



# Education Research Brief

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Office of Strategic Planning, Research, and Evaluation

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## Supply and demand of STEM workers

STEM jobs are growing, but are enough Massachusetts students qualified?

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Jobs in science, technology, engineering, and mathematics (STEM) are the backbone of the Massachusetts economy. They comprise a substantial share of employment: about 13 percent of the state's jobs and one-third of its gross state product are related to STEM. And they also generate jobs in other fields, such as business and professional services, further increasing their impact on the economy. These are highly creative, high-paying, and fast-growing jobs: the kinds of jobs the Commonwealth will need to keep if it is to remain economically healthy.

Massachusetts students perform relatively well on high school assessments in mathematics and science, and many are preparing to enter careers in STEM-related fields. Even so, some signals indicate that the state may not be producing enough well-qualified students to fill all the available jobs in these fields. Many STEM occupations are seeing increasing job vacancy rates within the state, indicating a possible mismatch of supply and demand. To bolster the state economy and ensure that its students remain competitive for Massachusetts-based STEM jobs, the Commonwealth will need to improve the STEM education of all students and strengthen the pipeline from high school through college and beyond.

### STEM supply and demand

The Massachusetts Statewide STEM Indicators Project (MASSIP)<sup>1</sup> has defined STEM-related *occupations* as architecture and engineering occupations; computer and mathematical occupations; life, physical, and social science occupations; and healthcare practitioner and technical occupations. Using this definition, roughly 438,000 people were employed in STEM occupations in Massachusetts in 2004. These workers compose 13 percent of the state's total employment and one-third of the state's managerial, professional, and technical workforce.<sup>2</sup>

Similarly, the *industries* that tend to employ a disproportionate share of STEM workers—professional and technical services, healthcare, information, and finance and insurance—also represent a significant share of the state's economy. According to data from the

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<sup>1</sup> MASSIP is a joint project by the University of Massachusetts Donahue Institute and the Massachusetts Board of Higher Education to develop benchmark STEM education and economic data indicators.

<sup>2</sup> UMass Donahue Institute, Research and Evaluation Group. *Massachusetts Statewide STEM Indicators Project (MASSIP): Overview of Indicators and Year One Data*. July 2006.

Bureau of Economic Analysis, these four industries together contributed one-third of the state's entire gross state product in 2005 as well as most of the state's net growth in gross state product between 2004 and 2005.

Looking forward, the Massachusetts Department of Workforce Development projects faster-than-average job growth for all four of the state's core STEM occupational groups (see Table 1). Thirty percent of the state's total employment growth in the next decade will come from just these four groups. This will yield nearly 80,000 net new positions and a total of 160,000 job openings in STEM occupations, or roughly 16,000 open STEM positions per year.<sup>3</sup>

Table 1: Projected growth in STEM occupations in Massachusetts, 2004 to 2014

Occupation	Jobs in 2004		Projected jobs in 2014		Growth rate
	Number	% of total	Number	% of total	
Healthcare practitioners & technical	197,310	20.0%	231,920	24.1%	17.5%
Computer & mathematical	116,000	11.8%	146,010	20.9%	25.9%
Life, physical, & social sciences	47,470	4.8%	54,890	5.2%	15.6%
Architecture & engineering	77,330	7.8%	84,710	5.1%	9.5%
<i>Total, STEM occupations</i>	<i>438,110</i>	<i>12.8%</i>	<i>517,530</i>	<i>14.0%</i>	<i>18.1%</i>
<i>Total, all occupations</i>	<i>3,421,650</i>	<i>100.0%</i>	<i>3,687,430</i>	<i>100.0%</i>	<i>7.8%</i>

Source: Massachusetts Department of Workforce Development, *Massachusetts Employment Projections Through 2014*.

Out of the 30 occupations expected to grow the fastest in Massachusetts over the next decade, 20 are STEM occupations, and an additional 5 are in occupations that support STEM workers (e.g., home health aides and medical assistants). These positions also tend to require significant amounts of education. According to the Department of Workforce Development's most recent projections, nearly all of the expected job openings in STEM occupations over the next decade will require at least an associate's degree, and more than half will require a bachelor's degree.

Indications show that filling STEM positions is becoming increasingly difficult. Several STEM-related occupations are beginning to experience high job vacancy rates, which can be a symptom of a gap between workforce supply and demand. The most recent state survey of job vacancies, from second quarter 2006, showed that all four of the state's STEM occupational groups were experiencing job vacancy rates at or above the statewide vacancy rate average of 3.0 percent.<sup>4</sup> Life, physical, and social sciences were particularly heavily affected, with vacancy rates of 5.9 percent, or nearly double the state average; similarly, 4.4 percent of healthcare occupations were vacant. All four occupations also appeared in

<sup>3</sup> Massachusetts Department of Workforce Development. *Employment Projections 2004-2014: Current and Projected Employment by Occupation and Education and Training Requirements*.

<sup>4</sup> Massachusetts Department of Workforce Development. *Massachusetts Job Vacancy Survey: Hiring Trends by Industry and Occupation, 2<sup>nd</sup> Quarter 2006*.

Commonwealth Corporation's recent list of occupations with critical vacancies in Massachusetts.<sup>5</sup>

One might expect that these high job vacancies might be driven, at least partially, by lack of interest in these fields. But puzzlingly, the strong demand for students trained in STEM fields is matched by significant student interest in these fields, especially at the high school level. According to data from the College Board, 36 percent of the state's college-bound juniors taking the PSAT in 2006-2007 indicated an interest in a STEM-related major.<sup>6</sup> This compares to 16 percent interested in the humanities; 13 percent in business, 11 percent in the social sciences, 4 percent in education; and the remainder in other fields or undecided. At the college level, one-fifth of post-high school degrees awarded in Massachusetts (at all levels, from associate's through Ph.D.) are in STEM-related fields, yielding nearly 20,000 new college graduates prepared for STEM work each year.<sup>7</sup>

With a projected 16,000 open STEM positions each year as compared to 20,000 new STEM graduates, why is the state seeing evidence of possible shortages of STEM workers?

### Mobility and the market

One important factor is the time lag between degree choice and job entry. Students choose their fields of study at least partially on the basis of the condition of the labor market. But they do not complete school until four or five years later, when labor market conditions may have changed. For instance, data from the Integrated Postsecondary Education Data System of the U.S. Department of Education demonstrate that the state saw a substantial decline in student completions of computer science programs in the mid 2000s, with more than a 10 percentage point decline in completions between 2003 and 2005 alone. This drop-off likely reflects the economic declines in the technology industry in the recession of the early 2000s, which took a few years to filter into college major choices. The technology industry is on the rise again, but it will take a few years before students perceive that economic signal and gravitate back towards technology fields. In the meantime, technology fields are seeing high vacancy rates. Thus, it is possible that the shortages may be due to a mismatch or missed signals between students' fields of study and employers' needs.

But even more importantly, people are mobile. No reliable data are available on what share of the 20,000 Massachusetts college STEM graduates stay in the state after graduation, nor what share of the state's high school graduates with STEM interests ultimately settle in Massachusetts for employment. But it is certainly plausible that a sizable share may move out-of-state. The market for STEM employment is national and even international in scope, and other factors like cost of living or quality of life may make other states more attractive to young graduates.

Just as Massachusetts job seekers may look out-of-state for employment, Massachusetts employers hiring in STEM fields can draw upon a national and international pool of

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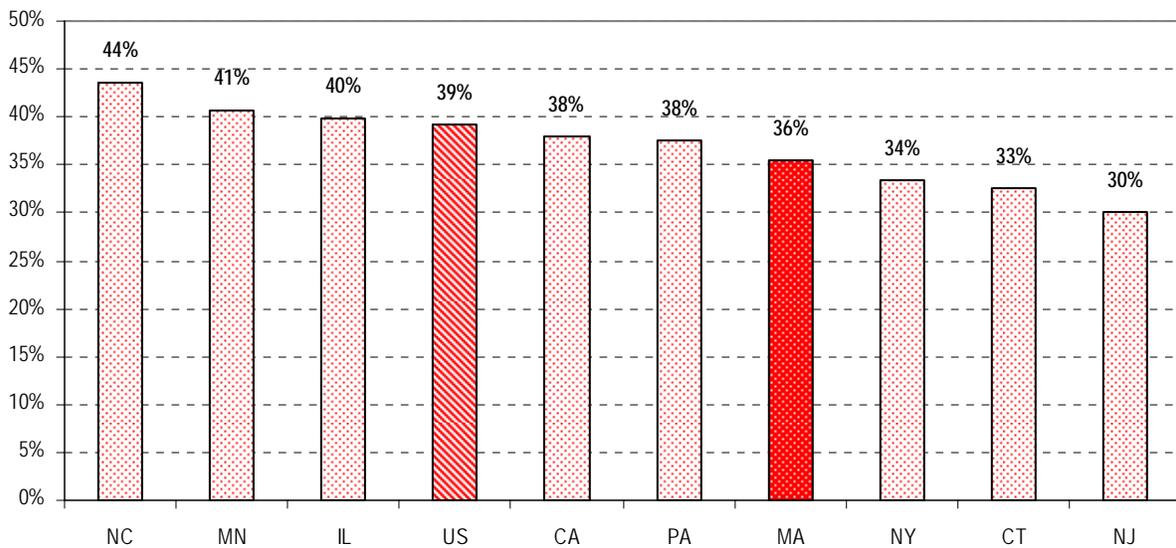
<sup>5</sup> Navjeet Singh and Jonathan Latner, Commonwealth Corporation. "Where are the Critical Vacancies?" Research and Evaluation Brief, March 2007.

<sup>6</sup> College Board. *PSAT/NMSQT 2006-2007 College-bound High School Juniors: Summary Report – Massachusetts*. 2007.

<sup>7</sup> UMass Donahue Institute, Research and Evaluation Group. *Massachusetts Statewide STEM Indicators Project (MASSIP): Overview of Indicators and Year One Data*. July 2006.

applicants. And currently, Massachusetts students' share of that pool appears to be waning. While interest in STEM is certainly high, the 36 percent share of Massachusetts college-bound students considering STEM majors is below the national average of 39 percent and below most of our competitor states' rates (see Figure 1). Similarly, the 20,000 STEM graduates represents a 13 percent increase in STEM graduates since 1993-1994, much less than the nationwide 31 percent increase in STEM graduates. Furthermore, the Commonwealth has seen a 16 percent increase in college graduates overall during this period. As a result, as a share of all Massachusetts college graduates, STEM majors have declined by 2 percent over this period—even as STEM majors as a share of college graduates increased by 0.7 percent nationwide.<sup>8</sup>

**Figure 1: Share of college-bound juniors interested in STEM majors**  
Massachusetts, U.S., and competitor states, 2006-2007



Source: College Board

Indeed, the state is losing students, and therefore potential STEM workers, at every stage in the educational pipeline. By 2014, 56 percent of new jobs in the state, and 32 percent of total openings (new jobs plus replacements), will require an associate's degree or higher.<sup>9</sup> Yet the National Center for Public Policy and Higher Education reports that for every 100 students in Massachusetts who enter ninth grade, only 76 graduate from high school, 52 enter college, 40 enroll in their sophomore year of college, and 29 graduate from college within four years. Keeping more students in school through at least an associate's degree would substantially increase the number of potential STEM workers available to Massachusetts employers.

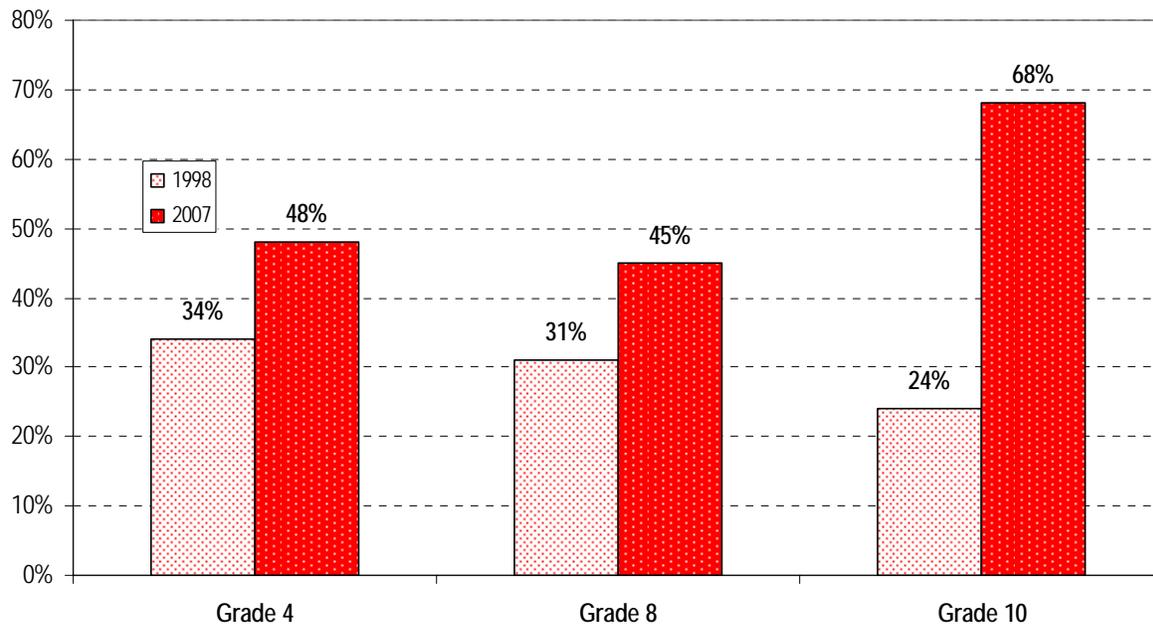
<sup>8</sup> UMass Donahue Institute, Research and Evaluation Group. *Massachusetts Statewide STEM Indicators Project (MASSIP): Overview of Indicators and Year One Data*. July 2006.

<sup>9</sup> Massachusetts Department of Workforce Development. *Employment Projections 2004-2014: Current and Projected Employment by Occupation and Education and Training Requirements*.

## Student preparation and performance

Another key factor is student preparation for and performance in STEM work. In a national labor market, it is not enough to be interested in STEM fields; students must also be prepared to excel. Relative to national averages, Massachusetts high school student performance in STEM-related fields is both above average and increasing over time. For instance, in 1998—the first year of MCAS testing—34 percent of fourth graders, 31 percent of eighth graders, and just 24 percent of tenth graders scored at the proficient or advanced level in mathematics. In 2007, those rates were 48 percent, 45 percent, and 68 percent, respectively.<sup>10</sup> (See Figure 2.)

Figure 2: Percent of Massachusetts students scoring proficient or advanced on the MCAS mathematics test, 1998 and 2007



Source: Massachusetts Department of Education

At the same time, however, there are still worrisome gaps in performance across subgroups. For instance, while 82 percent of Asian and 75 percent of white students scored proficient or advanced on the tenth grade mathematics assessment in 2006, only 45 percent of black and 42 percent of Hispanic students scored that high. The state's workforce will increasingly be comprised of blacks and Hispanics as their share of the overall state population increases. In order for the future workforce to be sufficiently skilled to meet employers' needs, the state cannot afford to leave any subgroup behind; it will need to challenge more black and Hispanic students to achieve proficiency in STEM fields.

Furthermore, although the state's high school students tend to perform well on assessments relative to their peers in other states, their performance is often still not high enough to meet the expectations of employers and institutions of higher education. For instance, even among those students who pass the state assessments and gain admission to college, many require remediation to perform adequately at the college level. Recent preliminary reports

<sup>10</sup> Massachusetts Department of Education. *School and District Profiles*. <http://profiles.doe.mass.edu/>

from the new statewide School-to-College Database, jointly produced by the Massachusetts Department of Education and the Board of Higher Education, indicate that among all 2005 high school graduates who entered a Massachusetts public college or university as a first-time, full-time, degree-seeking candidate in fall 2005, a full 28 percent enrolled in a developmental (remedial) mathematics course. This included 5 percent of University of Massachusetts students, 16 percent of state college students, and 55 percent of community college students. For students who enter college behind in mathematics, succeeding in post-collegiate careers in STEM fields will be a great challenge.

### **Strengthening the pipeline: The Department of Education's role**

Increasing the STEM achievement of all students and strengthening the STEM pipeline from primary and secondary education into higher education and ultimately into STEM careers is critical to the state's economic health and its students' economic competitiveness. It is also something no individual organization can accomplish on its own with a single program or policy decision. It requires collaboration among state and local agencies; schools, institutes of higher education, and workforce development programs; and the public and private sectors more generally. And it requires effort on multiple fronts to address the multiple roots of the problem.

Recognizing this, the Massachusetts Department of Education has been collaborating with partners across the state to strengthen the two parts of the pipeline over which the Department has the most influence: teacher knowledge and skills and student proficiency. Some of its activities in this regard include:

- Requiring students in the Class of 2010 and beyond to pass a high-school level examination in biology, chemistry, physics, or technology/engineering in order to graduate from high school.
- Raising the score required to pass the state's annual mathematics student assessment.
- Recommending a high school program of studies for college and career readiness (MassCore), including four years of mathematics and three years of lab-based science, to align high school coursework with the requirements for postsecondary education.
- Strengthening the mathematics knowledge required of elementary and special education teachers by specifying in more detail the content they are expected to have mastered and requiring a passing score on the mathematics section of the teacher licensure exam.
- Developing and participating in programs focused on improving teacher content knowledge and support in STEM, such as Professional Development Institutes, the Intel Mathematics Initiative, the Mathematics and Science Teacher Scholarship Program (in partnership with the Board of Higher Education), and the Comprehensive School Reform Mathematics Initiative.
- Participating in the Trends in International Mathematics and Science Study (TIMSS) and in the development of a national end-of-course optional Algebra II exam.

- Working with the Board of Higher Education to develop a School-to-College Database that, for the first time, allows the state to track public high school graduates into the state's public colleges and assess the relationship between high school performance and college outcomes.
- Partnering with and participating in STEM working groups sponsored by the University of Massachusetts STEM Initiative, the STEM Pipeline Fund, the Goddard Council, and other public and private entities.

These Department strategies work in tandem with parallel efforts by numerous other public and private partners to keep students on the STEM career pipeline. Taken together, these efforts should bolster the Commonwealth's ability to compete economically on a national and global scale and should work to yield a better-prepared, more qualified Massachusetts STEM workforce of tomorrow. \*

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