

EXECUTIVE SUMMARY

The United States is losing its edge in innovation and is watching the erosion of its capacity to create new scientific and technological breakthroughs. Increased global competition, lackluster performance in mathematics and science education, and a lack of national focus on renewing its science and technology infrastructure have created a new economic and technological vulnerability as serious as any military or terrorist threat.

- A Commitment to America's Future, 2005¹

Keeping Illinois Competitive confirms the importance of stronger science, technology, engineering, and mathematics (STEM) education to our state's competitiveness. This report identifies current strengths and critical challenges facing Illinois as it strives to flourish in a global economy where other nations and U.S. states compete.

Illinois' future economic vitality requires a skilled workforce that can adapt to new technologies regardless of the occupation; a research agenda for innovation; and well-informed, productive citizens. The 21st Century Illinois workers and citizens must have rich, multi-dimensional backgrounds in order to be successful in the emerging economic and cultural environment. The focus of this report is on the STEM subjects (science, technology, engineering, and mathematics), which comprise part of a comprehensive education.

After a review of demographic, technological, and globalization trends, as well as Illinois' performance on a variety of STEM indicators, *Keeping Illinois Competitive* concludes that Illinois faces five challenges. Addressing these challenges will require the public and private sectors working together to ensure that the STEM education system prepares the skilled workers needed to support Illinois' economic development and quality of life.

Challenge One: Student Academic Achievement

Slightly more than half of Illinois high school students have the requisite mathematics and science skills for postsecondary education or jobs in the emerging new economy.

Challenge Two: Alignment to 21st Century Knowledge and Skills

State curricula, assessments, and pedagogy are not consistently aligned with the 21st Century knowledge and skills needed for the state's economic vitality.

Challenge Three: Teacher Preparation

Many mathematics and science teachers do not have the proper qualifications or access to ongoing professional development to improve their teaching.

Challenge Four: Investment in STEM Education

Strategies may not be adequate to recruit and retain the most qualified individuals for STEM professions and for research and development for innovation.

Challenge Five: Lifelong Learning

In the 21st Century, all citizens and workers will need increasing mathematics and science skills and opportunities for lifelong learning.

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TRENDS AFFECTING BUSINESS AND EDUCATION IN ILLINOIS

Keeping Illinois competitive requires meeting the challenges created by converging demographic, technological, and globalization trends. In this environment, the U.S., including Illinois, is experiencing a declining middle class, a future with potentially too few skilled workers, and a need for workers with 21st Century skills and knowledge.

The Decline in the Middle Class

The most recent recession had a greater effect on Illinois than in the U.S. as a whole. Between 1990 and 2005, Illinois lost nearly one-fourth of its manufacturing industry jobs, and the proportion of employees in high-technology establishments decreased from 1998 to 2002 by 9.12% to 8.24%.ⁱⁱ Even though the unemployment rates in Illinois metro areas are at the lowest levels in five years, they are still higher than the national average.ⁱⁱⁱ

The total number of jobs increased in Illinois; however, there was a loss of higher-paying jobs and an increase in lower-paying jobs, resulting in lower household incomes.^{iv} Of the 30 fastest growing occupations in Illinois, 40.5% pay less than \$25,000 annually and 37.2% pay more than \$45,000.^v If the projections hold, the middle class may continue to erode.

A Projected Shortage of Skilled Workers for the Future

In Illinois, the number of “exit-age” workers (65 years and older) will be twice the number of “entry-age” workers (18 to 24 years old) by 2015.^{vi} As skilled Baby Boomers retire, an increasing proportion of the workforce will be from segments of the population that historically have lower levels of postsecondary education. The largest increase will be in Hispanic workers. In 2000, over half of the Hispanic working population had less than a high school credential, and only 13% held a college degree.^{vii} As workers from groups with low levels of postsecondary education become a larger part of the Illinois workforce, the average educational level of the Illinois worker may decrease if the disparity in degree attainment does not change.

Maintaining the critical workforce may be increasingly difficult. In 2003, 3.56% of the Illinois workforce was employed in science and engineering occupations, compared to 3.61% nationwide. Compared to other large industrial and neighboring states, Illinois has a higher percentage of workers in computer specialties, except for California, and fewer engineers, except for Florida and New York.^{viii} In addition, there are projected critical shortages in some occupations; for example, health care.

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Changing Knowledge and Skills Needed for 21st Century Workers

Keeping Illinois competitive requires K-12 curricula that prepare all students to pursue postsecondary education or to obtain a livable-wage job.^x The partnership for 21st Century Skills identified a basic core that includes core subjects; 21st Century content including an international perspective; learning and thinking skills; information and technology skills; and life skills. The partnership specified that the skills should be taught in an integrated, balanced approach, and authentic assessments should be used to assess student learning.^x

Implementing this core could impact how education is organized, delivered, and assessed. The 21st Century worker needs to understand multiple disciplines; for example, an engineer needs to understand human factors, marketing, financial planning, and entrepreneurship. Rote learning and drills will retain an instructional role, but much more emphasis would shift to authentic problems which integrate several disciplines if the 21st Century core were implemented.

In summary, Illinois needs a STEM education system that provides high-quality, lifelong learning for all workers and citizens; increases the educational attainment of under-represented groups, including the black and Hispanic populations; and supports the research and development needed to increase productivity in critical shortage occupations, as well as create higher-paying jobs.

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STEM EDUCATION ISSUES FOR 21st CENTURY COMPETITIVENESS

Based on the demographic, technological, and globalization trends and analyses of national and international STEM indicators, *Keeping Illinois Competitive* identifies five challenges facing Illinois.

Challenge One: Student Academic Achievement

Slightly more than half of Illinois high school students have the requisite mathematics and science skills for postsecondary education or jobs in the emerging new economy.

Issues

1. Academic achievement on state mathematics and science assessments by Illinois low-income students is significantly lower than that of their peers.
2. Low-income, black, and Hispanic populations have lower levels of postsecondary education than their peers.
3. Many students in Illinois high schools do not have opportunities to study college-preparatory academic curricula or explore rigorous career and technical education pathways.
4. Significant numbers of high school graduates take remedial mathematics coursework in college, and taking remedial courses reduces the likelihood that students will finish degree programs.

Background

In international, national, and state assessments, Illinois students perform at the highest levels and at the extremely lowest levels. Some Illinois students compete successfully with Singapore, Hong Kong, and Japan, the highest-rated countries. Students in some low-income Illinois districts performed below the international average. Here are some high-end achievements:

- The First in the World Consortium and Naperville District 203 showed that Illinois has some of the world's top performers on international science and math tests.^{xi}
- On national tests (NAEP), Illinois Asian students are highly competitive.^{xii}
- On Advanced Placement tests, higher proportions of Illinois students perform at the college-credit level than nationally, although the percentage taking Advanced Placement tests is lower than the national average.^{xiii}

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There are disparities in achievement across the grade levels and among subgroups of students, as indicated in the Illinois state assessment results.^{xiv}

- Students decrease in their levels of achievement as they move from the early grades through high school. The percentage of students meeting or exceeding the state standards in mathematics decreases from 79% in 3rd grade to 53% in 11th grade. In science, the decreases are similar – from 71% meeting or exceeding the standards in 4th grade to only 53% meeting or exceeding the standards in 11th grade.
- In third grade, 6 out of 10 low-income students meet or exceed standards; by 8th grade only 3 out of 10 meet the standards, and by 11th grade the number has decreased to fewer than 3 out of 10.
- The performance of Hispanics has improved but is still well below that of their white and Asian peers. In third grade mathematics, 15% more of the white students than Hispanic students meet or exceed state standards; the gap doubles by 11th grade.
- In 3rd grade, about 1 in 2 black students meet the state standards, and by 11th grade, only 1 in 5 meet the state standards.

On the national assessments, Illinois students performed at the national average; however, Illinois also has some of the largest achievement gaps in the U.S.

- The difference between the scores of 4th grade Illinois low-income students and their “not low-income” peers was the largest gap in the nation.
- Only 9% of the 4th grade and 6% of the 8th grade Illinois black students achieved a “proficient” level” on the national test, and over half did not reach the “basic” level in mathematics.
- 8th grade Hispanic students had higher scores than their U.S. Hispanic peers in mathematics; however, only 13% were at the national “proficient” level.

Whether the indicator is high school completion rates, readiness for college, or readiness for work, Illinois students who are low-income, black, and/or Hispanic do not fare as well as their white and Asian peers.^{xv}

- The high school completion rates appear to be increasing in Illinois; however, only 70-75% of all of the 9th grade students will complete high school. Fewer than 50% of the black and Hispanic male students will graduate.
- Significantly more white and Asian students in Illinois, both male and female, graduate as compared to their U.S. peers.
- Significantly more male and female black students in Illinois drop out than their U.S. peers.
- The number of Illinois public high school graduates is projected to increase by 8.3% between 2002 and 2014, compared to a national increase of 9%. In Illinois, there is a disproportionate projected growth for the Hispanic population. If these projections hold true, and if the performance of the ethnic minority groups does not improve, Illinois may have increasing numbers of students from the populations most likely to drop out of school.

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Challenge Two: Alignment to 21st Century Knowledge and Skills

State curricula, assessments, and pedagogy are not consistently aligned with the 21st Century knowledge and skills needed for the state's economic vitality.

Issues

1. Content area performance descriptors and state assessments do not cover 21st Century skills such as those in the "Applications of Learning" or the career and workforce skills that are part of the *Illinois Learning Standards*.
2. A statewide, inclusive process to regularly review and update the *Illinois Learning Standards* and performance descriptors to include cutting-edge technology and research-based pedagogy does not exist at this time.
3. The emerging instructional models that integrate disciplines and are grounded in authentic, real-world problems could be explored by state level organizations.
4. Current data-collection methods in the state do not provide accurate, consistent information on graduation and drop-out rates or the pathways students take through the P-20 educational system.

Background

The content delivered in Illinois classrooms should lead to high school graduates who are prepared for both postsecondary education and a livable-wage job. Significant numbers of Illinois high school graduates do not meet these benchmarks.^{xvi}

- Over 35% of Illinois students performed at the highest levels (6 or 7 out of 7) on the WorkKeys in Applied Mathematics.
- 8.2% scored lower than the level required for any of the WorkKeys job profiles; over twice as many low-income students were at this low level.
- 65% of the highest income students are the "most ready" for college, compared to only 20% of the lowest-income students.
- Less than 11% of the black high school graduates and less than 17% of the Hispanic high school graduates are prepared for college, compared to 55% of the Asian high school graduates and 55% of the white high school graduates, according to the Illinois Education Research Council.

Keeping Illinois competitive requires the learning standards and graduation requirements to be aligned with the 21st Century core of knowledge and skills in order to sustain the state's economic vitality.^{xvii}

- Illinois raised high school graduation requirements in 2005, but not to the level advocated by national groups; most recent studies agree that the knowledge and skills required for college are quite similar to the knowledge and skills required for entry-level jobs.

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- The current high school graduation requirements are focused on “seat time” and are not explicitly aligned with the standards.
- Even though the *Illinois Learning Standards* have received above-average national ratings, the “Applications of Learning” sections of the standards which reflect the additional 21st Century skills and knowledge are not included in the benchmarks, performance descriptors, and state-level assessments.

Challenge Three: Teacher Preparation

Many mathematics and science teachers do not have the proper qualifications or access to ongoing professional development to improve their teaching.

Issues

1. The training necessary to meet the minimum state certification requirements for the subjects they teach is either not being provided for, or not being pursued by, all Illinois science and mathematics teachers who are not fully qualified.
2. Barriers exist that prevent mathematics and science teachers from acquiring and implementing new content knowledge and pedagogical skills in the classroom.

Background

Significant numbers of students are taught mathematics and science by teachers who do not have the required certification to teach in their assigned subject areas:^{xviii}

- Slightly more than 50% of 8th grade mathematics teachers in Illinois are certified to teach mathematics and 26% have elementary certification. Nearly one-fourth have neither certification.
- In Illinois high schools, one-third of chemistry teachers, two-fifths of physics teachers, about one-half of biology teachers, and nearly three-fourths of earth science teachers do not hold the proper state certifications to teach in these content areas.
- The Associates of Arts in Teaching (AAT) in science and mathematics was created for the purpose of increasing the numbers and quality of community college students wishing to transfer to teacher education programs and ultimately be certified in critical shortage areas such as mathematics and science.
- Scholarships and tuition waiver programs—such as Illinois Future Teacher Corp Program, Illinois Special Education Teacher Tuition Waiver, Minority Teachers of Illinois, Robert C. Byrd Scholarship Program, Golden Apple Foundation, and the Illinois Teacher Loan Repayment Program—are available for those pursuing careers as educators, particularly for those willing to teach in high-risk schools.

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Challenge Four: Investment in STEM Education

Strategies may not be adequate to recruit and retain the most qualified individuals for STEM professions and for research and development for innovation.

Issues

1. Parents say that awareness programs aimed at recruiting high-potential students to postsecondary STEM education are inadequate.^{xix}
2. Barriers exist which discourage or prohibit students, especially low-income students, from enrolling in and completing STEM programs.^{xx}
3. P-20 instructional activities that develop the skills needed for innovation have not been identified and disseminated.
4. Investment in STEM research has decreased in recent years.

Background

Illinois needs innovative STEM research and development to increase productivity in critical shortage occupations, to increase innovation in business and industry, and to keep Illinois competitive both nationally and globally.^{xxi}

- 57% of Illinois high school graduates go directly into college, the same as for the U.S., but within six years, slightly more Illinois students complete four-year degrees than found nationally.
- From 1994 to 2004, the number of students in Illinois colleges and universities increased with a significant increase in the Hispanic population but a decrease in the black population.
- In 2004, Illinois colleges and universities granted over 10,000 bachelor and higher degrees in computer and information science, engineering, and mathematics.
- Over half of the master's and doctoral degrees were granted to non-residents.

Resources are needed to build Illinois' capacity for innovation.^{xxii}

- Illinois is one of the higher volume publishing states in terms of the number of academic articles per science and engineering doctorate.
- From 1997 to 2003, the number of academic patents per 1,000 academic doctorate holders increased from 10.5 to 13.0 in the United States and from 7.7 to 10.5 in Illinois.
- For 2001 to 2003, the U.S. Small Business Innovation Ratio to \$1 million gross state product was 141, compared to Illinois' ratio of 43.
- From 1998 to 2003, the percentage of R & D conducted by industry in the private sector decreased in the United States from 2.14% to 2.06%. In Illinois, the percentage of industry-performed R & D increased from 1.90% in 1998 to 2.00% in 2000 but decreased to 0.85% in 2003.
- Illinois has one of the largest P-12 funding gaps in the U.S. between the average expenditures of the top and bottom quartile of low-income districts.

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Challenge Five: Lifelong Learning

In the 21st Century, all citizens and workers will need increasing mathematics and science skills and opportunities for lifelong learning.

Issues

1. Continuing education is needed to keep all workers' skills current.
2. Citizens may not be sufficiently aware of the need for all citizens to keep their STEM knowledge and skills up to date.

Background

It is important for all Illinoisans, as employees and as citizens, to understand the STEM issues that affect their lives. Keeping Illinois competitive requires all workers to keep their skills up to date according to their occupational standards.^{xxiii}

- Many of Illinois' unemployed engineers and computer scientists have college educations; however, the job openings are in the newer technologies.
- Nearly 90% of the surveyed parents indicated that the science and engineering communities need to do a better job of telling today's students about STEM job opportunities.

These five challenges provide a starting point for dialogue. Keeping Illinois competitive will require all public and private sectors working together to create coordinated, integrated, innovative solutions to these challenges.