 2006–07, but growth was considerably lower than that of foreign nationals studying in the EU 32 zone.

Large differences exist between countries. At one extreme, in Cyprus, the majority of citizens are enrolled abroad (1,380 abroad for every 1,000 at home); at the other, in the United Kingdom, studying in a foreign country is rare (12 abroad for every 1,000 in the United Kingdom). The vast majority of students from the EU 32 who are pursuing a degree in another country choose a country in the same region.

With regard to credit mobility, according to ERASMUS statistics, the number of students embarking in a study-abroad program more than doubled in the 11-year period between 1998–99 and 2008–09, to nearly 200,000. Despite this growth, the number of students participating in ERASMUS represents a very small share (less than 1%) of EU 32 students.

Spain, Finland, Malta, Poland, Portugal, and Slovakia are more attractive as study-abroad destinations than for degree-type studies. Compared to the other EU 32 countries in 2006–07, these countries hosted more ERASMUS students than foreign degree students. Although the United Kingdom has a large number of college students, it has one of the lowest numbers of study-abroad students.

In the case of both degree and credit mobility, in 2008–09, 21 out of the 32 countries were either net exporters or net importers. Eastern European countries tended to be net exporters (with the exception of the Czech Republic and Hungary), and countries from Western and Northern Europe tended to be net importers. Ten countries were net importers of degree-seeking students but net exporters of study-abroad students. These countries include Germany, France, the Czech Republic, and Hungary.

Students in the social sciences, business, and law; engineering; and humanities and arts more often embarked on ERASMUS study-abroad programs than students in mathematics, computing, sciences, agriculture, and teacher training and education science.†

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* ERASMUS also provides opportunities for student placements in enterprises and for university staff teaching and training, and it also funds cooperation projects between higher education institutions across Europe.

† The data do not allow comparisons by degree level.

Global Comparison of S&E Doctoral Degrees

More than 200,000 S&E doctoral degrees were earned worldwide in 2010.[46] The United States awarded the largest number of S&E doctoral degrees of any country (about 33,000), followed by China (about 31,000), Russia (almost 16,000), Germany (about 12,000), and the United Kingdom (about 11,000) (appendix table 2-39). About 58,000 S&E doctoral degrees were earned in the European Union (EU; see "Glossary" for member countries).

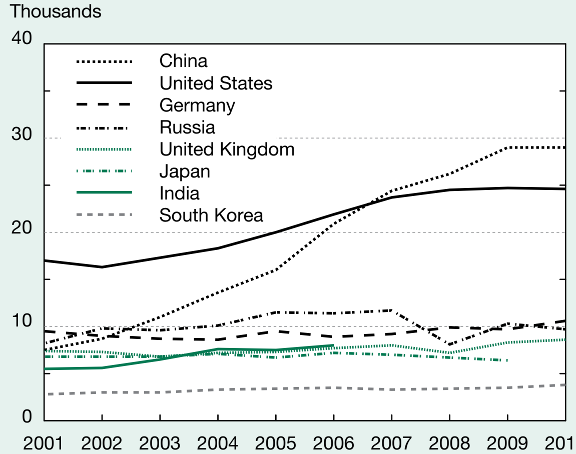
Women earned 41% of S&E doctoral degrees awarded in the United States in 2010, about the same percentage earned by women in Australia, Canada, the EU, and Mexico (appendix table 2-40). In the United States, women earned nearly half of the S&E doctoral degrees awarded to U.S. citizens and permanent residents in 2010 (appendix table 2-31). Women earned close to half of S&E doctoral degrees in Portugal and Italy but less than one-quarter of those in the Netherlands, South Korea, and Taiwan (appendix table 2-40).

The number of S&E doctoral degrees awarded in China rose steeply between 2000 and 2009 and leveled off in 2010. Although the rise was steeper in China, the trend was similar to the recent trend in doctoral production in the United States (appendix tables 2-41 and 2-42).

In 2007, China surpassed the United States as the world's largest producer of natural sciences and engineering doctoral degrees (figure 2-33). In the United States, as well as in France, Germany, Italy, Spain, Switzerland, and the United Kingdom, the largest numbers of S&E doctoral degrees were awarded in the physical and biological sciences (appendix table 2-41).

In Asia, China has been the largest producer of S&E doctoral degrees since 2000 (appendix table 2-42). As China's capacity for advanced S&E education increased, the number of S&E doctorates awarded rose from about 4,000 in 1996 to more than 31,000 in 2010, a substantially faster rate of growth than that of the number of doctorates earned by Chinese citizens in the United States during the same period (figure 2-34). In the mid-1990s the number of "homegrown" Chinese doctorate recipients and the number of doctorate recipients of Chinese origin with U.S. degrees were very similar, but since then the gap has grown considerably because of the large increase of doctorates awarded in China. In 2007, the Chinese Ministry of Education announced that China would begin to limit admissions to doctoral programs and would focus more on quality of graduates (Mooney 2007). The number of S&E doctorates awarded in India, South Korea, and Taiwan also increased from 1996 to 2010, but at a lower rate; in Japan the numbers rose consistently through 2006 but declined in the following years. In China, Japan, South Korea, and Taiwan, more than half of S&E doctorates were awarded in engineering. In India, close to three-quarters of the S&E doctorates were awarded in the physical and biological sciences (appendix table 2-42).

Figure 2-33
Natural sciences and engineering doctoral degrees, by selected country: 2001–10

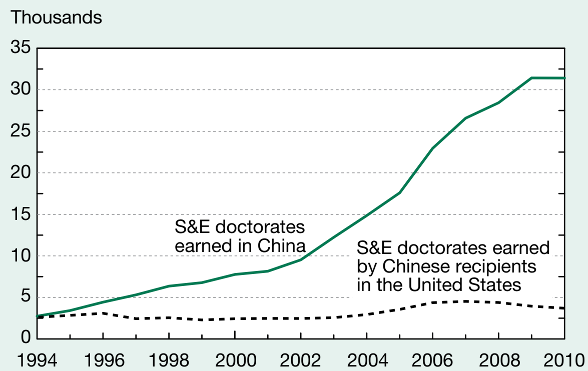


NOTES: Natural sciences and engineering include biological, physical, earth, atmospheric, ocean, and agricultural sciences; computer sciences; mathematics; and engineering. Data for India are not available for 2007–10; data for Japan are not available for 2010.

SOURCES: China—National Bureau of Statistics of China; India—Department of Science and Technology; Japan—Government of Japan, Ministry of Education, Culture, Sports, Science and Technology, Higher Education Bureau, Monbusho Survey of Education; Russia—Institute for Statistical Studies and Economics of Knowledge/National Research University, Higher School of Economics; Germany and South Korea—Organisation for Economic Co-operation and Development, Education Online database, http://www.oecd.org/education/database/; United Kingdom—Higher Education Statistics Agency; and Organisation for Economic Co-operation and Development, Education Online database, http://stats.oecd. org/Index.aspx; United States—National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System (WebCASPAR), http://webcaspar.nsf.gov.

Science and Engineering Indicators 2014

Figure 2-34
S&E doctoral degrees earned by Chinese students at home universities and U.S. universities: 1994–2010



NOTE: Degree recipients in the United States include permanent and temporary residents.

SOURCES: China—National Research Center for Science and Technology for Development and Education Statistics Yearbook of China (various years); United States—National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2012) of the Survey of Earned Doctorates, 2011.

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Global Student Mobility

Students have become more internationally mobile in the past two decades, and countries are increasingly competing for them. According to data from UNESCO, the number of internationally mobile students nearly doubled between 2000 and 2010, to 3.6 million (UNESCO 2011).[47] In general, students migrate from developing countries to the more developed countries and from Europe and Asia to the United States. However, a few countries have emerged as regional hubs in their geographic regions—for example, Australia, China, and South Korea for East Asia and South Africa for sub-Saharan Africa (UNESCO 2009). In addition, several countries have set targets for increasing the numbers of international students they host; among these are Jordan (which plans to host 100,000 students by 2020), Singapore (150,000 by 2015), Japan (300,000 by 2025), and China (500,000 by 2020) (Bhandari and Belyavina 2012).

Some students migrate temporarily for education, whereas others remain abroad permanently after completing their studies. Some factors influencing the decision to seek a degree abroad include the policies of the countries of origin regarding sponsoring their citizens' study abroad, the tuition fee policies of the countries of destination, the financial support the countries of destination offer to international students, the cost of living and exchange rates that affect the cost of international education, and the perceived value of obtaining a foreign credential. The long-term return from international education also depends on how international degrees are recognized by the labor market in the country of origin (OECD 2010). For host countries, enrolling international students can help raise revenues from higher education and can also be part of a larger strategy to attract highly skilled workers, in particular as demographic changes in many developed countries cause their own populations of college-age students to decrease (OECD 2012) (appendix table 2-43).[48]

In recent years, many countries have expanded their provision of transnational education. One growing trend is the establishment of branch campuses: offshore programs established by higher education institutions in foreign countries. Branch campuses give students the opportunity to earn degrees from foreign universities without leaving their home countries. According to research by the Observatory on Borderless Higher Education, by the end of 2011, 200 degree-awarding international branch campuses were operating worldwide, and 37 new ones were planning to open in 2012 and 2013 (Lawton and Katsomitros 2012). Collaborative programs, such as international joint and dual-degree programs, are another trend in transnational education. In these programs, students study at two or more institutions; after successfully completing the requirements, they receive a separate diploma from each institution in dual-degree programs or a single diploma representing both institutions in joint degree programs (CGS 2010). The most common fields for dual degrees at the master's level are business, engineering, and the social sciences; at the doctoral level, engineering and physical sciences predominate (for additional details, see sidebar, "Transnational Higher Education," in NSB 2012).

More internationally mobile students (both undergraduate and graduate) go to the United States than to any other country (figure 2-35). Other top destinations for international students include the United Kingdom (11%), Australia (7%), France (7%), and Germany (6%). Together with the United States, these countries receive about half of all internationally mobile students worldwide.

Although the United States remains the destination for the largest number of internationally mobile students

Figure 2-35
Internationally mobile students enrolled in tertiary education, by selected country: 2010

NOTES: Data are based on the number of students who have crossed a national border and moved to another country with the objective of studying (i.e., mobile students). Data for Canada and the Russian Federation correspond to 2009. Data for the Netherlands and Germany exclude advanced research programs (e.g., doctorate). Data for Spain exclude advanced research programs and tertiary-type B programs (e.g., associate's).

SOURCE: UNESCO Institute for Statistics, special tabulations (2013).

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worldwide, its share in all fields has declined from 25% in 2000 to 19% in 2010 (UNESCO 2011). Between 2005 and 2010, the U.S. share in the natural sciences and engineering declined as well, but an increase in international students coming to the United States to study social and behavioral sciences kept the overall S&E share stable (table 2-17).

In the United States, international students are a small proportion (about 3%) of students enrolled in higher education (including both undergraduate and graduate levels); this proportion is higher at the graduate level. In other countries, the proportion of international students is much higher. Australia, with a much smaller higher education system than the United States, has a higher percentage (21%) of international students but a lower share (7%) of international students worldwide. Other countries with relatively high percentages of international higher education students in their higher education systems include the United Kingdom (16%), Austria (15%), Switzerland (15%), and New Zealand (14%).[49] In Switzerland and the United Kingdom, more than 4 out of 10 doctoral students are international students. A number of other countries, including New Zealand, Australia, the United States, Ireland, Sweden, and Canada, have relatively high percentages (more than 20%) of doctoral students who are internationally mobile (OECD 2012).

Since the late 1990s, the United Kingdom has been actively working to improve its position in international education, both by recruiting foreign students to study in the country and by expanding its provision of transnational education (British Council 2013; UK Council for International Student Affairs 2013). Between 1994 and 2010, foreign student enrollment in S&E fields in the United Kingdom increased, especially at the graduate level, with increasing flows of students from China and India (appendix table 2-44). The overall pattern of top countries is similar to that of the United States. In 2010, foreign students made up 48% of all graduate students studying S&E in the United Kingdom (an increase from 29% in the mid-1990s). Foreign students accounted for 60% of graduate students in mathematics and computer sciences, as well as in engineering. Students from China and India accounted for most of the increase, but the number of graduate students from Nigeria, Pakistan, the United States, France, Ireland, and Germany also increased considerably. At the undergraduate level, the overall percentage of foreign students in S&E did not increase as much during this period. As a result of recent stricter student visa regulations that apply to those from non-EU countries, in the last year, foreign enrollment declined at the graduate level, mainly due to a decline in the number of students from India and Pakistan. The declines were larger in mathematics and computer sciences and in engineering (appendix table 2-44).

Japan has increased its enrollment of foreign students in recent years (both in S&E and in all fields) and in 2008 announced plans to triple foreign enrollment in 12 years (McNeil 2008, 2010). Nonetheless, growth has slowed considerably in the last 2 years (appendix table 2-45; appendix table 2-41 in NSB 2012), perhaps caused in part by the March 2011 earthquake and tsunami (McNeil 2012). In 2012, slightly more than 70,000 foreign students were enrolled in S&E programs in Japanese universities, similar to 2010, and up from 57,000 in 2004. Unlike in the United Kingdom, foreign S&E student enrollment in Japan is concentrated at the undergraduate level, accounting for more than two-thirds of all foreign S&E students. Foreign nationals accounted for 3% of undergraduate and 17% of graduate

Table 2-17
Internationally mobile students in selected OECD countries and the United States: 2005 and 2010

			S&E					
	All fields		Total		Natural sciences and engineering		Social and behavioral sciences	
Host location	2005	2010	2005	2010	2005	2010	2005	2010
Worldwide	2,814,917	3,645,622	NA	NA	NA	NA	NA	NA
OECD countries[a]	2,128,579	2,574,710	800,052	995,295	598,416	746,718	201,635	248,577
United States	590,158	684,807	242,358	301,447	202,516	245,937	39,842	55,510
United States/OECD (%)[a]	27.7	26.6	30.3	30.3	33.8	32.9	19.8	22.3
United States/ worldwide (%)	21.0	18.8	NA	NA	NA	NA	NA	NA

NA = not available.

OECD = Organisation for Economic Co-operation and Development.

[a] OECD countries include those where data on internationally mobile students by field of study were available: Austria, Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

NOTE: Internationally mobile students are students who have crossed a national border and moved to another country with the objective of studying (i.e., mobile students).

SOURCE: UNESCO Institute for Statistics, special tabulations (2013).

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S&E students in Japan. The vast majority of the foreign students were from Asian countries. In 2012, Chinese students accounted for 70% of the foreign S&E undergraduate students and 59% of the foreign S&E graduate students in Japan. South Koreans were 18% of the foreign undergraduates and 9% of the foreign graduate students. Indonesia, Vietnam, Malaysia, Thailand, Mongolia, and Nepal were among the top 10 countries of origin for both undergraduates and graduate students (appendix table 2-45).

Foreign students constitute an increasing share of enrollment in Canadian universities at the undergraduate level. In 2010, foreign S&E students accounted for about 7% of undergraduate S&E enrollment in Canada, up from 5% in 2000. At the graduate level, the proportion of foreign students in S&E fields was stable during that period (19%). In 2010, at both the undergraduate and graduate levels, the highest percentages of foreign S&E students were in mathematics and computer sciences and in engineering. At the undergraduate level, China was the top country of origin of foreign S&E students in Canada, accounting for 13% of foreign undergraduate students, followed by France and the United States (11% each). At the graduate level, the top country of origin of foreign S&E students was France (13%), followed by Iran and China (11% each) (appendix table 2-46).

Although the United States hosts the largest number of international students worldwide, U.S. students constitute a relatively small share of foreign students worldwide. About 57,000 U.S. students (in all fields) were reported as foreign students by OECD and OECD-partner countries in 2010, far fewer than the number of foreign students from China, India, South Korea, Germany, Turkey, or France. The main destinations of U.S. students were the United Kingdom (15,600), Canada (9,100), Germany (3,900), France (3,400), New Zealand (3,200), and Australia (3,000)—mostly English-speaking OECD countries (OECD 2012).

Nearly 275,000 U.S. university students enrolled in study-abroad programs in the 2010–11 academic year (credit mobility), a 1% increase from the preceding year but a 78% rise from 2000–01 (IIE 2012). Nearly 40% were enrolled in programs during the summer term; more than one-third enrolled in programs lasting one semester, 13% in short-term programs lasting up to 8 weeks, 4% for the academic or the calendar year, and the rest for one or two quarters or a month. About 9% were master's and 1% were doctoral students; the rest were undergraduates, primarily juniors or seniors. Nearly two-thirds of the U.S. students studying abroad were women and more than three-quarters were white. More than one-third were studying in S&E fields: 23% in social sciences, 8% in physical or life sciences, 4% in engineering, 2% in mathematics or computer sciences, and 1% in agricultural sciences; these proportions have been stable since 2000–01. The leading destinations for study-abroad programs in the 2010–11 academic year were the United Kingdom, Italy, and Spain, followed by France and China.

According to a recent study conducted by IIE and Project Atlas, more than 43,000 U.S. students are enrolled in academic degree programs in the 13 countries represented (degree mobility). Most students were enrolled in master's degree programs (44%), followed by students in bachelor's degree programs (39%) and doctoral programs (19%). Almost three-quarters of them studied in Anglophone countries; the top destination was the United Kingdom. Humanities, social sciences, and business and management were the most popular broad fields of study for students pursuing a degree abroad (Belyavina and Bhandari 2012).

Conclusion

S&E higher education in the United States is attracting growing numbers of students. The number of bachelor's and master's degrees awarded in all fields and in S&E fields continues to rise, having reached new peaks in 2011. Most of the growth in undergraduate S&E education occurred in science fields, in particular in the social and behavioral sciences and in the biological sciences. In engineering, bachelor's degrees have increased consistently for the last 10 years but have not yet reached the record high levels attained in the 1980s. After a steep decline between 2004 and 2007, computer sciences degree awards began to rebound. The number of master's and doctoral degrees awarded grew in all major S&E fields. In the last decade, growth in doctoral degrees awarded occurred mostly in the natural sciences and engineering fields.

Over the last two decades, higher education spending and revenue patterns and trends have undergone substantial changes, which intensified during the recent economic downturn. Public institutions faced competing demands in a tight budget environment, caught between declining state appropriations and the need to maintain educational quality and access. Community colleges, which serve diverse groups of students and play a key role in increasing access to higher education, were particularly affected, as the number of students seeking an affordable college education increased.

Foreign student enrollment in S&E has recovered since the decline post-9/11. In recent years, foreign student enrollment has increased considerably at the undergraduate and graduate levels, both in S&E and non-S&E fields.

Globalization of higher education continues to expand. Universities in several other countries have expanded their enrollment of foreign S&E students. The United States continues to attract the largest number and fraction of internationally mobile students worldwide, although its share of foreign students in all fields has decreased in recent years. The share of international students in the natural sciences and engineering fields declined as well, but an increase in international students coming to the United States to study social and behavioral sciences has kept the overall S&E share stable.

Higher education is undergoing rapid transformation. The growth of distance and online education through MOOCs and similar innovations expands access to knowledge and has the potential to decrease the cost of some degrees, at the same time as pressures have been increasing to reduce rising costs. However, it is too early to assess whether MOOCs will be widely adopted by different types of institutions, whether increased access will be accompanied by increased learning, and what consequences online and distance innovations will bring to the higher education landscape.

Notes

1. Data on postdoctoral scientists and engineers are included in chapters 3 and 5. Data on stay rates of doctorate recipients are included in chapter 3.

2. U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), fall 2011, Institutional Characteristics component, special tabulation.

3. For a crosswalk between the Classification of Instructional Programs (CIP) codes and the academic fields in enrollment and completion tables, see https://webcaspar.nsf.gov/Help/dataMapHelpDisplay.jsp?subHeader=DataSourceBySubject&type=DS&abbr=DEGS&noHeader=1&JS=No, accessed 23 August 2013.

4. High Hispanic enrollment institutions are those whose undergraduate, full-time equivalent student enrollment is at least 25% Hispanic, according to fall 2011 data in the Integrated Postsecondary Education Data System, directed by the National Center for Education Statistics. HBCUs are listed by the White House Initiative on Historically Black Colleges and Universities. The Higher Education Act of 1965, as amended, defines an HBCU as “any historically black college or university that was established prior to 1964, whose principal mission was, and is, the education of black Americans, and that is accredited by a nationally recognized accrediting agency or association determined by the Secretary [of Education] to be a reliable authority as to the quality of training offered or is, according to such an agency or association, making reasonable progress toward accreditation.”

5. Minority-serving institutions include HBCUs (see endnote 4), high Hispanic enrollment institutions, and tribal colleges.

6. See tables 5-8, 5-9, and 5-10 in NSF/NCSES 2013a for additional details.

7. U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), fall 2011, Institutional Characteristics component, special tabulation.

8. In 2011–12 IPEDS began asking institutions whether they were exclusively a distance education institution, that is, whether all of their programs were offered via distance education, defined as “education that uses one or more technologies to deliver instruction to students who are separated from the instructor and to support regular and substantive interaction between the students and the instructor synchronously or asynchronously.” A distance education course is a course in which the instructional content is delivered exclusively via distance education. A distance education program is a program for which all the required coursework for program completion can be completed via distance education courses. Examinations, orientation, and practical experience components of courses or programs are not considered instructional content. For more details, see the IPEDS online glossary at http://nces.ed.gov/ipeds/glossary/.

9. For the definition of “net tuition revenue,” see “Glossary.” Definitions of standard expense categories are available at http://www.deltacostproject.org/resources/pdf/Delta-Spending-Trends-Production.pdf, and an explanation of revenue sources is available at http://www.deltacostproject.org/pdfs/Revenue_Trends_Production.pdf.

10. Another large source of revenue for very high research institutions is “hospitals, independent operations, and other sources,” which includes revenue generated by hospitals operated by the institution and revenues independent of or unrelated to instruction, research, or public services.

11. In 2010, income from private and affiliated gifts, investment returns, and endowment income at private very high research institutions ($62,000 per FTE) was more than the income from net tuition ($23,000 per FTE) and federal appropriations ($28,000 per FTE) combined (appendix table 2-4).

12. Another large source of expenditures for very high research institutions is “auxiliary enterprises, hospitals and clinics, and independent and other operations.” Auxiliary enterprises include dormitories, bookstores, and meal services.

13. The 4-year and graduate institutions category includes the following 2005 Carnegie institution types: doctorate-granting universities/high research activity, doctoral/research universities, master’s colleges/universities, and baccalaureate colleges. The figures in this section correspond to the public institutions.

14. Community colleges are the public “associate’s colleges” in the 2005 Carnegie Classification.

15. The proportion of U.S.-trained doctorate holders employed at community colleges in adjunct positions grew from 12% in 1993 to 28% in 2010, according to estimates from the Survey of Doctorate Recipients. This suggests that one of the ways community colleges may have reined in expenses during this period was to increase their reliance on adjuncts.

16. In this section, data on net tuition and fees paid by full-time undergraduate students are based on data reported to the College Board by colleges and universities in the Annual Survey of Colleges. Net tuition and fees equal published tuition and fees minus total grant aid and tax benefits. Data on net tuition revenues reported in the section “Trends in Higher Education Revenues and Expenditures” are based on IPEDS data. Net tuition revenue, in this case, is the amount of money the institution takes in from students after institutional grant aid is provided.

17. For more details, see Figure 2009_8 at http://trends.collegeboard.org/college-pricing/figures-tables/net-prices-by-income-over-time-public-sector and Figure 2009_9 at http://trends.collegeboard.org/college-pricing/figures-tables/net-prices-by-income-over-time-private-sector. Accessed 29 July 2013.

18. Clinical psychology programs and programs that emphasize professional practice (professional schools and PsyD programs) are associated with higher debt, but even in the more research-focused subfields of psychology, lower percentages of doctorate recipients were debt-free, and higher percentages had higher levels of debt, than those in other S&E fields. For information on debt levels of clinical versus nonclinical psychology doctorates in 1993–96, see *Psychology Doctorate Recipients: How Much Financial Debt at Graduation?* (NSF 00-321) at http://www.nsf.gov/statistics/issuebrf/sib00321.htm (accessed 6 November 2013).

19. The population projections in this section and in appendix table 2-15 are based on the latest population projections published by the Census Bureau, which are in turn based on the 2010 Census (http://www.census.gov/population/projections/data/national/2012/downloadablefiles.html, accessed 15 May 2013). In its publication "Projection of Education Statistics," NCES projects enrollment trends in postsecondary institutions. However, in the latest publication (Hussar and Bailey 2013), NCES used Census projections from 2008, which were based on the 2000 Census. Unlike the Census Bureau, NCES incorporates disposable income (a measure of ability to pay) and age-specific unemployment rates (a measure of opportunity costs) in its projections.

20. These data are from sample surveys and are subject to sampling error. Information on estimated standard errors can be found in appendix D of the annual report *The American Freshman: National Norms Fall 2012*, published by the Cooperative Institutional Research Program of the Higher Education Research Institute, University of California–Los Angeles (http://www.heri.ucla.edu/monographs/TheAmericanFreshman2012.pdf). Data reported here are significant at the 0.05 level.

21. The number of S&E degrees awarded to a particular freshman cohort is lower than the number of students reporting intentions to major in S&E. It reflects losses of students from S&E, gains of undecided students and students from non-S&E fields after their freshman year, and general attrition from bachelor's degree programs.

22. The PCAST report also included associate's degrees trends in the natural sciences and engineering. The proportion of associate's degrees in these fields was also fairly stable at about 5%, except in the early 2000s when it increased to 8%–9% because of the rise in the number of associate's degree awards in computer sciences, which declined after 2004.

23. The data in this section come from the Institute of International Education (IIE) and the Student and Exchange Visitor Information System (SEVIS). IIE conducts an annual survey of about 3,000 accredited U.S. higher education institutions. An international student in this survey is defined as anyone studying at an institution of higher education in the United States on a temporary visa that allows academic coursework, primarily F and J visas. SEVIS collects administrative data, including the numbers of all foreign national students enrolled in colleges and universities in the United States. Data on exchange visitors are not included in this chapter; some limited data on this topic can be found in chapter 3.

24. The figures include active foreign national students on F-1 visas in the SEVIS database, excluding those participating in optional practical training (OPT). Students with F visas have the option of working in the United States by engaging in OPT, temporary employment directly related to the student's major area of study, either during or after completion of the degree program. Students can apply for 12 months of OPT at each level of education. Starting in 2008, students in certain STEM fields became eligible for an additional 17 months of OPT. The number of students in OPT varies according to labor market conditions. According to data from SEVIS, the number of students with F1 visas in OPT declined sharply between November 2010 and November 2011 and rose back up steeply by November 2012 (68,510 in November 2010; 22,820 in November 2011; and 80,680 in November 2012).

25. These data include foreign students pursuing both bachelor's and associate's degrees. Comparable data for U.S. citizen and permanent resident students do not exist. However, the proportion of S&E associate's and bachelor's degree awards earned by U.S. citizens and permanent residents is considerably lower.

26. About 14% of recent S&E bachelor's degree recipients who earned their degree between 1 July 2007 and 30 June 2009 had previously earned an associate's degree (National Science Foundation, National Center for Science and Engineering Statistics, National Survey of Recent College Graduates 2010, special tabulation).

27. Data on degree completion from NCES were obtained from WebCASPAR (https://webcaspar.nsf.gov/). Data uploaded in WebCASPAR correspond to NCES provisional data, which undergo all NCES data quality control procedures and are imputed for nonresponding institutions. These data are used by NCES in their First Look (Provisional Data) publications.

28. Data for racial and ethnic groups are for U.S. citizens and permanent residents only.

29. Data on degree completion from NCES were obtained from WebCASPAR (https://webcaspar.nsf.gov/). Data uploaded in WebCASPAR correspond to NCES provisional data, which undergo all NCES data quality control procedures and are imputed for nonresponding institutions. These data are used by NCES in their First Look (Provisional Data) publications.

30. For longer trends in degrees, see NSB 2010. For more detail on enrollment and degrees by sex and by race and ethnicity, see NSF/NCSES 2013a.

31. Data for racial and ethnic groups are for U.S. citizens and permanent residents only.

32. The Survey of Graduate Students and Postdoctorates in Science and Engineering was redesigned in 2007. Because of methodological changes, the data collected from 2007 through 2010 are not strictly comparable to those collected before 2007. As a result, care should be used when assessing trends within the GSS data. Throughout the appendix tables in this chapter, "2007new" reports the data as collected in 2007, and "2007old" provides the data as they would have been collected in 2006. In addition, between 2008 and 2010, the survey conducted a more rigorous follow-up with institutions regarding the exclusion of practitioner-oriented graduate degree programs. Some or all of the declines in psychology and other health fields in 2008–10 are likely due to this increased effort to exclude practitioner-oriented graduate degree programs rather than changes in actual enrollments. Care should therefore be used when examining long-term trends. Because of this methodological change, in this section, "S&E" excludes psychology and other health fields. For a detailed discussion on the survey redesign, please see appendix A, "Technical Notes," in *Graduate Students and Postdoctorates in Science and Engineering: Fall 2007* (http://www.nsf.gov/statistics/nsf10307/).

33. Special tabulation NSRCG (2003, 2006, 2008, 2010).

34. See NSF/NCSES 2013a for more detail on enrollment of foreign students by sex.

35. The figures include active foreign national students on F-1 visas in the SEVIS database, excluding those on OPT (temporary employment directly related to the student's major area of study either during or after completion of the degree program). See endnote 24.

36. Data on degree completion from NCES were obtained from WebCASPAR (https://webcaspar.nsf.gov/). Data uploaded in WebCASPAR correspond to NCES provisional data, which undergo all NCES data quality control procedures and are imputed for nonresponding institutions. These data are used by NCES in their First Look (Provisional Data) publications.

37. Chapter 3 includes a sidebar on a 2012 NIH report discussing how employment patterns in the biological sciences have changed in the last two decades.

38. Data for racial and ethnic groups are for U.S. citizens and permanent residents only.

39. In 2008, NCES allowed optional reporting in three new doctoral degree categories: doctor's—research/scholarship, doctor's—professional practice, and doctor's—other. Degrees formerly classified as professional degrees (e.g., MDs and JDs) could then be reported as doctoral degrees, most often as doctor's—professional practice. Data for 2008 and 2009 included only those doctorates reported under the old category plus those reported as doctor's—research/scholarship. Data for 2010 and 2011 included data reported as doctor's—research/scholarship, as the old category was eliminated. As a result of these methodological changes, doctor's—research/scholarship degrees in "other health sciences" declined sharply between 2009 and 2010. To facilitate comparability over time, "S&E" excludes "other health sciences" throughout the sections "S&E Doctoral Degrees," "Doctoral Degrees by Sex," and "Doctoral Degrees by Race and Ethnicity."

40. Data on degree completion from NCES were obtained from WebCASPAR (https://webcaspar.nsf.gov/). Data uploaded in WebCASPAR correspond to NCES provisional data, which undergo all NCES data quality control procedures and are imputed for nonresponding institutions. These data are used by NCES in their First Look (Provisional Data) publications.

41. See table 32 in the *2011 Doctorate Recipients from U.S. Universities* report (NSF/NCSES 2012), where broad fields are aggregated as follows: life sciences includes agricultural sciences and natural resources, biological and biomedical sciences, and health sciences; physical sciences includes mathematics and computer and information sciences; and social sciences includes psychology.

42. For the corresponding proportion in the 1990s, see NSB 2008.

43. The number of S&E doctorate recipients from China surpassed that of Taiwan in 1990. Up until that year, Taiwanese students earned more U.S. S&E doctorates than Chinese, Indian, or South Korean students. (See NSB 2008 figure 2-25 and NSB 2010 figure 2-22.)

44. According to an international database compiled by the Program for Research on Private Higher Education, at the State University of New York at Albany, the United States and Japan have long-standing private higher education sectors, and Western Europe has an almost completely public higher education sector. Eastern and Central Europe and several African countries have recently seen growth in private higher education. In most countries in Latin America, more than half of all higher education institutions are private. For more information, see http://www.albany.edu/dept/eaps/prophe/index.html (accessed 15 May 2013).

45. These data are based on national labor force surveys and are subject to sampling error; therefore, small differences between countries may not be meaningful. The standard error for the U.S. percentage of 25–64-year-olds with a bachelor's or higher degree is roughly 0.1, and the standard error for the U.S. percentage of 25–34-year-olds with a bachelor's or higher degree is roughly 0.4.

46. In international degree comparisons, S&E does not include medical or health fields. This is because international sources cannot separate the MD degrees from degrees in the health fields, and the MDs are professional or practitioner degrees, not research degrees.

47. Internationally mobile students are students who have crossed a national or territorial border for the purposes of education and are now enrolled outside their country of origin. This concept is different from "foreign students," which

are those who are not citizens of the country where they are enrolled, but may, in some cases, be long-term residents or have been born in the country (OECD 2012).

48. The population of individuals ages 20–24 (a proxy for the college-age population) decreased in China, Europe, Japan, and the United States in the 1990s and is projected to continue decreasing in China, Europe (mainly Eastern Europe), Japan, South Korea, and South America. The U.S. population of 20–24-year-olds is projected to increase.

49. In Luxembourg, international students represent 41%, mostly due to the high level of integration with neighboring countries (OECD 2012).

Glossary

Baccalaureate-origin institution: The college or university from which an S&E doctorate recipient earned a bachelor's degree.

Credit mobility: Short-term, for-credit foreign study and exchange programs that last less than a full school year.

Degree or diploma mobility: For-credit foreign study programs in which students pursue a higher education degree outside their usual country of residence.

European Union (EU): As of June 2013, the European Union comprised 27 member nations: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Croatia joined the EU in July 2013. Unless otherwise noted, Organisation for Economic Co-operation and Development data on the EU include all 28 members; data on the EU from other sources are limited to the 27 nations that were members as of June 2013.

First university degree: A terminal undergraduate degree program; these degrees are classified as level 5A first university in the International Standard Classification of Education, which is developed by UNESCO, although individual countries use different names for the first terminal degree (e.g., *corso di Laurea* in Italy, *diplom* in Germany, *licence* in France, and *bachelor's degree* in the United States and in Asian countries).

G20: Group of Twenty brings together finance ministers and central bank governors from Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States, and the EU.

Internationally mobile students: Students who have crossed a national or territorial border for purposes of education and are now enrolled outside their countries of origin. This term refers to degree mobility in data collected by UNESCO/UNESCO Institute for Statistics, OECD, and Eurostat and excludes students who travel for credit mobility.

Natural sciences: Include agricultural; biological; computer; earth, atmospheric, and ocean; and physical sciences and mathematics.

Net price: The published price of an undergraduate college education minus the average grant aid and tax benefits that students receive.

Net tuition revenue: Total revenue from tuition and fees (including grant and loan aid used by students to pay tuition); excludes institutional student aid that is applied to tuition and fees.

Tertiary-type A programs: Higher education programs that are largely theory based and designed to provide sufficient qualifications for entry to advanced research programs and to professions with high skill requirements, such as medicine, dentistry, or architecture. These programs have a minimum duration of 3 years, although they typically last 4 or more years and correspond to bachelor's or master's degrees in the United States.

Tertiary-type B programs: Higher education programs that focus on practical, technical, or occupational skills for direct entry into the labor market and have a minimum duration of 2 years. These programs correspond to associate's degree programs in the United States.

Underrepresented minorities: Blacks, Hispanics, and American Indians and Alaska Natives are considered to be underrepresented minorities in S&E.

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