

**PREPARING THE
FUTURE WORKFORCE**
*Science, Technology, Engineering and
Math (STEM) Policy in K-12 Education*

ABOUT THE PUBLIC POLICY FORUM

The Milwaukee-based Public Policy Forum – which was established in 1913 as a local government watchdog – is a nonpartisan, nonprofit organization dedicated to enhancing the effectiveness of government and the development of southeastern Wisconsin through objective research of regional public policy issues.

PREFACE AND ACKNOWLEDGMENTS

This report was undertaken to provide citizens and policymakers with a comprehensive understanding of the relationship between future workforce needs and current K-12 education policy with regard to science, technology, engineering, and math (STEM). We hope that policymakers and community leaders will use the report's findings to inform discussions and policy debates in Wisconsin and the Milwaukee region.

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PREPARING THE FUTURE WORKFORCE

*Science, Technology, Engineering and Math (STEM)
Policy in K-12 Education in Wisconsin*

June 2009

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Executive Summary

Last December, the Science, Technology, Engineering, and Mathematics (STEM) Education Coalition – a national organization of more than 600 groups representing knowledge workers, educators, scientists, engineers, and technicians – wrote to President-elect Obama urging him to “not lose sight of the critical role that STEM education plays in enabling the United States to remain the economic and technological leader of the 21st century global marketplace.”

While that imperative appears to have resonated in Washington, has it and should it resonate in Madison? This report attempts to answer that question by examining the extent to which STEM skills *are* a necessity for tomorrow’s Wisconsin workforce, whether our schools are preparing students to be STEM-savvy workers, and where STEM falls in the state’s list of educational priorities.

We find that job growth predictions do indicate that both middle- and high-skills STEM jobs will provide much opportunity for future workers in Wisconsin. However, at the state level, education and budget policy has not fully recognized the greater importance of STEM education for today’s students. While there are many areas in which the state is making progress, those efforts are not falling under a common STEM “banner” that would communicate to local districts a priority on skills needed for high-demand occupations of the future. In addition, Wisconsin’s students may not be held to the same standards as students elsewhere, and may be at a competitive disadvantage.

The key findings of our analysis of STEM education in Wisconsin:

- **The jobs most in demand in Wisconsin in the next 10 years will require STEM skills and knowledge and, in many cases, post-secondary degrees.** Of the 10 specific occupations predicted to be the fastest growing in the state, eight require STEM skills or knowledge and six require a post-secondary degree. Meanwhile, of the 10 career clusters with the most predicted job growth, seven include occupations requiring STEM skills or knowledge.
- **While Wisconsin students perform relatively well in math and science when compared to peers nationally, there are indications that its math and science standards are lacking.** Wisconsin students score better than the national average when it comes to standardized math and science tests, graduation rates, and scores on the ACT test. However, the state’s math and science standards have been criticized for inadequacy and the state’s standardized tests may set the bar for proficiency too low.
- **The high percentage of STEM teachers hired under emergency procedures may indicate future issues with STEM teacher supply and quality.** While teacher preparation institutions in Wisconsin produce more STEM specialty teachers than are needed to replace retiring teachers and districts report having plenty of applications for open STEM specialty positions, roughly a third of all teachers hired under “emergency” licensure or certification

regulations, used only when a district cannot find a “fully qualified and licensed” teacher, are STEM teachers.

- **The state’s commitment to and prioritization of STEM education is a mixed bag.** Recent state budgets have fallen far short of funding STEM activities at Department of Public Instruction-requested levels. However, many large-scale policy changes, such as revising standards, adopting new assessment schemes, revamping teacher licensure requirements, or defining work-readiness, could have positive repercussions for STEM education.

In addition to examining state workforce development data and reviewing state-level policies and standards that impact STEM education, this report discusses several policy options that could be considered to build on localized STEM initiatives and establish a greater statewide imperative to prioritize STEM activities. Those include:

- Strengthen state standards in science, math, and other STEM fields, create model curricula in STEM fields, and align standards to workforce needs and college matriculation requirements.
- Create incentives to recruit and retain qualified STEM teachers and ensure districts use teacher standards and professional development goals in hiring, evaluation, promotion, and possibly compensation.
- Create incentives for more coordination of local efforts and increase support, both financial and regulatory, for district-level STEM initiatives.

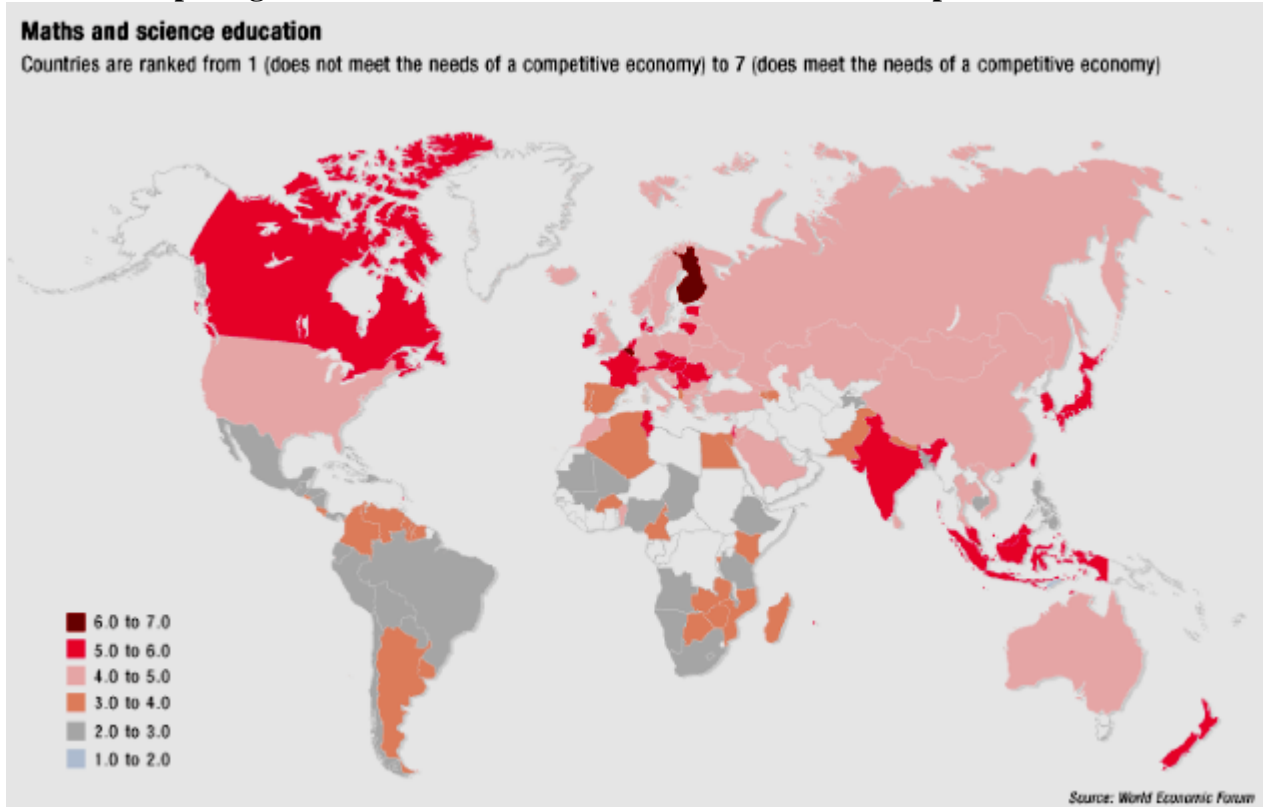
We conclude that Wisconsin is in need of a coordinated focus on STEM content and higher-level thinking skills in the K-12 system in order to meet its future workforce demands. The state has several initiatives underway that have the potential to positively impact STEM education, but to be truly impactful these initiatives will need coordination under a STEM banner.

Introduction

There is a growing consensus that the nation's future workforce, both those in new jobs and those replacing today's aging workers, will lack needed technological skills and knowledge if the content and standards of our current K-12 system are not revamped with specific workforce development goals in mind.

Indeed, in 2006, the international group the Organization for Economic Cooperation and Development ranked countries on a scale of 1 to 7 on their education systems' ability to produce a globally competitive workforce in the new economy. The U.S. ranked 4.5 on this scale, behind Canada, India, Japan, and several European countries, as seen in the map below.

Chart 1: Preparing students for the future: how the U.S. measures up to the rest of the world



The U.S. scores on the TIMSS test (Trends in International Mathematics and Science Study) indicate that our students are scoring slightly above the international average in 4th and 8th grade in math and science.¹ However, a different international assessment paints another picture. On the PISA exam (Program for International Student Assessment), which tests 15-year-olds, the U.S. scored lower than the international average in math and science.² These dichotomous results may be explained by the fact that the TIMSS is designed to test a student's content knowledge based on international standards, while the PISA measures a student's skills and competencies as applied in real-world situations (the educational "yield" of his or her schooling). Taken together, the scores on the two tests indicate that U.S. students are perhaps not as prepared as their international counterparts to apply the math and science knowledge they do have.

The skills and competency areas deemed lacking are those commonly captured by the acronym STEM—science, technology, engineering, and math. The future jobs that will rely on a STEM-savvy workforce include both those careers needing a college or advanced degree and the so-called "middle skills" jobs that are attainable for high school graduates with proper training. Middle skill occupations, which require at least some post-secondary education or training, are forecast to make up 45 percent of future job openings nationally, while a third of future job openings will be in high skills positions in which a four-year degree or more is required.³ Unfortunately, a broad consensus exists in industry that the nation's K-12 schools are not doing a good job preparing students for the workforce.⁴

Several national groups have formed over the past decade to draw attention to this need for a better prepared workforce and to reform the focus of K-12 education to include more STEM content and/or skills. Those groups often include corporate, industry, and union leaders who argue that the nation's economic future depends on businesses' ability to hire skilled workers, both to grow their businesses and to replace retiring baby boomers. Several of these national coalitions and their specific goals are detailed in Appendix I. At the state and regional levels, similar coalitions have been formed. (These groups are detailed in Appendix II.) One such group, the Wisconsin Technology Council, recently called for Wisconsin to make STEM a statewide public policy priority.⁵

This report assimilates the policy goals articulated by many of these state and local STEM coalitions, noting where Wisconsin has or is working on implementing similar policies and where opportunities for policy alternatives still exist. In addition, the need for future workers

¹ National Center for Education Statistics, Highlights From TIMSS 2007: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context, December 2008.

<http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2009001>

² National Center for Education Statistics, Highlights from PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context, December 2007.

<http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2008016>

³ Achieve, Closing the Expectations Gap: Fourth Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Careers, February 2009.

⁴ National Association of Manufacturers, 2005 Skills Gap Report—A survey of the American Manufacturing Workforce, December 2005. The survey finds 80% of manufacturers nationally feel K-12 schools do not prepare students for the workplace.

⁵ Wisconsin Technology Council, Educating a Tech-Savvy Workforce for Wisconsin, April 2009.

with strong STEM educational backgrounds is measured by analyzing state workforce projections. Finally, several state and local initiatives and efforts to create more STEM educational opportunities across Wisconsin are highlighted.

The purpose is to understand whether our state's education policies sufficiently emphasize the STEM knowledge and skills needed for tomorrow's workforce.

Data and methodology

Long-range state workforce projections are created by the Wisconsin Department of Workforce Development (DWD) using federally- and state-collected labor data. These data are organized by industry and occupational codes, allowing like jobs to be compared across industries and allowing industries to be disaggregated into specific jobs. Note that because the most recently available projections use 2006 data to project to 2016, the current economic downturn is not captured.

School district data are collected by the Wisconsin Department of Public Instruction (DPI) for accountability and regulatory purposes. Enrollment and spending data are provided for five representative districts across the southeast Wisconsin region, both to provide context for the highlighted state policies and to provide a sense of scope with regard to the number of future workers these policies are intended to affect. Achievement data are examined to measure how well-prepared current graduates are for STEM jobs. Data from DPI and Wisconsin colleges and universities on teacher preparation and specialization are analyzed to determine whether more STEM subject teachers are needed.

In addition to the above quantitative data, qualitative data were collected via interviews with and documentation from state elected officials, state administrators, district administrators, workforce development experts, and business leaders.

Section 1: Science, technology, engineering and math education and its relation to the future workforce

Wisconsin's future workforce needs

Few would debate that the future health of Wisconsin's economy depends on the skills and knowledge of its workforce. The extent to which these skills and knowledge need to be grounded in science, math, engineering, or technology, is slightly more contentious. As noted in the introduction, while more and more middle-skill jobs are requiring math and science fluency or technological savvy, the typical STEM job may still be thought of as limited to computer scientist, physician, or structural engineer. A more realistic definition of a STEM job, however, also should include the factory-line assembler utilizing automation technology, the home health aide, and the ironworker.

STEM education often is said to be “more than the sum of its parts”, meaning the STEM disciplines teach important critical thinking and problem-solving skills as well as content knowledge. STEM jobs in this report are defined more broadly than is often used in this type of analysis, as we aim to capture jobs that require content knowledge as well as critical thinking. As such, we do not limit our definition to only those jobs that require a four year degree, but include middle skills jobs that require some type of training beyond high school and for which the state-of-the-art of the industry requires basic math, science, or technological literacy. The broad definition of STEM used in this report is driven by the need for middle- and high-skill workers with strong STEM backgrounds; the potential for STEM knowledge to create innovation, research, and development across the region; and the need for highly qualified K-12 STEM teachers who can instill this knowledge in their students.

This workforce of tomorrow is in school today. Their K-12 education will prepare them to pursue their chosen careers, but will also prepare the region and the state to compete in the global economy. This section explores the state's workforce projections, highlighting the fastest-growing STEM-related industries or occupational fields, as well as occupations requiring STEM education.

The four charts below show the predicted Wisconsin job growth by percent change from 2006 to 2016 (the most up-to-date projections) and by total number of new and replacement jobs in 2016, for both occupational categories and specific occupations. Data is from the Wisconsin Department of Workforce Development.

Chart 2: Fastest-growing occupational categories, percent change 2006-2016

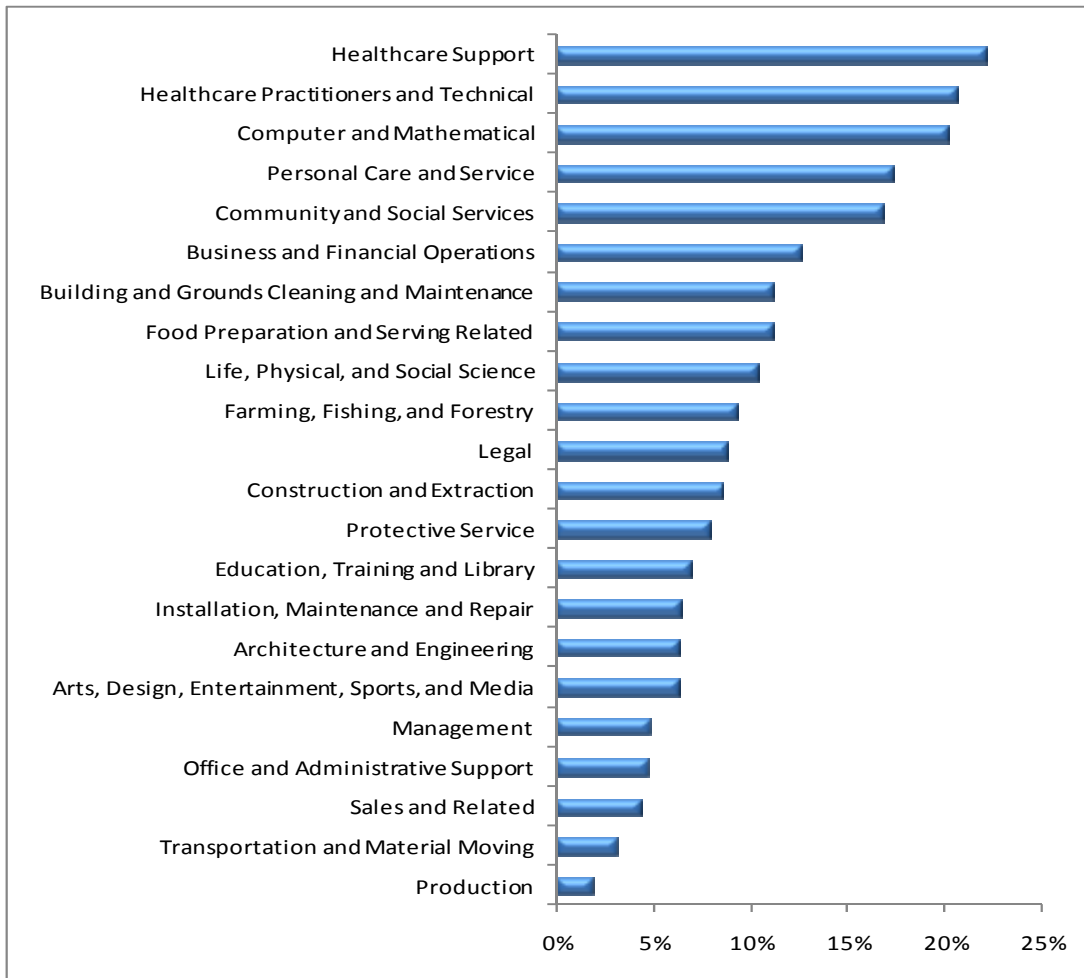


Chart 3: Most demanded occupational categories, total new jobs 2016

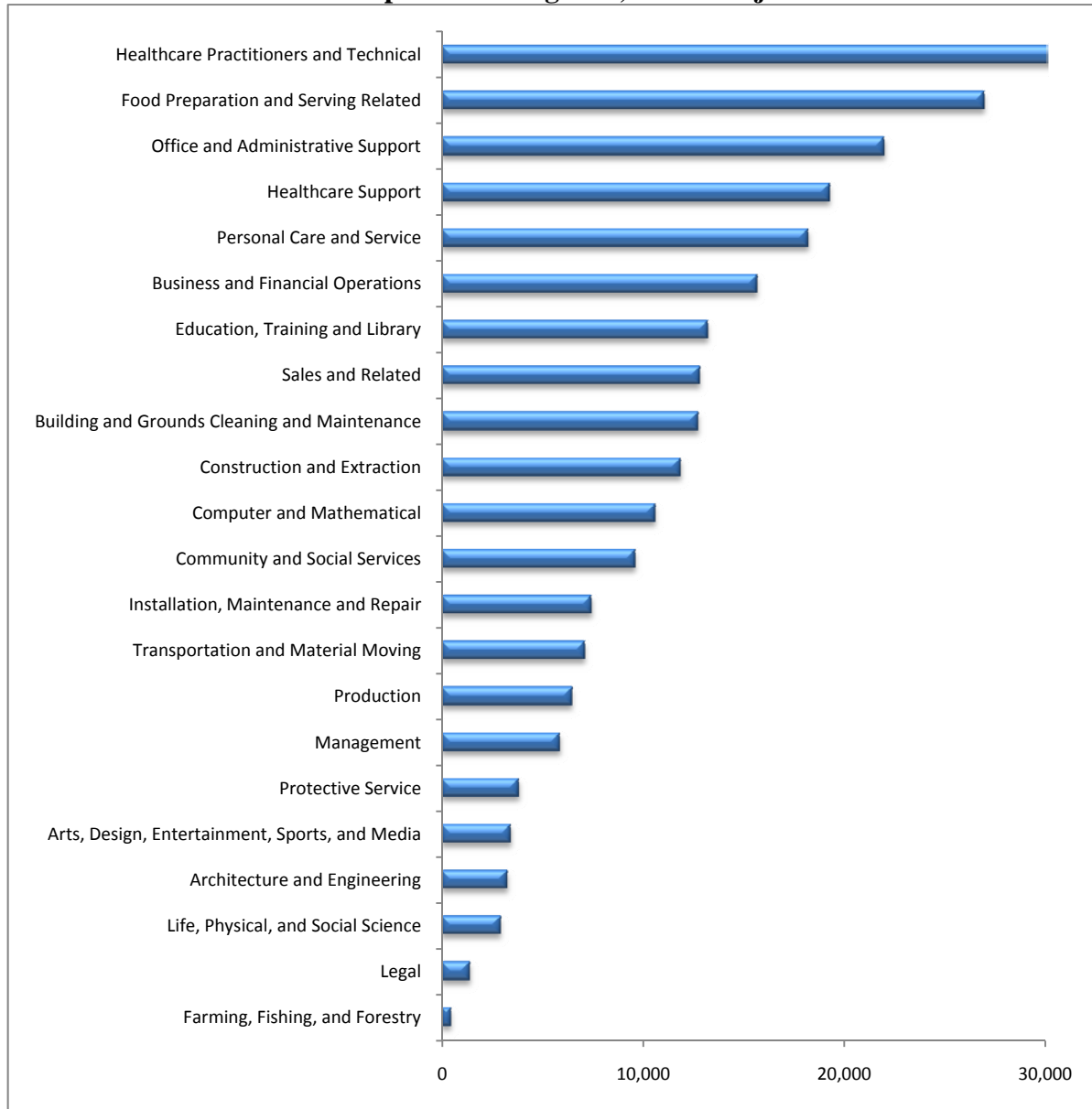


Chart 4: Fastest-growing occupations, percent change 2006-2016

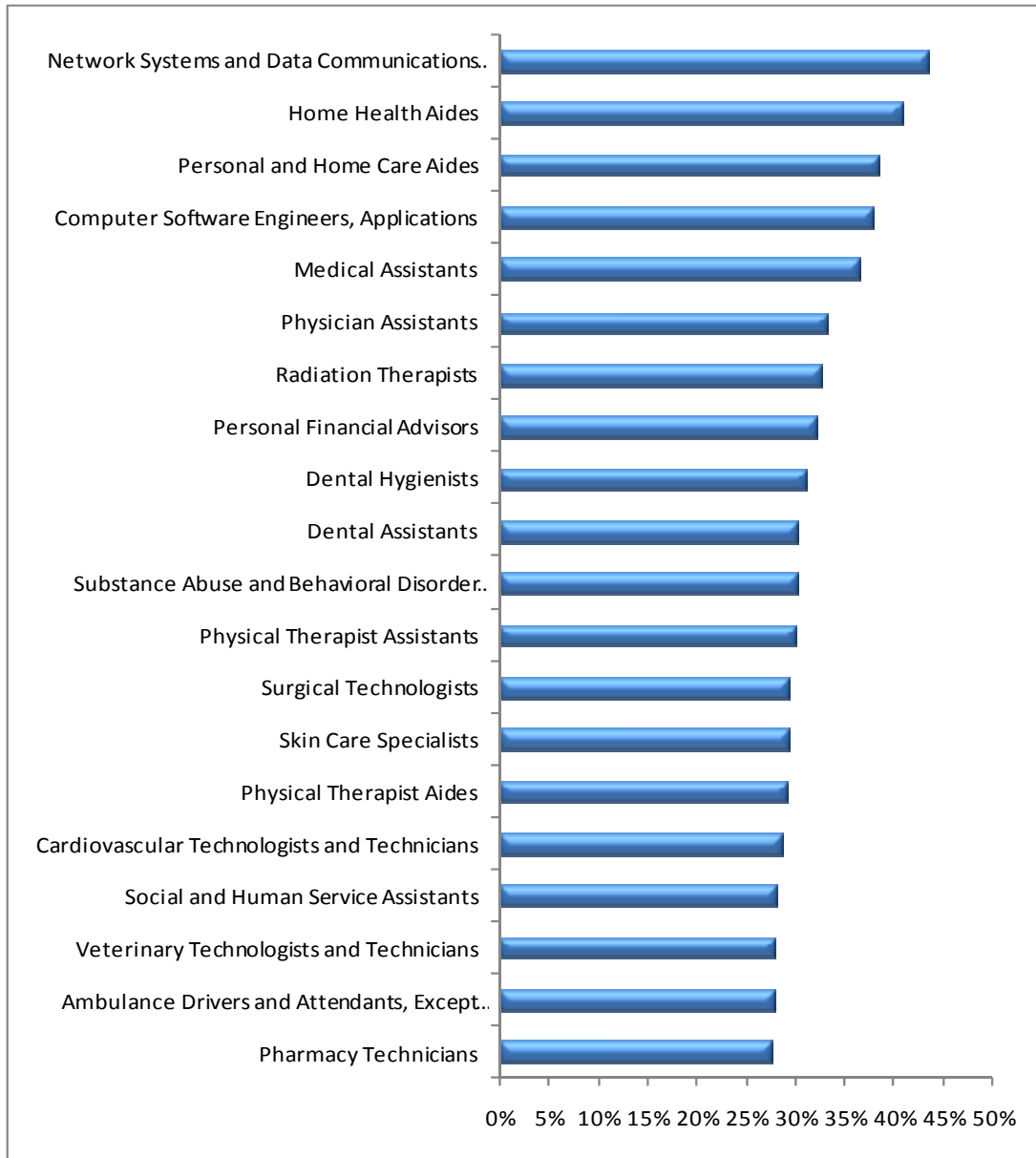
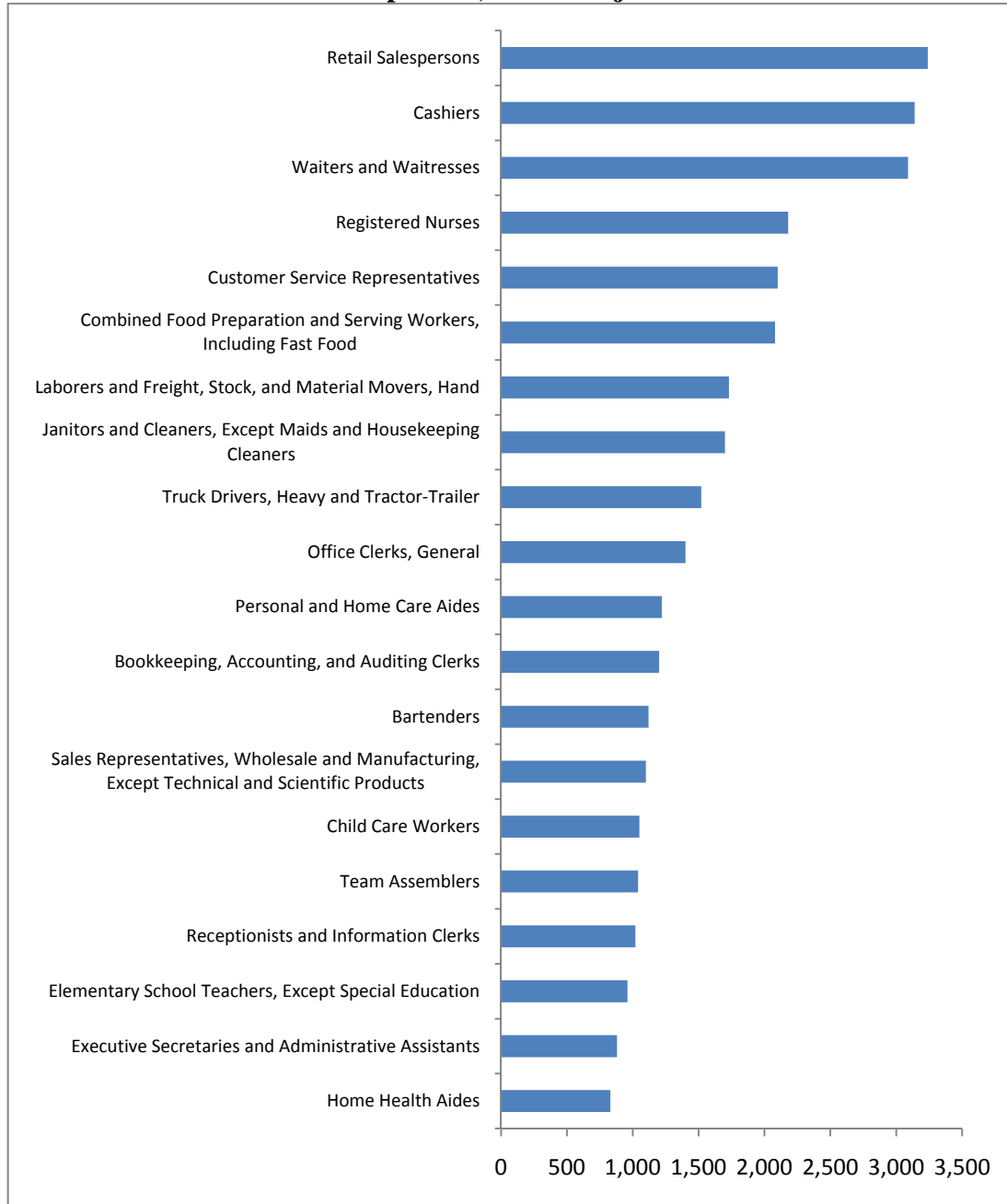


Chart 5: Most demanded occupations, total new jobs 2016



Although the most in-demand jobs of 2016 will be unskilled, low-pay positions in the service industry (Chart 5), STEM jobs dominate the fastest-growing job opportunities (Chart 4) and are higher-paying positions. In addition, math/computer and natural sciences are among the top ten fastest growing occupational categories for Wisconsin (Chart 2).

To take advantage of the opportunities presented by these growth occupations, workers will need beyond-basic STEM skills. Table 1 shows the Department of Workforce Development's predicted top ten occupations in terms of growth rate, six of which are in the health care field, and three of which require at least an associate degree. Just four of these jobs can be performed with only on-the-job training.

Table 1: Top ten fastest-growing jobs in Wisconsin

Occupational Title	2006 Jobs	2016 Jobs	% Employment Change	Avg. Ann. Salary	Education & training Path
Network Systems and Data Communications Analysts	5,150	7,390	43.5%	\$58,042	Bachelor's degree
Home Health Aides	16,550	23,310	40.8%	\$20,812	Short-term on-the-job training
Personal and Home Care Aides	22,030	30,540	38.6%	\$19,602	Short-term on-the-job training
Computer Software Engineers, Applications	8,830	12,170	37.8%	\$69,811	Bachelor's degree
Medical Assistants	7,120	9,720	36.5%	\$27,632	Moderate-term on-the-job training
Physician Assistants	1,110	1,480	33.3%	\$78,373	Master's degree
Radiation Therapists	490	650	32.7%	\$67,848	Associate degree
Personal Financial Advisors	3,170	4,190	32.2%	\$74,784	Bachelor's degree
Dental Hygienists	4,170	5,470	31.2%	\$55,069	Associate degree
Dental Assistants	5,340	6,960	30.3%	\$29,454	Moderate-term on-the-job training

STEM-related job opportunities are predicted to be particularly available in southeast Wisconsin, where seven of the top ten fastest growing jobs require STEM knowledge or skills, five of which need at least a four-year degree (Table 2).

Table 2: Top ten fastest-growing jobs in southeast Wisconsin

Occupational Title	2006 jobs	2016 jobs	% employment change	Average annual wage	Education & training
Personal Financial Advisors	1,150	1,770	53.9%	\$79,627	Bachelor's degree
Network Systems and Data Analysts	1,650	2,470	49.7%	\$60,666	Bachelor's degree
Home Health Aides	6,640	9,580	44.3%	\$21,147	Short-term on-the-job training
Personal and Home Care Aides	9,020	12,970	43.8%	\$19,586	Short-term on-the-job training
Computer Software Engineers	3,690	5,150	39.6%	\$70,249	Bachelor's degree
Medical Assistants	2,600	3,560	36.9%	\$27,992	Moderate-term on-the-job training
Skin Care Specialists	110	150	36.4%	\$23,574	Postsecondary vocational training
Social and Human Service Assistants	2,450	3,280	33.9%	\$29,540	Moderate-term on-the-job training
Financial Analysts	800	1,070	33.8%	\$65,964	Bachelor's degree
Physician Assistants	390	520	33.3%	\$83,117	Master's degree

The need for workers with strong STEM backgrounds is illustrated more compellingly when jobs are grouped by career cluster, the concept schools use when teaching about future career opportunities. A career cluster is a grouping of occupations and broad industries based on commonalities. The 16 federally-defined career clusters organize academic and occupational knowledge and skills into a coherent secondary school course sequence and identify pathways from secondary schools to two- and four-year colleges, graduate schools, and the workplace. Interestingly, the Department of Workforce Development does not utilize these career cluster codes when presenting workforce or employment data. However, the federal government requires the Department of Public Instruction and local school districts that receive federal Perkins program funding for career education to use career clusters in designing technical and career education. Thus, K-12 administrators and educators cannot easily translate state workforce data into information upon which they can base curricular or policy decisions.

The sixteen federally defined career clusters are:⁶

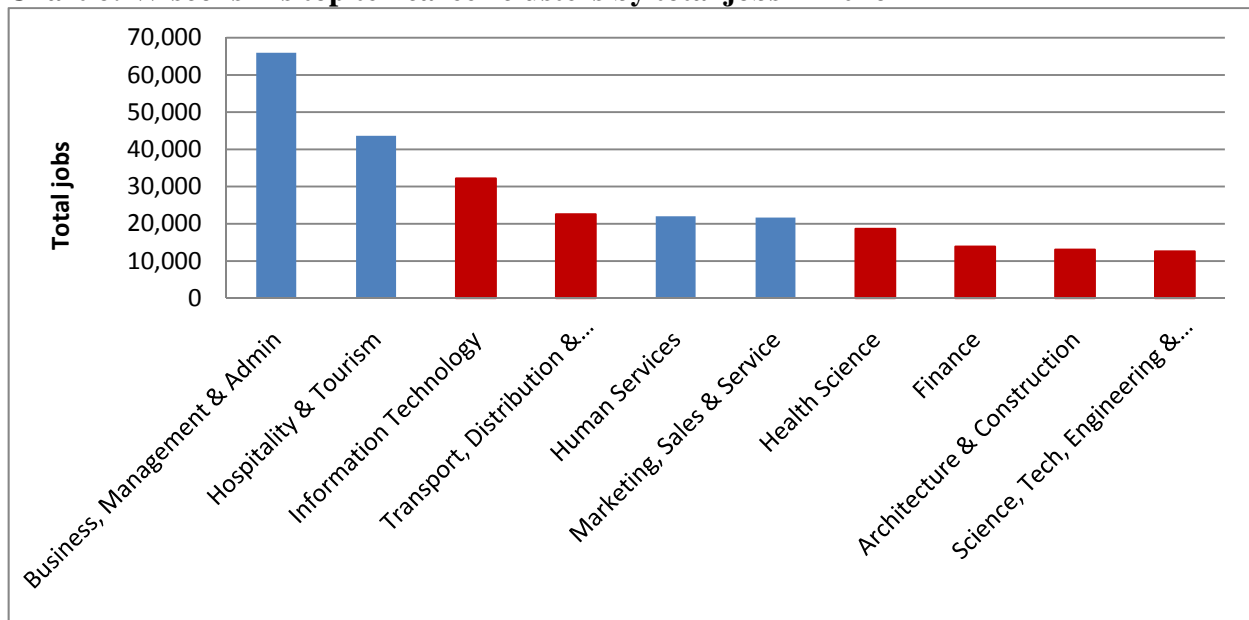
- Agriculture, food, and natural resources
- Architecture and construction
- Arts, A/V technology, and communication
- Business management and administration
- Education and training
- Finance
- Government and public administration

⁶ www.careerclusters.org

- Health science
- Hospitality and tourism
- Human services
- Information technology
- Law, public safety, corrections, and security
- Manufacturing
- Marketing
- Science, technology engineering and math
- Transportation, distribution, and logistics

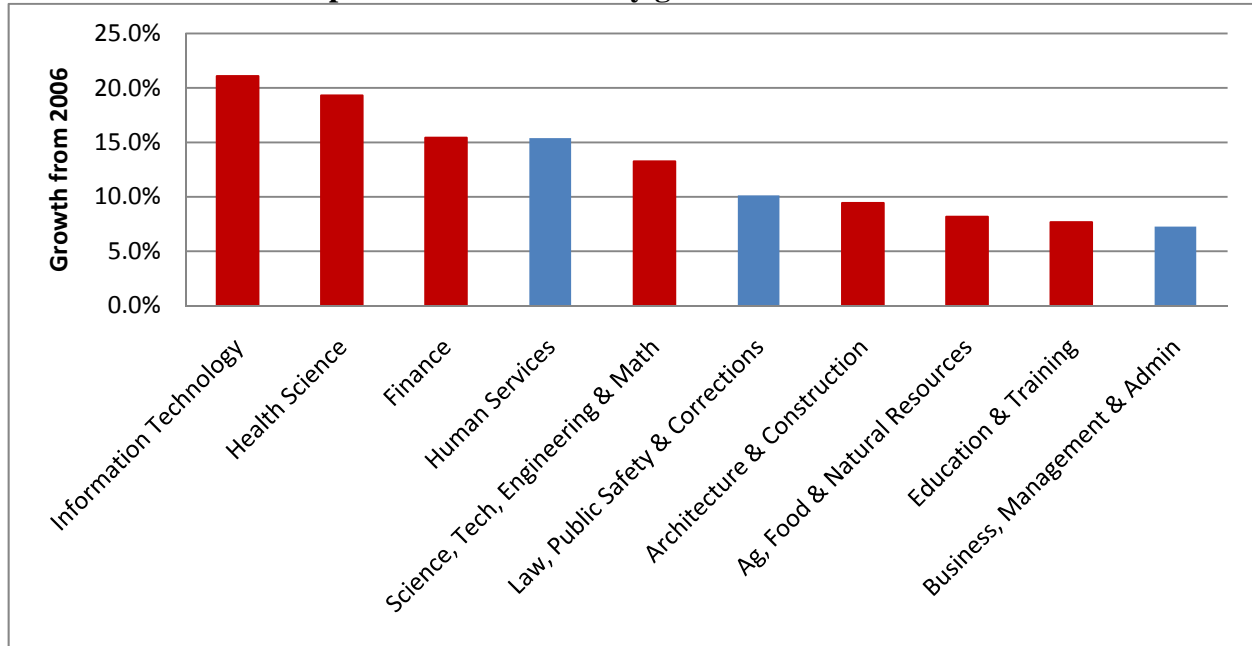
In Charts 6 and 7, the same state workforce projections presented above are presented according to career clusters. Clusters with a significant number of STEM jobs are in red. Again, our definition of STEM-related jobs is quite broad, as it encompasses more than just the scientific and engineering jobs included in the federally-defined science, technology, engineering, and math career cluster. Chart 6 indicates that six of the ten largest job clusters in 2016 will require employees with more-than-basic STEM knowledge or skills. Chart 7 shows that all but three of the fastest growing career clusters will consist of STEM-related jobs.

Chart 6: Wisconsin’s top ten career clusters by total jobs in 2016



Note: Clusters with significant STEM jobs in red.

Chart 7: Wisconsin's top ten career clusters by growth 2006-2016



Note: Clusters with significant STEM jobs in red.

The state workforce projections therefore predict a growing need for workers with STEM knowledge and skills into the future. And while these opportunities will create a demand for students who are well prepared to enter the workforce or succeed in college, the STEM job market possibly may be driven by supply as well.⁷ A “supply-side” strategy surmises there is a high potential for students with strong STEM backgrounds to create innovative new technologies, products, or solutions to social problems, and therefore requires even more STEM-savvy workers than predicted by workforce projections alone.

A supply-side strategy may also be prudent given the recent economic downturn, which is not reflected in the latest DWD job projections. If workers with STEM knowledge and skills are more likely to serve as catalysts for job growth, ensuring more Wisconsin graduates are prepared to serve in that role may be a means to economic recovery. If such job growth does not occur, however, Wisconsin likely would produce more STEM workers than STEM work opportunities, potentially exacerbating the brain drain of college graduates to other states. Thus, a supply side strategy must be accompanied with a culture of entrepreneurship and sufficient venture capital to generate job growth.

⁷ Gail O’Kane and Bruce Steurnagel, *Revisiting the Data on STEM Workforce Needs*, Minnesota State Colleges and University System, 2007.

Section 2: Are the state's school districts meeting the needs of tomorrow's employers?

The findings in Section 1 demonstrate the importance of understanding whether Wisconsin is prepared to meet, and perhaps even exceed, the need for future STEM workers. Are Wisconsin's students secure in their STEM content knowledge, as measured by standardized tests? Are enough of Wisconsin's students interested in STEM fields and do they plan to enter the STEM workforce? Does Wisconsin have enough quality STEM teachers in K-12 to meet our current and future needs?

Student performance

On the whole, Wisconsin students perform slightly better than their peers nationally, though the performance of both is lackluster. On the 2007 national NAEP test, 47 percent of Wisconsin 4th graders and 37 percent of 8th graders scored proficient or advanced in math. While this performance is not particularly impressive, Wisconsin's average scale score in math for both 4th and 8th grade was higher than the national average. Similarly, on the science exam, Wisconsin students averaged a higher scale score than the nation as a whole in 2005, yet achieved proficiency at a rate of just 35 percent for 4th grade and 39 percent for 8th grade.⁸

While NAEP scores are not designed to reflect a Wisconsin student's knowledge based on the *state's* standards, NAEP is designed to measure a student's knowledge and skills in each content area based on a content framework developed by the National Assessment Governing Board. These frameworks specify "subject-specific content and thinking skills needed by students in order to deal with the complex issues they encounter inside and outside their classrooms" and can be used by states or districts as models for curricular and methodological standards.⁹

Students' knowledge per the Wisconsin state standards is assessed with the Wisconsin Knowledge and Concepts Exam (WKCE). Comparing the results of the WKCE exams given in grades 4 and 8 to the NAEP results illustrates the difference between the state standards and the NAEP framework. Statewide, 77 percent of Wisconsin 4th graders scored proficient or above in math on the 2008 WKCE; the corresponding portion of 8th graders is 76 percent. In science, 75 percent of 4th graders and 75 percent of 8th graders scored proficient.¹⁰

⁸ NAEP, state profile. <http://nces.ed.gov/nationsreportcard/states/profile.asp>

⁹ NAEP, frameworks. <http://nces.ed.gov/nationsreportcard/frameworks.asp>

¹⁰ This gap in proficiency between the NAEP test and the WKCE has called into question the rigor of the state's standards. An *Education Next* analysis by Paul Peterson and Rick Hess gives Wisconsin a C- grade for its proficiency standards as compared to both the 2005 and 2007 NAEP tests, although the authors note that unlike in many other states, the gap between WKCE and NAEP scores has shrunk over the past 5 years. Paul Peterson and Rick Hess, Keeping an Eye on State Standards, *Education Next*, Summer 2006. <http://www.hoover.org/publications/ednext/3211601.html>

In southeast Wisconsin most school districts tend to out-perform the rest of the state on the WKCE, while scores in the Milwaukee and Racine districts are quite low. Table 3 provides a representative example of districts in the region.¹¹

Table 3: Students scoring at or above proficient, 2008

	4th gr. WKCE		8th gr. WKCE	
	Math	Science	Math	Science
Germantown	98.5%	93.7%	90.5%	88.5%
Milwaukee	51.7%	49.3%	39.9%	41.2%
Mukwonago	87.7%	88.3%	86.5%	88.6%
Racine	60.1%	63.8%	55.2%	57.2%
St. Francis	74.6%	67.6%	77.6%	81.2%
Region	72.5%	70.7%	69.4%	68.4%
State	76.6%	75.1%	75.3%	74.5%

In fact, the entire Milwaukee Public Schools district (MPS) is deemed “in need of improvement” under the requirements of the federal No Child Left Behind Act and is subject to a corrective action plan. MPS is the only such district in the state. Across Wisconsin there were a total of 56 schools identified as in need of improvement after the 2007-08 tests, including 38 schools in the Milwaukee Public Schools district.

Statewide, the percentage of high school students who completed high school with a regular diploma in the 2006-07 school year was 89.6 percent.¹² Of these high school graduates, 52.2 percent planned to attend college, 21.9 percent planned to attend vocational or technical college, 1.3 percent had specific job training plans, and 6.8 percent planned to enter the job market directly. In southeast Wisconsin, the percentage of high school students who completed high school with a regular diploma was 86.2 percent, somewhat less than the statewide graduation rate. More of the region’s high school graduates said they planned to attend college (57 percent). The percentage of southeast Wisconsin graduates who planned to enter job training programs or start working immediately was the same as the state as a whole, but comparatively fewer reported plans to attend vocational or technical college (17.3 percent).

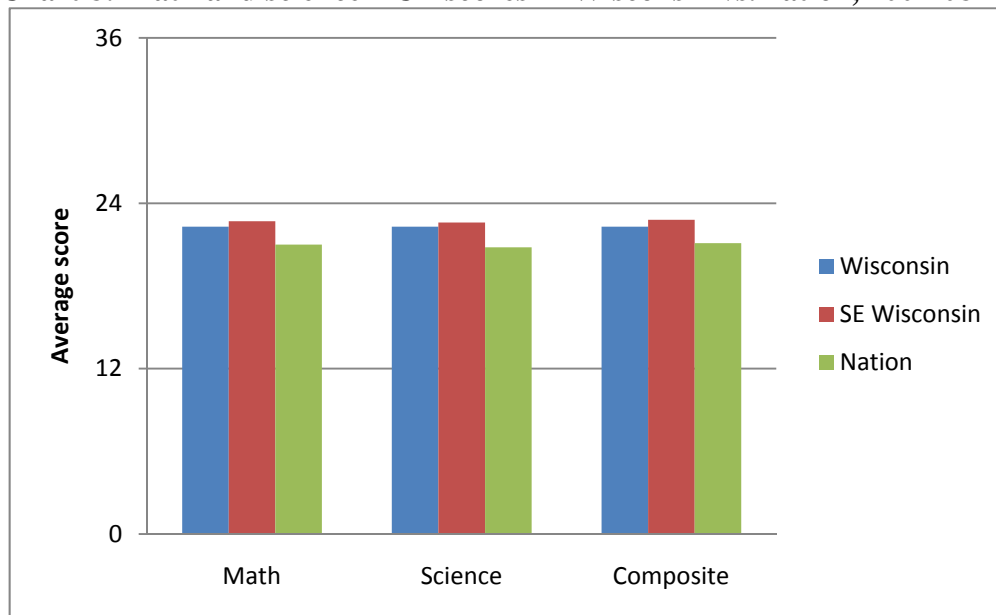
The state’s high college matriculation rate likely is related to the high scores Wisconsin students earn on the ACT test, which is taken voluntarily by juniors and seniors and is used by colleges and universities to assess college readiness. The statewide average ACT math score in 2007-08 was 22.3, out of a maximum score of 36, as was the average science score. The composite score in that year also averaged 22.3. Average scores for southeast Wisconsin students in 2007-08 were even higher: the average ACT math score was 22.7, the average science score was 22.6,

¹¹ For WKCE scores in all subjects for all southeast Wisconsin school districts, see the Forum’s annual Report on Public Schooling in Southeast Wisconsin at: <http://www.publicpolicyforum.org/pdfs/Research%20Brief%20schooling%20book%2008.pdf> and the accompanying poster with school district rankings at: http://www.publicpolicyforum.org/pdfs/school_poster%202008.pdf

¹² Wisconsin’s graduation rate is higher than the national average of 70.6 (for the class of 2005). See *Education Week*, School to College: A special supplement to Diplomas County 2008, Editorial Projects in Education Research Center, June 2008. <http://www.edweek.org/ew/toc/2008/06/05/index.html>

and the average composite score was 22.8. Nationally, the average math score in 2007-08 was 21.0, the average science score was 20.8, and the average composite score was 21.1. (See Chart 8.)

Chart 8: Math and science ACT scores in Wisconsin vs. nation, 2007-08



Source: ACT

Students' interest in STEM careers

Wisconsin students heading to college indicate significant interest in STEM careers. According to the College Board, of the 19,981 Wisconsin high school juniors taking the PSAT/NMSQT in 2008-2009 and intending to go to college, 43 percent indicated an interest in a STEM-related major (compared to 39 percent nationwide). The most popular majors overall were those in health professions and health sciences, capturing the interest of 22 percent of PSAT takers this year.¹³ Among the much smaller pool of high school seniors taking the SAT in 2008, 45 percent of 3,124 college-bound students expressed an interest in a STEM-related major.¹⁴

The College Board does not analyze students' preparation for these future careers as evidenced by their SAT scores, but does report the mean reading and math SAT scores by field of interest. Of the survey's 14 categories of majors that are STEM-related, in only one category was the students' mean reading score higher than their math score, perhaps indicating that students with stronger math backgrounds are more interested in STEM careers.¹⁵

¹³ College Board, PSAT/NMSQT 2008-2009 College-bound High School Juniors: Summary Report—Wisconsin, 2008. http://professionals.collegeboard.com/profdownload/WI_09_05_02_01-juniors.pdf

¹⁴ College Board, 2008 College-bound Seniors: State Profile Report—Wisconsin, 2008.

http://professionals.collegeboard.com/profdownload/Wisconsin_CBS_08.pdf

¹⁵ Ibid.

A similar picture is painted by the more limited data collected by ACT, Inc. of the 25,884 Wisconsin students taking the ACT in 2008. The ACT reports that 32 percent of ACT takers are interested in majoring in high-growth careers such as education, computer sciences, and health care. An analysis of their scores by field of interest indicates that students interested in computer specialties have higher math and science scores than students interested in other fields. However, students interested in health care have the lowest math and science scores among the high-growth interests.¹⁶

STEM teacher supply, demand, and quality

The DPI annually commissions a report on teacher data for use in determining educator workforce trends and future projections. The most recently available report finds that between September 2005 and August 2006, a total of 5,404 people graduated from public or private colleges or universities in Wisconsin with some kind of education or educational administrator degree and were eligible to apply for a state teaching license. In addition, another 221 individuals completed alternative credentialing programs in the state.

Of these 5,625 potential teachers, 2,181 received degrees or credentials in secondary education specialties, and 27 percent of those specializing received a STEM-related degree or credential.¹⁷ This bodes well for Wisconsin's future teaching workforce, as the same report finds that in 2006-07, of secondary teachers over age 55, 19 percent with specialized credentials had them in STEM-related areas. If the state can continue to produce more STEM teachers than it needs to replace retiring teachers, then expanded STEM courses and curricula may be possible.¹⁸

However, there are also indications that the current workforce is short on qualified STEM teachers. In 2006-07, there were 684 secondary and middle school teachers in Wisconsin with emergency credentials, including 504 licensed teachers teaching in a specialty category that did not match their license category, and 180 unlicensed teachers with emergency permits. Thirty-one percent of the emergency licenses and 41 percent of the emergency permits were for teaching STEM-related subjects.¹⁹ Under state regulations, emergency licenses and permits are only granted if the district can provide evidence that a search was conducted, but failed to identify and hire a fully qualified and licensed teacher.²⁰

The DPI teacher workforce report does not specify in which districts these emergency teachers are working, but the state's federally-required highly qualified teacher plan states that half of the

¹⁶ ACT, Inc. College and Workforce Training Readiness: The Future Workforce of Wisconsin, 2008.
<http://www.act.org/news/data/08/pdf/workforce/Wisconsin.pdf>

¹⁷ Wisconsin Educator Supply and Demand Project, Supply and Demand: An examination of data trends in educational personnel for Wisconsin Public Schools, Department of Public Instruction, 2007.
<http://dpi.wi.gov/tepd/pdf/supdem07.pdf>

¹⁸ It should be noted, however, that the data on education program graduates likely overcounts future teachers, as some may choose not to go into teaching and some may seek jobs outside Wisconsin.

¹⁹ Wisconsin Educator Supply and Demand Project, Supply and Demand: An examination of data trends in educational personnel for Wisconsin Public Schools, Department of Public Instruction, 2007.
<http://dpi.wi.gov/tepd/pdf/supdem07.pdf>

²⁰ Wis. Admin. Code Chapter PI 34.21

emergency licensed teachers teach in five districts: Green Bay, Kenosha, Madison, Milwaukee, and Racine.²¹ Therefore, it appears likely that a significant portion of the state’s emergency-licensed STEM teachers are teaching in southeast Wisconsin.

It should be noted that under the federal requirements a teacher who is teaching in a specialty other than that for which he or she is certified is not considered “highly qualified.” (This is true even if that teacher has an academic degree in the specialty field.) In addition, Wisconsin does not have a credential for teachers of multi-disciplinary specialty courses. If a course integrates several STEM disciplines, as many project-based classes do, districts may run afoul of the federal law, even though there is no such multi-disciplinary STEM teacher credential.

A rough estimate of the STEM specialties in which it is most difficult to find teacher candidates can be made from a survey of 266 districts conducted for the annual teacher data report. The table below indicates that for every one vacancy in physics, for example, there were a mere six applicants. In comparison, for every vacancy in general science there were over 26 applicants.²²

Table 4: Supply of specialty teachers (STEM specialties in orange)

2006-07	Total vacancies	Total applicants	Ratio of applicants to vacancies
Agricultural education	94	138	1.47
Art	65.1	1720	26.42
Biology	26.5	642	24.23
Business education	51.7	651	12.59
Chemistry	21.83	327	14.98
Driver education	1	5	5.00
Earth science	15.5	218	14.06
ESL/ELL/bilingual	69.33	868	12.52
English/speech/theatre/journalism	168.13	4817	28.65
Family & consumer education	41.13	321	7.80
Foreign language	93.4	888	9.51
General science	55.33	1472	26.60
Health education	13.4	340	25.37
Library/media	41.8	446	10.67
Math	120.95	2930	24.22
Music	122.39	1677	13.70
Physical education	87.71	3578	40.79
Physics	14.5	92	6.34
Reading	41.9	781	18.64
Social studies	109.75	7209	65.69
Technology education	70	703	10.04

²¹ DPI, Revised Highly Qualified Teachers Plan, Sept. 2006. http://dpi.wi.gov/esea/pdf/wi_hqt_plan.pdf

²² Survey respondents included 48 southeast Wisconsin school districts. For a list, see: <http://dpi.wi.gov/tepd/pdf/supdem07.pdf>

In sum, the math and science performance of Wisconsin students, while not at the lowest end of the scale compared to their national and international counterparts, certainly may be cause for concern when the future workforce needs of our state are taken into account. For southeastern Wisconsin, these deficiencies are even more troubling.

These concerns are exacerbated by the fact that the ability of school districts to improve their students' performance in STEM fields will depend at least partially on having enough qualified STEM teachers. While certain STEM specialty areas seem to have plenty of qualified candidates, there are some fields in which more teachers are and will be needed. In southeast Wisconsin, the supply of chemistry, physics, and technology education teachers was found to be below average as of 2007. For biology and earth science, supply was found to be well below average.²³

Finally, as more and more STEM courses are taught in integrated and multidisciplinary classrooms focused on critical thinking and problem-solving, the most appropriate credential to be held by the teacher is not obvious. Having sufficient STEM teachers for traditional math and science courses may be eclipsed by the need for teachers who are highly qualified to teach project-based courses that include content from several STEM subject areas.

Securing more STEM teachers at the local level is important, but other initiatives likely will be necessary to meet the state's future workforce needs. As the following sections of this report explain, state level policy plays a critical role.

²³ Wisconsin Educator Supply and Demand Project, Supply and Demand: An examination of data trends in educational personnel for Wisconsin Public Schools, Department of Public Instruction, 2007. <http://dpi.wi.gov/tepd/pdf/supdem07.pdf>

Section 3: Standards, assessments, and accountability

There are three areas related to STEM where current state policy needs to be evaluated and where certain policy alternatives should be debated:

- Do the state's *standards, assessments, and accountability* policies reflect what students need to know and do in a future global economy?
- Are there enough *high-quality teachers and school leaders* with expertise in STEM subjects across all grade levels?
- Do *quality statewide and local innovations* get enough support, both with resources and regulatory policies?

In this and the following two sections, the importance of each of these areas is discussed, the current relevant state policies are outlined, and alternative policy options are presented. The alternative policy options are based on the recommendations of the National Governor's Association, the U.S. Chamber of Commerce, the New Commission on the Skills of the American Workforce, and the Partnership for 21st Century Skills, among others.²⁴

If the state's current commitment to STEM education were measured only by the state budget, it would appear quite minimal. The current budget of the Department of Public Instruction (DPI) has few line items specifically funding STEM-related policies or activities. In addition, DPI requests for STEM-related funding are often not fulfilled in the budgeting process, resulting in fewer funds for these activities than may be needed.

For the 2007-09 biennium, DPI requested \$157,500 in general purpose revenues in both fiscal years (a total of \$315,000 over the biennium) to address the achievement gap in student performance in STEM fields and in STEM-related career pursuits. The funds were to be utilized for STEM grants to districts, Project Lead The Way (see description below), and for professional development for STEM teachers. DPI also requested statutory authority to begin a statewide STEM initiative.²⁵ The Governor's proposed budget, however, provided \$109,500 in each fiscal year (\$219,000 over the biennium) for STEM grants to districts and for professional development activities. The Governor's budget also included the statutory authority sought by the department.²⁶ In the end, the final budget signed by the Governor granted the statutory authority, but funded just \$61,500 per fiscal year (\$123,000 over the biennium) for STEM grants, less than half of the original request by DPI.²⁷

In the 2009-2011 biennium, the DPI made four STEM-related funding requests: 1.) State bonding of \$5 million in FY2011 for capital improvements to schools, including technological improvements; 2.) An appropriation of \$1 million in FY2011 for STEM grants to school districts; 3.) Funds to create four regional STEM academies (\$253,000 in FY10 and \$1,148,000

²⁴ See Appendix I for a complete list.

²⁵ DPI, summary of 2007-09 biennial budget request. <http://www.dpi.state.wi.us/pb/pdf/sumtable0709.pdf>

²⁶ Wisconsin Department of Administration, summary of Governor's 2007-09 biennial budget request.

http://www.doa.state.wi.us/debf/doc_view2asp?budid+42

²⁷ 2007 Wisconsin Act 20. <http://www.dpi.state.wi.us/pb/pdf/act20sum.pdf>

in FY2011) to “meet a comprehensive plan for excellence in STEM education that responds to labor trends and workforce needs,” and to “provide STEM content, courses, and experiences for high school junior and senior students;” and 4.) Continued funding of \$250,000 in each fiscal year for grants supporting Project Lead The Way.²⁸ The Governor’s proposed budget included decreased funding for both PLTW (\$235,000 in each fiscal year) and the STEM grants (\$60,900 in each fiscal year).²⁹ Due to the state’s budget crisis, STEM grants, like most other K-12 funding were cut in the Joint Finance Committee, to \$60,000 per year.

With the 2009-2011 budget yet to be finalized, it remains to be seen how much money will ultimately be earmarked for STEM efforts this biennium. However, many other K-12 funding and policy decisions that are not specifically STEM focused could have a major impact on the ability of the state to meet STEM workforce needs. And in fact, DPI does seem to include STEM goals in many of its programs and policies; examples are highlighted in this report. With a new Superintendent of Public Instruction, some of the important funding and policy decisions and their potential impacts on STEM education could be ripe for debate.

Standards

Rigorous STEM standards help ensure greater competitiveness in the global economy, while modern assessments tied to those standards help educators monitor students’ progress and teachers’ effectiveness. Strong accountability policies help communities intervene in schools that are not succeeding in meeting these standards.

Wisconsin gets low marks from several organizations concerned about educational policy for its current standards and assessment methods, especially the math and science standards, which were adopted in 1998. The 2009 edition of *Education Week’s* annual *Quality Counts* report gives Wisconsin an overall grade of C+ for standards, assessments, and accountability, which translates into a 38th place ranking among the 50 states and D.C.³⁰ *Education Week* critiques Wisconsin’s standards for not being specific, clear, or grounded in content. In addition, the standards have not been revised often enough.

The Institute for a Competitive Workforce, housed at the U.S. Chamber of Commerce, gives Wisconsin a D grade for the lack of rigor in its standards, noting that the state’s science standards in particular receive very low marks.³¹

The American Federation of Teachers goes further in its criticism, finding that not a single subject-matter standard in Wisconsin met its criteria for strength or coherence, mostly because

²⁸ DPI, biennial budget request. <http://www.dpi.state.wi.us/pb/pdf/combineddins0911.pdf>

²⁹ DPI, summary of Governor’s 2009-11 biennial budget request. <http://www.dpi.state.wi.us/pb/pdf/govbudsum0911.pdf>

³⁰ *Education Week*, Quality Counts 2009, Editorial Projects in Education Research Center, 2009. <http://www.edweek.org/ew/qc/2009/17src.h28.html>

³¹ U.S. Chamber of Commerce, Leaders and Laggards: A State-by-state Report Card on Educational Effectiveness, 2007. <http://www.uschamber.com/icw/reportcard/default>

the standards are not specific enough in terms of the skills and competencies students are expected to have.³² The AFT also prefers standards at each grade level, rather than at clusters of grade levels such as “high school.”

The Fordham Institute also finds fault with the state standards’ lack of specificity, awarding Wisconsin an overall grade of D-, including an F for science and a D for math.³³ The critique of the science standards is particularly blistering:

This document’s flaws are myriad. It is vague. It is heavy in process. It is so light in content as to be nearly useless. What’s worse, Wisconsin’s school districts are required to devise a curriculum from these standards, such as this: “Using the science themes and knowledge of chemical, physical, atomic, and nuclear reactions, explain changes in materials, living things, earth’s features, and stars.” How does one do that? Depth is nowhere to be found. No teacher or curriculum developer can possibly derive a useful course of instruction from this document.

According to DPI, Wisconsin’s science standards “follow the format and content of the National Science Education Standards” of 1996 and are an attempt to “capture the knowledge and skills needed to be a scientifically literate citizen.” They “do not represent the level of achievement expected in higher level courses.”³⁴ They do not include the expectations of learning at each grade level; they represent the goals to be achieved by the end of grades 4, 8, and 10 only.³⁵ They do not specify the content or process goals for specific high school science courses.

Wisconsin’s math standards are also “general guidelines” and are not “a prescription for instructional practice.” Like the science standards, they do not include every grade level, nor are they specific to particular high school math courses.

Wisconsin has model standards for information technology and literacy³⁶ and for technology education.³⁷ The information technology and literacy standards are comparatively more specific than the math and/or science standards, but the technology education standards are less concrete. Neither set of technology-related standards includes expectations for every grade level. Both sets of standards were published in 1998. In addition, it is unclear to what extent these standards are actually implemented at the local level; although districts are to submit plans every five years specifying how these standards are to be executed, the state does not evaluate the plans, give any feedback, or track districts’ implementation.

³² American Federation of Teachers, Sizing Up State Standards 2008. <http://www.aft.org/pubs-reports/downloads/teachers/standards2008.pdf>

³³ Chester E. Finn, Jr. et al. The State of State Standards 2006, Thomas B. Fordham Institute, 2006. http://www.edexcellence.net/detail/news.cfm?news_id=358&id=130

³⁴ <http://dpi.wi.gov/standards/sciintro.html>

³⁵ In late May 2009, DPI announced it will develop math and English standards for each grade level.

³⁶ <http://dpi.wi.gov/standards/pdf/infotech.pdf>

³⁷ <http://dpi.wi.gov/standards/pdf/teched.pdf>

Wisconsin does not provide model STEM curricula for any grade, although a framework for what will be tested on the WKCE is provided for grades 4, 8, and 10 and curricular planning guides are available.

According to a survey by Achieve,³⁸ Wisconsin joins 22 other states in planning upcoming revisions to the state standards. Wisconsin's new standards are anticipated for 2010 and have been promised to be aligned with the expectations of college and the workplace. As a member of Achieve's American Diploma Project, Wisconsin has committed to:

- Align high school academic content standards in English and math with the demands of college and career;
- Require students to complete a college- and career-ready curriculum so that earning a diploma ensures that a student is ready for post-secondary opportunities;
- Administer statewide high school assessments anchored to college- and career-ready expectations; and
- Create comprehensive accountability and reporting systems that promote college and career readiness for all students.

The American Diploma Project has also resulted in Wisconsin working to develop its first statewide definition of college readiness. A uniform definition of college readiness is intended to reduce confusion for teachers, students, and parents, and also enables post-secondary institutions to clarify their expectations and admissions requirements. Content and process standards aligned with post-secondary pathways allow graduates to enter higher education prepared for its rigors.

The DPI is developing college readiness standards aligned with college and career expectations and has indicated it plans to raise graduation requirements in accordance with those expectations. Wisconsin has joined the national Partnership for 21st Century Skills (P21), but the focus on the importance of 21st century skills really began with the recommendations by the superintendent's High School Task Force in October 2006, which include the following changes to high school curriculum:³⁹

- Emphasizing the need for innovation
- Design of rigorous, authentic learning experiences
- Personal connections and individualized learning plans for each student
- Solid business and community partnerships

In January 2007, the state formally joined P21 and announced a goal of bringing "21st century teaching and learning skills to every school system in the state."⁴⁰ Such skills include

³⁸ Created in 1996 by the nation's governors and corporate leaders, Achieve is an independent, bipartisan, non-profit education reform organization based in Washington, D.C.

³⁹ DPI, State Superintendent's High School Task Force Report. http://dpi.wi.gov/sprntdnt/pdf/hstask_report.pdf

⁴⁰ DPI (press release), "Wisconsin Launches Education Initiative to Bring 21st Century Skills to Every School Student," January 17, 2007. http://dpi.wi.gov/eis/pdf/1.17.07_wi21stcenturylaunch.pdf

“information and communication literacy, critical thinking, communication, collaboration, global awareness and business, economic and civic literacy.”⁴¹

As a kickoff to the implementation of the 21st Century Skills framework, DPI held a Business Summit on 21st Century Skills in March 2007. The purpose of this summit was “to gain the perspective of business and commerce leaders on workforce needs and to engage the business community in defining 21st century skills which should be prioritized in the PK-16 education system.” Participants of the business summit were asked to describe the knowledge and skills that an eighth grader would need in order to enter the workforce in five to ten years.⁴²

The recommendations from this summit influenced DPI’s decision to review content standards, as described above. However, with regard to STEM specifically, the state has not specified plans to create standards that align STEM expectations between elementary, middle, and high schools and create a coherent K-12 STEM system, as called for by the National Governor’s Association.

Assessments

Of course, standards are only as rigorous as the assessment tool used to measure students’ understanding of them. Wisconsin’s current assessment test, the Wisconsin Knowledge and Concepts Exam (WKCE), administered in grades 4, 8, and 10 for science and in every grade from 3rd to 10th for reading and math, has been criticized for setting the bar too low.

As discussed above, when compared to the state’s national NAEP exam results, the WKCE results indicate that the state’s definition of proficiency may be too low. The National Center for Education Statistics agrees that comparing a state’s proficiency standards to the NAEP proficiency standard indicates the relative stringency of those standards. As shown in Chart 9, a score of at least 225 on the NAEP test would equal proficiency on the 4th grade math WKCE; the comparable score in 8th grade would be 263. However, in order to meet the NAEP definition of proficient, the 4th grade math score must be at least a 249, while 8th graders must score at least 299.⁴³

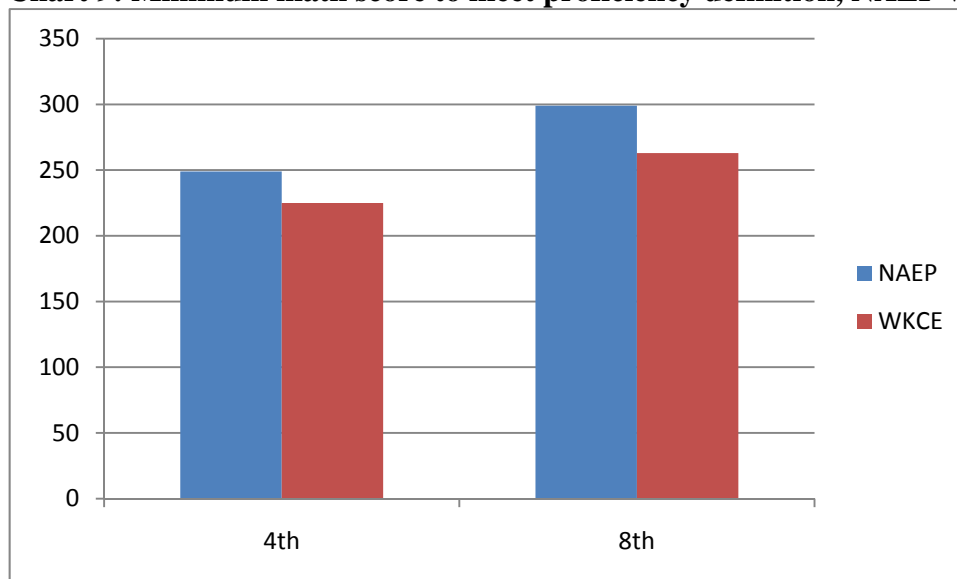
⁴¹ It should be noted that the P21 movement has been strongly criticized as forsaking content in favor of ill-defined skills. The main objections to a focus on skills development are as follows:

- It is difficult to measure skill acquisition and hold teachers accountable.
- Evidence is lacking that these skills benefit graduates once they are in the workplace.
- There is nothing so unique about the 21st century that requires new or different skills than prior centuries.
- Teachers may lose autonomy if skills-based pedagogy is required.

⁴² DPI, Overview of Business Summit on 21st Century Skills. <http://dpi.wi.gov/cal/doc/overview.doc>

⁴³ National Center for Education Statistics, Mapping 2005 State Proficiency Standards Onto the NAEP Scales, U.S. Dept. of Education Institute of Education Sciences, June 2007. <http://nces.ed.gov/nationsreportcard/pdf/studies/2007482.pdf>

Chart 9: Minimum math score to meet proficiency definition, NAEP vs. WKCE



Source: Institute of Education Sciences

This gap between NAEP and WKCE proficiency scores led the U.S. Chamber of Commerce to give Wisconsin a C grade for “truth in advertising about student proficiency.”⁴⁴ Similarly, the gap prompted *Education Next* to give Wisconsin a C- grade for its proficiency standards in both 2005 and 2007.

Education Week did note that unlike in many other states, the gap between WKCE and NAEP scores had shrunk since 2002.⁴⁵ However, a different methodology finds a lack of evidence for improvements over time. When the WKCE’s minimum score to meet proficiency (the proficiency “cut score”) is compared to that of the Northwest Evaluation Association’s Measures of Academic Progress (MAP) test, the Wisconsin 8th-grade tests were found to have gotten easier from 2003 to 2005. The gap in cut scores between the WKCE and the MAP was narrower in the lower grades; however, across all grades the math proficiency cut score gap was at least 5 percentile points and ranged up to 22 percentile points.⁴⁶

Wisconsin has undertaken an evaluation of its current assessment system by convening the Next Generation Assessment Task Force to research what kind of assessment tool will work best for determining students’ acquisition of workforce-ready skills and knowledge. The task force includes representatives from business, commerce, and education.⁴⁷ This group will make recommendations to the Superintendent of Public Instruction in late spring of 2009 on “assessment strategies and delivery models that provide the greatest promise for accurately

⁴⁴ U.S. Chamber of Commerce, *Leaders and Laggards: A State-by-state Report Card on Educational Effectiveness*, 2007. <http://www.uschamber.com/icw/reportcard/default>

⁴⁵ Paul Peterson and Rick Hess, *Keeping an Eye on State Standards*, *Education Next*, Summer 2006. <http://www.hoover.org/publications/ednext/3211601.html>

⁴⁶ John Cronin, et al. *The Proficiency Illusion*, Thomas B. Fordham Institute and Northwest Evaluation Association, October 2007. http://www.edexcellence.net/doc/The_Proficiency_Illusion.pdf

⁴⁷ For a list of task force members see: <http://dpi.wi.gov/oea/pdf/members.pdf>

demonstrating students' attainment of 21st century skills." The state has indicated that it plans to unveil the new assessments in 2010.

The task force⁴⁸ is evaluating the need for balanced assessment systems (incorporating both assessments that provide "snapshot" information of a student's knowledge as well as "real-time" assessments that provide ongoing data to the teacher so that the students' current needs can be incorporated into teaching) and is looking into best practices from other states. The following themes arising from their research give us some insight into what the task force's final recommendations to the superintendent likely will include:

1. The assessments should have classroom relevance and be useful to teachers.
2. Teachers should be involved in developing the assessments.
3. Students should be able to take the test multiple times.
4. Immediate feedback should be available to the teacher and student.
5. Assessments should be connected to career and college readiness.

Accountability

The state's accountability mechanisms also appear to be in need of some improvement. A contributing factor in the state's C+ grade from *Education Week* for standards and accountability was the lack of sanctions for failing schools. Unlike some other states, Wisconsin does not have requirements in addition to the NCLB's "adequate yearly progress" requirement, nor do its sanctions for poorly performing schools go beyond the federal sanctions.⁴⁹

Education Week does give Wisconsin kudos for having a longitudinal data system in place for tracking students' progress throughout their K-12 career. The data system tracks a student's enrollment, progress on the WKCE, graduation, and results from AP or ACT tests. However, the system is missing three of the ten "essential elements" as defined by the Data Quality Campaign: the ability to match a student with his or her teacher, the ability to link to a student's transcript, and the ability to track students into their post-secondary schooling. Wisconsin indicates it plans to include post-secondary data in the system sometime after 2011.⁵⁰ Until then, the data system is unable to help policymakers determine whether performance on state assessments predicts success in college.

⁴⁸ According to interviews with some task force members, the task force is not involved in efforts to re-evaluate state standards. Concerns have been voiced, given that the task force's research has indicated that assessments should be tied to curricular standards. In addition, these task force members feel the short time frame in which the task force is expected to do its work is not sufficient.

⁴⁹ *Education Week*, Quality Counts 2009, Editorial Projects in Education Research Center, 2009. It should be noted that the sanctions of the NCLB itself are controversial; whether states should have sanctions above and beyond those of the NCLB is highly contentious.

⁵⁰ Data Quality Campaign. <http://www.dataqualitycampaign.org/survey/states/WI>

Policy alternatives

Many national policy groups have made the case for state-level policy reforms that increase the number of students exposed to STEM content and careers, improve student math and science outcomes, and better meet employers' workforce needs. Among these groups there is a surprisingly high level of agreement as to priorities and strategies. The policy options outlined below reflect those policy reforms endorsed by the National Governor's Association, the U.S. Chamber of Commerce, the Commission on the Skills of the American Workforce, and the Partnership for 21st Century Skills.

1. Strengthen state standards in science and math and other STEM fields; create model curricula in STEM fields

Re-evaluation of content standards is long overdue, and DPI's stated intention to revise math and English standards is appropriate. DPI should also investigate whether the time is right to revise science standards as well. The best standards are those that provide the clearest possible guidance to administrators and teachers as they develop curricula.

This is especially important because Wisconsin does not provide model curricula in most STEM content areas. Other states have created model STEM curricula, most notably Delaware, which requires districts who wish to use their own curricula to demonstrate that their alternatives are as rigorous as the state's model. The Delaware curriculum arose from the Delaware Science Coalition, created by the governor, and was subjected to pilot studies prior to adoption.⁵¹

Similarly, planning and testing model curricula at the state level is something Wisconsin should debate. District administrators in southeast Wisconsin report working very hard to develop up-to-date, rigorous, and career-based curricula for the "T" and "E" elements of STEM, in particular. If our local districts need help, a statewide effort to develop model STEM curricula may be seen as valuable; there may be a need for state guidance that supersedes traditional concerns about local control.

At any rate, because STEM often is considered to be "more than the sum of its parts", rigorous STEM standards that can be met via an integrated curriculum are important. As more and more STEM educators see a need for teaching content without regard to the "label" on the course, there is a risk that standards will not be implemented on the local level if that multi-disciplinary coursework is excluded. Having standards that recognize math concepts are taught in physics courses, for example, as well as in math courses, allows districts some flexibility in creating new methods of delivering content. Content and process standards that are not tied to specific course titles are especially useful to districts that are using project-based learning in which one course covers several aspects of STEM skills and content by tackling a common problem over the entire year or semester. In addition, the standards that relate to skills and process should be specific enough to ensure clarity, yet not so specific that there is a disincentive for project-based learning,

⁵¹Innovation America, Building a Science Technology, Engineering, and Math Agenda, National Governor's Association, 2007. <http://www.nga.org/Files/pdf/0702INNOVATIONSTEM.PDF>

where the students themselves decide on the process to use in solving a problem. They may not use the same process anticipated by the teacher, but so long as the same skills are developed, the student-driven solution should meet state standards.

2. Align standards to workforce needs and college matriculation requirements

The UW System's strategic plan, Advantage Wisconsin, calls for the system to work closely with PK-12 schools to ensure students are prepared for college-level math. The related "action step" calls for the system to "identify competencies needed for college preparation and align those with academic standards for high school."

Working with DPI to do so would go a long way toward achieving the coherent PK-16 STEM system called for by the National Governor's Association. In addition, however, standards and expectations for STEM in the elementary and middle grades need to be aligned. By making educators' responsibilities at each grade level more transparent to them, as well as to parents, it is thought that better-prepared graduates will result. In addition, it may help students see career opportunities earlier.⁵²

DPI should also work closely with the technical college system to ensure Wisconsin's high school graduates are prepared to perform well on placement exams for apprenticeship programs and other career training programs.

Finally, the workforce data collected and disseminated by the state Department of Workforce Development could be packaged in a more user-friendly manner for K-12 educators and administrators. Compiling the data into the federally-defined career clusters that districts and technical colleges are familiar with would be one way to do so.

3. Align assessments to new standards

It should be noted that changing assessment schema is actually quite difficult because many of the assessment tools currently in place are not equipped to assess such skills as critical thinking, information technology, or work readiness. While these skills are not currently reflected in the state assessments, since 2000-2001 Wisconsin school districts have been able to grant Employability Skills Certificates to high school students completing unpaid work experience requirements. (The skills that the student must master are those identified by the U.S. Department of Labor's Secretary's Commission on Achieving Necessary Skills.)⁵³

Additionally, funding is an issue. Since the state is federally required to test students using the assessments already in place, it likely will be difficult to afford incorporation of additional assessments. However, some states have overcome that difficulty. Kentucky, for example, recently passed legislation that continues its current testing in reading and math to meet NCLB

⁵² Innovation America, Building a Science Technology, Engineering, and Math Agenda, National Governor's Association, 2007. <http://www.nga.org/Files/pdf/0702INNOVATIONSTEM.PDF>

⁵³ DPI, Employability Skills Standards. <http://dpi.wi.gov/cte/esintro.html>

requirements while adding new tests in 2011 that will be aligned to new “deeper, fewer, and cleaner” standards.⁵⁴

Wisconsin must ensure that once its new math and English standards are adopted, they are reflected in the assessments measuring student performance. Currently, Wisconsin’s Next Generation Task Force is in the research phase to determine what kind of assessment tool will work best for determining students’ acquisition of 21st century skills and workforce readiness. The task force has been looking into the Michigan assessment model, which assesses high school students’ college- and work-readiness by requiring them to take both the ACT college entrance exam and the ACT’s WorkKeys job skills assessment in addition to state standardized tests. Eight other states also currently require high school students to take an assessment designed to specifically measure college- and/or work-readiness. Three other states have such requirements in the planning process, and one state (California) offers these types of assessments on a voluntary basis.⁵⁵ If interested in recommending this type of assessment for Wisconsin, the task force must ensure that the tested content is compatible with the state’s forthcoming standards for workforce readiness.

Yet creating an entirely new assessment may not be necessary. Other states, such as Michigan and Colorado, have adopted national tests. Here in Wisconsin, the working group tasked with generating concrete ways of implementing the UW System strategic agenda made the following recommendation with regard to improving students’ math and science preparation:⁵⁶

To help students become better prepared prior to enrolling in UW institutions, the UWS should partner with outside organizations such as ACT or the Gates Foundation to provide college preparatory curriculum in all schools and strengthen academic preparation in science and math and to create equitable high school outcomes in all core subject areas. Working directly with ACT, the State of Wisconsin could adopt and fund the EPAS program where every 8th grader will take the EXPLORE test (8th grade ACT), every 10th grader the PLAN (10th grade ACT), and every high school senior would take the ACT assessment. Since ACT is a curriculum-based test, this would help teachers and school administrators identify early intervention needs for students.

Alternatively, state-level participation in international assessments such as TIMSS or PISA would reinforce the intent for state standards to be world-class, and would allow the state’s students to benchmark progress against peers around the globe.⁵⁷

It should be noted that even if the state moves slowly on the creation of new assessments or the adoption of national or international assessments, there is nothing to prevent a district from

⁵⁴ David Hoff, “Kentucky tests tied to tougher standards,” *Education Week*, April 1, 2009.

⁵⁵ Achieve, *Closing the Expectations Gap* 2009.

⁵⁶ UW System, *Strategic Framework to Advantage Wisconsin, More Graduates Report of think tank #2*, 2008. <http://advantage.wisconsin.edu/reports/TTReports/FinalReport2online.pdf>

⁵⁷ Innovation America, *Building a Science Technology, Engineering, and Math Agenda*, National Governor’s Association, 2007. <http://www.nga.org/Files/pdf/0702INNOVATIONSTEM.PDF>

administering additional assessments, which many currently do. The state may wish to investigate which districts are using which tests and why; if there is a commonly used test endorsed by districts across the state, it might meet the state's needs without further burdening most districts.

4. Improve accountability for students' post-secondary success

The Data Quality Campaign has identified 10 essential elements of a longitudinal data system for accountability, including the tracking of students throughout K-12 and into higher education. According to the Campaign, Wisconsin's longitudinal system meets 7 of the 10 elements.⁵⁸

One of the missing elements is the lack of transcript information. While a student's enrollment and achievement on standardized tests can be tracked, Wisconsin's database does not gather information on the courses the student took, or who taught them. In addition, the system does not currently follow students beyond high school, although the state indicates that is a long-range goal for the ISES system.

It seems imperative that Wisconsin include transcript information and the collection of post-secondary data in the system if the state hopes to measure the effectiveness of new content standards and new assessments. Including these types of information would reveal which high school courses best prepare students for college by ensuring their content knowledge and which schools or teachers are most successfully teaching those courses. In addition, the data collected by the longitudinal data system can provide educators at all K-12 levels with the information needed to improve instruction and improve preparation for post-secondary learning.

⁵⁸ Data Quality Campaign: Using Data to Improve Student Achievement, 2008.
<http://www.dataqualitycampaign.org/survey/states/WI>

Section 4: High quality STEM teachers

Teacher licensing

As discussed above, Wisconsin seems to have sufficient numbers of STEM teachers currently. However, not much is known about the quality of these teachers and there may develop a greater need for STEM teachers with more rigorous state standards that include more aspects of STEM than just core math and science. Finally, current data indicates that 17 percent of STEM teachers in the state are over 55 years old, portending a need for new teachers to take their place as they retire over the next decade.

One way in which some states are combating real or perceived shortages of STEM teachers is alternative credentialing. Wisconsin allows 14 organizations across the state to grant an alternative teacher credential (seven of which are in southeast Wisconsin), including one at UW-Oshkosh specifically for math and science teachers. In addition, the state has provisions for emergency licensing of teachers who are otherwise qualified but lacking a state credential. However, the most recent Wisconsin data indicate that alternative licensing programs in the state are not producing significant numbers of STEM specialty teachers; in fact, there were just 25 such graduates in 2007.⁵⁹ Alternative credentialing is often used by people to come to teaching later in their careers and who already have four-year degrees in some other discipline. Having accessible and affordable alternative credentialing programs clears the path for STEM professionals to obtain their teaching licenses and bring their knowledge of their industry into the classroom.

After graduating from a traditional or alternative teacher preparation program, all specialty teachers in Wisconsin must also pass a subject-matter exam before being eligible for a teaching license. Teachers licensed to teach broadfield science, physical science, chemistry, physics, earth and space science, biology, or life and environmental science must pass the Praxis II general science: content knowledge exam. Math teachers must pass the Praxis II mathematics: content knowledge exam and technology education teachers must pass the Praxis II technology education exam.

In addition to passing the requisite Praxis exam, new teachers in Wisconsin must now demonstrate their knowledge and abilities by creating a portfolio that showcases their understanding of the state teaching standards. This portfolio requirement came about as part of a statewide effort to improve teacher quality, the Wisconsin Quality Educator Initiative. The Initiative, promulgated by DPI in 2000 as Chapter PI 34 of the Wisconsin Administrative Code after six years of planning for redesign of the educator preparation and licensing process, resulted in three major changes in how teachers are licensed:

⁵⁹ Wisconsin Educator Supply and Demand Project, Supply and Demand: An examination of data trends in educational personnel for Wisconsin Public Schools, Department of Public Instruction, 2007
<http://dpi.wi.gov/tepd/pdf/supdem07.pdf>

1. The focus of teacher preparation switched from counting courses and credits to demonstrating competency and performance (through the creation of portfolios demonstrating the knowledge and skills required by state teacher standards). The portfolio requirement is in addition to the educational institution's degree requirements and does not supplant them.
2. License renewal now results from planned, self-directed, professional development rather than accumulation of credits and is guided by the teacher standards.
3. License categories are now broader and are defined by developmental levels of students.

As a result of the quality initiative, Wisconsin has a new tiered system for teacher licensing that was put into effect in 2004. "Initial educators" have successfully completed an approved educator preparation program and have received a license from the state for the first time. These teachers hold their "initial educator" licenses for three years and during this time must complete a professional development plan, which must be reviewed by a trained three-member peer review team. Once the plan has been approved, the teacher receives a "professional educator" license. The new renewal process for the professional educator license is being phased in; those teachers who had initial educator licenses can only renew their professional educator license with the successful completion of a professional development plan. Teachers who were licensed prior to September 2004 can renew their professional educator licenses by either a professional development plan or completing six credits at the university level.⁶⁰ Finally, the state offers a voluntary 10-year "master educator" license that can be achieved via accreditation by the National Board for Professional Teaching Standards, the Wisconsin Master Educator Assessment Process, or by completing the Wallace Fellows program for urban principals.

These new requirements apply to both specialty and general classroom teachers, meaning that STEM teachers also must develop individualized professional development plans overseen by a review team. This requirement seems promising for the improvement of STEM teaching quality, as teachers will be able to gain content knowledge and explore new teaching methodologies via non-traditional professional development activities in addition to the typical district- or school-led teacher training days or summer classes at local colleges. STEM teachers interested in participating in Project Lead The Way (discussed more thoroughly in the next section), for example, have the opportunity to utilize Project Lead The Way teacher training programs to meet state license renewal criteria.

What the state currently lacks is a multi-disciplinary STEM credential appropriate for coursework that presents STEM material in an integrated fashion and that focuses on critical thinking and problem-solving. Credentials of this type are being discussed in many states and by many teacher education institutions, including at least one in Wisconsin. The need for this type of credential is not only driven by project-based learning methodology, but by the requirements of the federal No Child Left Behind Act, which define a high quality teacher as one holding a certification specific to the coursework being taught.

⁶⁰ Professional Standards Council and Teacher Education, Professional Development and Licensing Team, 2006-07 Annual Report, Wisconsin Department of Public Instruction.

Other policies

Districts, meanwhile, have four responsibilities specifically spelled out in the administrative rules:

- Providing ongoing orientation that is collaboratively developed and delivered by school boards, administrators, teachers, support staff, and parents/families;
- Providing support seminars which reflect the appropriate standards (teacher, pupil services personnel, administrator), and the mission and goals of the school district;
- Designating an administrator who may serve, subject to school board approval, on the initial educator's professional development plan (PDP) team; and
- Providing a qualified mentor for initial educators.

A 2008 survey of initial educators indicates that 89 percent have received a designated mentor from their district and 81 percent of those mentors are located in the same school as the initial teacher. However, a third of the mentors are not currently working in similar teaching positions as their mentees and a third do not have past experience similar to the mentee's current teaching assignment. In addition, 49 percent of initial teachers with mentors indicate that their mentors have not observed them in the classroom and 65 percent indicate they have not observed their mentor in the mentor's classroom.⁶¹

Unfortunately, the survey results are not broken down by teaching specialty so it is not clear to what extent STEM specialty teachers have mentors who are also STEM teachers, or who are teaching in the same STEM discipline. It is encouraging, however, that districts, for the most part, seem to be meeting the requirements of the new rules in terms of the support they must offer to initial teachers. The state should collect more specific data regarding the support offered to specialty teachers, including STEM teachers, in order to properly evaluate the effectiveness of the new licensing standards at improving teacher quality.

State schools of education are also making changes to adapt to the new licensing rules. For example, UWM, which produces almost 10 percent of graduates with teaching degrees in Wisconsin, has utilized two recent grants to better align course requirements with state law, Praxis II, and MPS learning targets. In 2003, UWM was the recipient of a \$5 million Teachers for a New Era (TNE) grant from the Carnegie Foundation, which was matched by UWM, including \$1.5 million in endowed funding (private support). In conjunction with the Milwaukee Partnership Academy and MTEA, the TNE initiative aims to revise teacher preparation programs so as to include evidence-based practices, engage higher education faculty in the arts and sciences in the education of new teachers to improve subject matter knowledge, and utilize master teachers as clinical faculty in the school of education.

Design teams at UWM were formed to revise the curricula and coursework in the school of education to be consistent with the goals of the TNE. The math design team and its efforts were funded and aligned with the Milwaukee Mathematics Partnership, described below. The natural

⁶¹ DPI, Initial Educator Survey 2007-2008. <http://dpi.wi.gov/tepd/pdf/iesurveytch08.pdf>

science design team was funded in part by a Title II federal grant, and includes UWM science faculty, research faculty from the school of education's center for math and science education, and master teachers-in-residence at UWM on leave from MPS.⁶²

The Milwaukee Mathematics Partnership was funded by grants from the National Science Foundation and DPI's Math and Science Partnership program with \$20 million in 2003, which will fund work through 2010. The partnership includes MPS, UWM, and MATC and is aimed at making evidence-based curricular and institutional changes at the K-12 and teacher prep levels that will result in improved teacher quality and better K-12 student outcomes. In its first five years, the MMP resulted in over 50,000 hours of professional development in math across MPS.

The MMP is based on a Comprehensive Mathematics Framework (CMF) developed in 2002 that is designed to improve students' understanding and comprehension of mathematics concepts and operations, ability to solve problems and apply their understanding, compute accurately, justify solutions through logical reasoning, and be engaged in mathematics as useful and doable.

The CMF is used by UWM to develop math teachers, while MPS uses it as a set of standards to teach mathematics to K-12 students. As a result of the MMP, MPS has implemented evidence-based math learning targets at all grade levels based on the CMF standards and aligned with state assessments, created classroom assessments that are based on the CMF standards and the learning targets, revised the math textbook selection process to ensure every school is utilizing texts that meet the criteria of the CMF, has created math learning teams led by math teacher leaders in every school, and created a math functional plan guided by the CMF, the district's strategic plan, and the NCLB-required district improvement plan.

Since implementation of the MMP, test scores in math in MPS have risen, as well as math teacher retention. The MMP and its comprehensive framework could be a model for other teacher preparation programs and districts.

In sum, Wisconsin has made significant policy changes in recent years aimed at improving teacher quality overall. What has been missing at the state level is a specific focus on STEM teachers. In southeast Wisconsin that gap has been at least partially filled by efforts at UWM to improve teacher preparation in math and science, and by MPS to improve math teacher in-school support and professional development.

Policy alternatives

Policy reform around teacher preparation, retention, and pay garners less consensus than that aimed at standards, assessment, and accountability. Policies options such as providing pay incentives tied to student outcomes are extremely controversial. However, there are many places

⁶² Consortium for Policy Research in Education, *Teachers for a New Era: Designing Policy Environments to Support High-Quality Teacher Preparation*, Wisconsin summary, Carnegie Foundation, January 2006. http://www.teachersforanewera.org/act_sendfile.cfm?fileid=42

across the country in which these types of policies are being debated, sometimes even tested. Similar debates should occur in Wisconsin.

1. Support promising models of preparing and developing STEM teachers

Local efforts such as those at UWM and MPS noted above need state support in order to gain traction. The existing DPI Math and Science Partnership grants program has the potential to allow replication of the Milwaukee Math Partnership across the state, as well as develop a similarly successful science model, and should grow as the statewide need for more STEM professional development grows.

Southeast Wisconsin has other innovative local professional development initiatives as well, most notably the Center for Educational Innovation and Regional Economic Development. The Center was created by the CESA #1 board in 2006 to help the region's districts focus on talent development of the future workforce. The Center supports the state's P21 efforts by serving as a resource for schools and districts, creating innovative project initiatives linked to P21 goals, and coordinating regional school improvement efforts. The Center also serves to connect K-12 educators and administrators with regional economic development efforts such as M7 and the Regional Workforce Alliance, and with state-led efforts. Finally, the Center offers professional development for educators, serves as a clearinghouse for related research, and offers an alternative licensing program.

One way to strengthen ties between K-12 classrooms and the workplace is to encourage STEM professionals to enter the teaching profession. Alternative credentialing programs are essential for the development of these teachers, who already have one or more degrees in STEM fields and who do not seek to return to school full-time to obtain another degree.

These types of local teacher preparation and professional development initiatives need support at the state level, not only with resources, but also with regulatory flexibility. For example, allowing a local teacher preparation institution or CESA to access student-level performance data that can be tracked over time would permit measurement of the effectiveness of the professional development program. In addition, a successful local program may deserve statewide implementation, in which case state resources and state policy support would be required.

2. Create incentives to recruit and retain qualified STEM teachers

The most recent analysis of teacher turnover in Wisconsin, conducted by the research arm of the North Central school accreditation body, found that although the state's rate of turnover was lower than the national average, the teachers most likely to leave the profession were secondary school teachers in arts, science, math, and foreign languages.⁶³ The researchers' recommended policy for Wisconsin and its Midwest neighbors? A "retention bonus" for teachers in these high-attrition subject areas: "Teachers who successfully complete one year of service would be

⁶³ Theobald & Michael, *Teacher Turnover in the Midwest: Who Stays, Leaves, and Moves?* North Central Regional Educational Laboratory, 2002. <http://www.ncrel.org/quality/mobility/turnover.htm>

eligible to participate in such a program. For each year of service, a teacher would have a bonus set aside in his or her name. The first year's bonus would be distributed when the teacher completes a fixed number of years (e.g., five years of continuous service). Such a program could follow a five-year vesting schedule for a set period. If a teacher leaves a district, unvested funds would be forfeited.”

Wisconsin, however, is not out of step by not having such a program. The 2008 Quality Counts report by *Education Week* gives Wisconsin a C+ grade for improving teaching quality, due to our above-average ranking of 18 among all states.⁶⁴ The policies Wisconsin lacks are lacking in most states:

- No system of pay-for-performance which financially rewards teachers for improved student performance (present in just seven states).
- No cap on the number of teachers allowed to teach in a field other than that in which they are licensed (four states), nor are parents notified of out-of-field teachers (five states).
- Teachers are not required to be evaluated annually, nor are evaluations tied to student performance (twelve states).
- There are no state-funded fiscal incentives for teachers to teach in certain teaching assignments, such as STEM subjects (present in 16 states).

While Wisconsin’s policy deficiencies in these areas do not put us out of sync with the national norm, other states appear to be moving more aggressively to implement these types of policies. In Massachusetts, for example, as a result of the university system-led state STEM initiative, the governor has proposed differentiated pay for teachers in high-demand subject areas, as well as a “Readiness Science and Math” teaching fellowship program to increase that state’s supply of STEM teachers. The fellowship program is targeted at teachers with math and science 4-year degrees who wish to earn master’s degrees. The fellowship defrays their tuition costs while they are teaching in schools with significant numbers of low-income students.⁶⁵ Ohio, meanwhile, has handled the debate over pay-for-performance by confirming it as a local issue and not formalizing a state policy or creating a state fund or program. Instead, the state’s department of education has issued guidelines for use by local districts and teachers unions when negotiating new pay-for-performance strategies.

Wisconsin should debate the merits of implementing teacher retention incentives, and should monitor the debate and implementation of such policies in other Midwestern states, especially our immediate neighbor states. Earlier this decade, the North Central Regional Education Laboratory found that between 20 percent and 50 percent of applicants for open teaching positions in Wisconsin came from other states, mostly in the Midwest.⁶⁶ If teachers are crossing

⁶⁴ *Education Week*, Quality Counts 2008: Wisconsin, Editorial Projects in Education Research Center, 2008. <http://www.edweek.org/media/ew/qc/2008/18shr.wi.h27.pdf>

⁶⁵ Gov. Deval Patrick, Ready for 21st Century Success: The New Promise of Public Education, June 2008. <http://www.mass.gov/Eeoe/docs/ma-edplan-finalrev1.pdf>

⁶⁶ Debra Hare et al., Teacher Shortages in the Midwest: Current Trends and Future Issues, North Central Regional Educational Laboratory, 2000.

state lines in their search for jobs, Wisconsin cannot afford to leak education school graduates to more lucrative positions elsewhere. Conversely, having an attractive incentive package for highly qualified teachers may draw educators from elsewhere, in addition to helping retain the existing teacher workforce.

3. Ensure districts use teacher standards and professional development goals in hiring, evaluation, promotion, and possibly compensation

While the state's new teacher licensing rules have clear expectations for districts once a teacher has been hired, it is unclear to what extent districts utilize the teacher standards when evaluating teacher candidates prior to hiring, when conducting performance evaluations, or when negotiating compensation packages.

Districts in Wisconsin have latitude in their contract negotiations with their teachers unions regarding hiring, evaluation, and promotion processes and criteria. Other states are looking at ways of ensuring that teacher standards and professional development requirements impact more than just the minimum for maintaining a state license, but also are used at the local level as tools for evaluating and promoting deserving teachers. Ohio, for example, has guidelines for negotiations that specify recommended systems of evaluation; supports for educator learning and professional development; and creating financial incentives for certain teaching assignments, retention of high-performing teachers, and acquiring "master teacher" status.

Providing guidance to districts in how to utilize teacher professional development plans to recognize highly motivated teachers, for example, would give the state's teacher quality initiative more tooth at the local level and could potentially bolster teacher retention efforts, as well.

4. Create an integrated or multi-disciplinary STEM teacher credential

An integrated STEM teacher credential would provide districts with flexibility in meeting federal teacher quality requirements and encourage project-based coursework that incorporates many STEM subject areas.

Section 5: Other statewide and local initiatives

This section presents several examples of large-scale programs at the state and local level that exemplify cooperative efforts to match workforce needs with K-12 instructional goals. This is by no means a comprehensive catalogue of these efforts, nor have these programs been analyzed for effectiveness.

The purpose of this section is to highlight the types of programs that hold promise and, should they be shown to improve student performance outcomes, would need greater support from business, education, and state and local government.

State-funded local programs

STEM grants

Even though the state's DPI exhibits a commitment to STEM through various agency initiatives, the state budget has only funded two specific district-level endeavors: Project Lead The Way (see below) and STEM grants.

The STEM grants initiative is a program whereby the state provides funding of no more than \$5,000 per project to districts for innovative STEM programs that focus on serving students who are underrepresented in STEM fields. (This typically includes female and ethnic minority students.)⁶⁷ The grant program emphasizes the state's commitment to providing students with post-secondary education options as funded projects are required to have at least one community partner (i.e. business, non-profit, college/university). The state also screens for effectiveness by including an assessment requirement as well as a sustainability plan to ensure that one-time projects are not funded.⁶⁸

The 2007-08 school year was the first in which STEM grants were given. Thirteen were awarded in the state, six of which were given to Southeastern Wisconsin districts.⁶⁹ Fourteen districts received grants for the 2008-09 school year, only two of which were in Southeastern Wisconsin.⁷⁰

In its 2009-11 budget request, DPI addressed growing interest in the STEM grants program by asking that funding be increased from \$61,500 to \$1 million by 2011. However, the governor's proposed budget decreased funding to \$60,900 per fiscal year.

The 2007-08 STEM grant recipients in southeast Wisconsin were as follows:

⁶⁷ DPI, STEM grant program description. <http://dpi.wi.gov/cte/stemgrant.html>

⁶⁸ DPI, STEM grant application. <http://dpi.wi.gov/forms/doc/f2270.doc>

⁶⁹ DPI, 2007-08 approved STEM abstracts. <http://dpi.wi.gov/cte/doc/08stemabstracts.doc>

⁷⁰ DPI, 2008-09 approved STEM abstracts. <http://dpi.wi.gov/cte/pdf/09stemabstracts.doc>

- Elkhorn Area High School: \$4,763 for “Introducing Biotechnology,” a biotech class to “help reduce student reluctance to pursue science-based elective classes by creating familiarity,” and for an 8th grade biotech workshop with UW Extension.
- Elmbrook School District: \$4,845 for “Environmental Conservation,” in which high school students serve as mentors/coaches to middle school students as they design and develop fish cribs and work with a conservation game warden from the Department of Natural Resources.
- Kettle Moraine School District: \$4,900 for “Girls Robotics,” part of Project Lead The Way implementation, and which expands the existing Robotics Club to have a girls-only team.
- MPS: \$4,900 for “Enviro LCTV” at Lincoln Center of the Arts middle school, a course to “develop skills, abilities, and confidence in video technology by producing live, school-based broadcasts, bilingual DVD PSAs, and commercials.” The middle school students work with local college students and make visits to local TV studios.
- Waukesha School District: \$4,789 for “Promoting STEM through Robotics,” an afterschool opportunity in robotics for middle schoolers led by an engineer from GE Healthcare who mentors students and teachers as they assemble and program a robot to function under specific guidelines.
- Wilmot Union High School: \$4,900 for “Girls on the Move,” a component of Project Lead The Way that aims to increase the number of participating girls by targeting female students with STEM interests, strong math and science scores, or recommendations from teachers, and provides them with an opportunity to learn about engineering careers by taking field trips to colleges and workplaces.

For the 2008-09 school year, the amount of STEM grants requested was double the amount of available funds.⁷¹ Two districts in southeast Wisconsin were awarded grants: Burlington School District for “Forest Fair” and Kettle Moraine School District for a girls LEGO competition team.

STEM Equity Pipeline

The STEM Equity Pipeline has the same goal as DPI’s STEM grants: to increase the number of underrepresented students who desire to enter into STEM fields. The STEM Equity Pipeline is a national project which currently has seven states participating, including Wisconsin. Over the next three years, the goal is to add another eight states. Currently, DPI and Wisconsin Technical College System are in the process of assembling a STEM Equity Pipeline Project Team to “analyze the performance of different Wisconsin schools and colleges with regard to equity in STEM fields and will identify, test, and implement solutions to increase participation of groups currently underrepresented in STEM education.”⁷²

⁷¹ DPI (press release), “14 Districts receive STEM grants,” July 30, 2008. http://dpi.wi.gov/eis/pdf/dpi2008_109.pdf

⁷² DPI (press release), “Wisconsin to work for equity in participation in science, technology, engineering, and mathematics,” July 2, 2008. http://dpi.wi.gov/eis/pdf/dpi2008_99.pdf

Project Lead The Way

Project Lead The Way (PLTW) is a national non-profit organization that creates project-based courses in pre-engineering and biomedical sciences for middle and high school students.⁷³ After starting in 12 New York high schools in 1997, PLTW can now be found in 3,000 schools in all 50 states and D.C. The students who participate in PLTW learn about a career field and its educational pathway while utilizing teamwork, problem-solving, and analytical skills. The courses are designed to prepare students for 2- or 4-year college programs in technical and engineering fields.

According to PLTW, “Problem-based learning is both a curriculum organizer and an instructional strategy that presents a problem, which is relevant and related to the context where students are the stakeholders. Students synthesize and construct knowledge to help them actively grapple with the complexities of the problem and develop strategies to direct their own learning. When students experience a problem in context, they are more likely to make connections and thus see the value in what they are learning.”

PLTW courses offered by certified partner high schools satisfy DPI high school science requirements and are also accepted by all UW system campuses to fulfill science coursework requirements for matriculation. In addition, 17 private colleges or universities and the Wisconsin Technical College System accept PLTW coursework in satisfaction of their admissions requirements.⁷⁴

Currently, 163 schools in Wisconsin offer certified PLTW courses, including 48 in southeast Wisconsin. These schools are eligible for a share of the state’s annual \$250,000 appropriation for PLTW, which they may use to support professional development for PLTW teachers or for software acquisition for use in PLTW courses. However, because the state’s appropriation has not grown at the same rate as the number of participating schools, schools must apply for the state funds, which are capped at \$3,000 per school. As the two-week intensive teacher training courses required by PLTW cost approximately \$2,100 per teacher, the state’s small per-school allocation results in most PLTW costs being borne at the school or district level.

In southeast Wisconsin PLTW garners strong support from The Kern Family Foundation (sponsors of this research), the Helen Bader Foundation, the Greater Milwaukee Foundation, the NEA/AT&T Foundation, Rockwell Automation, GE Healthcare, P&H Mining, Harley-Davidson, Veolia Water, the Milwaukee School of Engineering, the Society of Manufacturing Engineers, and the National Action Council on Minorities in Engineering. State and federal funding streams have been braided together in support as well, including federal economic stimulus money for use in capital purchasing, federal Carl Perkins funding, federal Title 2 technology funds, and state workforce development funds.

⁷³ Project Lead The Way. <http://www.pltw.org/>

⁷⁴ Project Lead The Way Wisconsin. http://www.pltw-wi.org/pltw_college_credit/index.htm

Southeast Wisconsin workforce development programs

WIRED Innovation Fund

The effort to connect K-12 STEM education to workforce development in southeast Wisconsin is being led by the Regional Workforce Alliance (RWA). The RWA operates under the auspices of the M7 regional economic development group and is led by three regional workforce development boards.

The RWA won a \$5.1 million grant from the U.S. Department of Labor's WIRED Initiative. Nearly half of those funds will be re-granted as the WIRED Innovation Fund to support projects and activities aimed at preparing the 21st century workforce for jobs in next generation manufacturing, financial services, and the water industry. To provide an incentive for schools, businesses, economic development agencies, and community-based organizations to work together, only partnerships of organizations are eligible for the innovation fund grants. In addition, the partner organizations must match the grant funds within their operating budgets, so as to increase the likelihood of sustainability into the future.⁷⁵

Two rounds of grants totaling \$1.75 million have been awarded to date, funding 34 different partnerships. Twenty-two of these partnerships are engaged in exploratory projects that are planning or studying innovative solutions to regional talent development. Of these, nine are projects aimed at students enrolled in elementary, middle, or high school. In addition, of the eight demonstration grants funding pilot projects, four are focused on K-12 students. One of the four implementation awards, which fund efforts working on a regional scale, involves K-12 students.

These 14 K-12 projects are as follows:

- Planning for an “energy and automation” course at St. Thomas More High School, including a two-week pilot summer course about the generation, transportation, and use of energy, and which teaches computer programming skills.
- An exploratory project, ConnectED, to create a curriculum in green technology and the water industry in MPS and other districts in partnership with M7 and based on Project Lead The Way curriculum.
- An exploratory project by the Wisconsin Foundation for Independent Colleges to build pre-college capacity by increasing awareness of careers, access to college, partnerships with business, and shared pro-college centers.
- Expansion of the 2nd Chance Partners for Education model to Racine County, placing at-risk high school students in for-credit internships with manufacturers.

⁷⁵ Regional Workforce Alliance, Innovation Fund. <http://www.milwaukee7-rwa.org/wiki/show/WIRED%20Innovation%20Fund>

- Creation by Engineers & Scientists of Milwaukee of a STEM7 Clearinghouse of STEM-related resources and needs in the M7 region to connect partners and other supporters with schools.
- A survey by Discovery World Milwaukee of water education programs in place or planned in the region's K-12 schools and technical colleges and a comparison of those programs with the future needs of the water industry.
- A partnership between Hanson Dodge Creative and a MPS high school for a one semester pilot project to immerse select students in commercial arts professions through project-based learning.
- The convening of the PK-16 Coalition for Eco-Science and Service-Learning, designed to coordinate PK-16 STEM learning opportunities in the region and align with career pathways in green jobs.
- Planning for an online academic challenge for high schools students in the region that builds awareness among students , teachers, and parents of the water industry and creates connections between the industry, schools, and interested students.
- A career planning specialist in MPS to work with guidance counselors to help students learn about and prepare for manufacturing careers.
- A virtual classroom video documentary project, STEAM, about a diverse FIRST Robotics team that serves as a model for urban districts, as well as a second documentary project about the STEAM students.
- Support for school districts in CESA #1 for the delivery of relevant and innovative career education, ensuring students and parents through K-12 are aware of career opportunities in the region.
- A bridge curriculum to align existing Project Lead The Way curriculum with courses at partnering technical colleges, to allow students to obtain college credit for Project Lead The Way work in high school.
- A program to connect the BotsIQ robotics competition with the 21st Century skills framework, to expose students to multiple STEM concepts and career opportunities in the manufacturing industry.

Racine County Workforce Development Board “Higher Expectations”

The strategic plan adopted by the Racine County Workforce Development Board last May, deemed “Higher Expectations,” calls for local business leaders to compile, by occupation, the key entry-level knowledge, skills, and abilities required by employees in existing and emerging industries.⁷⁶ In addition, these “minimum employment qualifications” are to be integrated into the curricula of local schools districts and local educators are to receive industry-based training. Eventually, local districts may include these employment qualifications in their criteria for granting a high school diploma.

The strategic plan also calls for implementation of career academies in Racine to provide high schoolers with specialized, career-based learning opportunities. Potential academies include medicine, biotech, “green” business, advanced manufacturing, engineering, natural resources and education.

Policy alternatives

Assuming a STEM initiative at the local or state level is evaluated for effectiveness and shown to have a positive and desired impact, subsequent state policy can affect the initiative’s chance at being successfully replicated in other districts. Ensuring that proven programs have support, while encouraging the development of innovative new programs, is a delicate balance, yet essential if districts are to be responsive to employers’ current and future needs.

1. Create incentives for more coordination of local efforts

The extreme diversity of local efforts, many of them grassroots efforts, can be seen by visiting WISTEM.org, the “portal for all things STEM.” For an educator looking for a promising new program, hoping to find a business partner, or wanting to know more about a particular industry or career path, the task can be daunting. Indeed, without a clearinghouse type of service, successful local programs may operate in isolation when replication is truly the need. The new WISTEM portal is a good first step at providing this type of coordination and seems to be the largest and most fully developed coordination effort in the state.

Thus, the state agencies and public educational institutions that are currently partners in the portal could effectively use it as a tool for coordinating all their STEM-related programs and efforts, including internal efforts. In one manner of doing so, recipients of state STEM grants could be required to share their results with other districts via the portal (as could the WIRED innovation fund recipients). The more it is used in this way by state and local officials, the more useful it will be to educators, workforce development professionals, and employers. The usefulness to policymakers will grow as well, as a comprehensive clearinghouse of local efforts could improve their ability to support replication of projects with the highest potential to be successful with the greatest numbers of students.

⁷⁶ Racine County Workforce Development Board, Higher Expectations: A Workforce Development Strategy for Racine County, May 2008. <http://www.racinebizservices.com/Portals/1/News/Higher%20Expectations.pdf>

2. Fully engage in the “public” half of public-private partnerships

Using WISTEM again as an illustration, while a few state agencies and institutes of higher education are partners in that portal, it is not a state-funded project. While it is hosted by a state agency, the Educational Communications Board, it is not prominently featured on the website of the state agencies the public would more typically associate with either K-12 education or workforce development. The fledgling portal is thus an example of the type of grassroots project intended to bolster the STEM workforce that needs truly engaged public partners in order to be successful into the future.

Likewise, the Racine workforce development board’s efforts to ensure Racine employers can rely on the skills and abilities of high school graduates needs public partners willing to commit to the workforce development board’s vision. If school districts in Racine County are unwilling to revisit their high school graduation requirements, or if the state hinders their ability to do so, the vision will not become reality--industry leaders cannot improve K-12 outcomes on their own.

3. Increase support, both financial and regulatory, for district-level STEM initiatives

Similarly, even the initiatives with the most generous private funders cannot be sustainable if local districts’ budgets are too tight to accommodate them beyond the period of private support. Once a program has been shown to impact student engagement, student performance, or graduates’ employability, more state aid would obviously help the program’s sustainability and replication across the state.

But making it easier for proven programs to exist as part of the regular curricula would help as well. Programs that are seen as “extra-curricular” or “specials” are often those that are the first to fall to the wayside in tough budget cycles. Programs that serve to meet state content and/or credit requirements are less likely to be squeezed out. For example, allowing PLTW courses to satisfy high school science credit requirements has eased districts’ abilities to raise private funds for program development or implementation, as the end result is a program that meets the districts’ and its students’ basic educational needs, as opposed to one that is seen as a fashionable frill.

Conclusion

This report analyzes state education policy with regard to Wisconsin's future workforce. To what extent are science, technology, engineering, and math (STEM) skills a necessity for tomorrow's workforce? Are our schools preparing students to be STEM-savvy workers? Where does STEM fall in the state's list of educational priorities?

Job growth predictions indicate that both middle- and high-skills STEM jobs will provide much opportunity for future workers. However, at the state level, policy has not fully recognized the greater importance of STEM education for today's students. While there are many areas in which the state is making progress, those efforts are not falling under a common STEM "banner" that would communicate to local districts a priority on skills needed for high-demand occupations of the future. In addition, Wisconsin's students may not be held to the same standards as students elsewhere, and may be at a competitive disadvantage.

The state is in need of a more coordinated focus on STEM content and higher-level thinking skills in the K-12 system, if our future workforce is to meet the needs of a strong, healthy, and growing economy. The state has several initiatives underway that have the potential to impact STEM education, but to be truly impactful these initiatives will need integration highlighting their impact on STEM. Otherwise, state STEM policy appears disjointed and, from the districts' point of view, could be seen as less of a priority or less urgent.

To this point the state has been content to allow most of the focus on STEM to come from the local level and has given STEM funds directly to districts, although those funds have been minimal on a per-district basis. If that remains the situation, local efforts will need continued state fiscal and regulatory support in order to meet workforce demands. Districts also will need help to achieve better coordination, so as to ensure the most promising efforts are replicated and grown. Without state resources, not only is there little chance for coordination statewide, but there also is a risk that the most visible local efforts will attract more and more private support, while worthwhile fledgling efforts elsewhere are unable to get off the ground. The likely result would be uneven STEM opportunities across Wisconsin and unmet workforce demands in some pockets of the state.

Appendix I

To learn more about the national coalitions and partnerships whose policy recommendations serve as the underpinning for the policy alternatives presented in this report, please visit the websites below.

Achieve www.achieve.org

American Association for the Advancement of Science www.aaas.org

American Diploma Project Network (Achieve) www.achieve.org/ADPActionAgenda

Commission on Professionals in Science and Technology www.cpst.org

Education Commission of the States www.ecs.org

Innovation American (National Governor's Association) www.nga.org

National Action Council for Minorities in Engineering www.nacme.org

National Center on Education and the Economy www.ncee.org

The Council of Chief State School Officers www.ccsso.org

The Institute for a Competitive Workforce (U.S. Chamber of Commerce) www.uschamber.com/icw/

The New Commission on the Skills of the American Workforce (National Center on Education and the Economy) www.skillscommission.org

The Partnership for 21st Century Skills www.21stcenturyskills.org

The Society of Manufacturing Engineers Education Foundation www.smeef.org

SkillsUSA www.skillsusa.org

STEM Education Coalition www.stemedcoalition.org

Appendix II

Below are a few of the many state and local organizations and groups working on K-12 STEM education in Wisconsin. In addition to the groups listed below, most professional science, engineering, and technology associations have state or local chapters.

State

Badger State Science and Engineering Fair (Wisconsin Science Education Foundation) www.bssef.org

Information Technology Association of Wisconsin www.itawi.org

Project Lead The Way www.pltw-wi.org

Wisconsin Association of Physics Teachers www.wapt.org

Wisconsin Innovation Network (Wisconsin Technology Council)
www.wisconsintechcouncil.com/win/

Wisconsin Science Olympiad www.wisconsinso.org

Wisconsin Science Network www.wiscience.net

Wisconsin Society of Science Teachers www.wsst.org

Wisconsin Technology Education Association, Inc. www.wtea-wis.org

Wisconsin Technology Council www.wisconsintechcouncil.com

WiSTEM.org www.wistem.org

Regional

Engineers and Scientists of Milwaukee www.esmke.org

FIRST Wisconsin Regional Planning Committee www.wisconsinregional.org

Milwaukee Area Engineering and Technology Partnership
<http://www.marquette.edu/eng/pages/Rube/whatis.html>

Milwaukee Science Education Coalition www.esmke.org

MPS STEM Partners www.esmke.org

STEM7 Initiative (Engineers and Scientists of Milwaukee) www.esmke.org