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PERSPECTIVES

Massachusetts Association for Supervision and Curriculum Development
— fostering instructional and curriculum leadership in Massachusetts —

Future Ready: Advancing STEM Education

By Dennis Richards, MASCD President

Where does science, technology, engineering, and mathematics (STEM) education "fit" in our list of priorities for PK-12 education? If STEM education is our priority, does that mean we eliminate programs in the arts, social studies, or foreign languages when the proverbial axe has to fall on something to balance the budget? Imagine asking young Leo da Vinci if he wants to be a scientist or an artist or a young Tom Jefferson if he wants to be a scientist or a writer. We need to think differently. We need to trim back on the breadth of content expectations in the subjects, and instead, invest our energies in the core elements of subjects. This will allow teachers time to educate the whole child by focusing on the development and delivery of lessons that challenge, engage, and inspire students in STEM subjects.

Students are spending too much time in STEM and other classrooms remembering and understanding content, the lower level of Bloom's revised taxonomy[1]. The education system's traditions and mandates, however, are the culprit. We expect teachers to teach content so it is remembered and understood, and they work toward that expectation. The reasons for this state of affairs are, of course, complex, but our curriculum frameworks, mandated state testing, and consequences associated with failing to achieve adequate yearly progress are key factors that foster the classroom conditions we must transform.

When students tell us school is "boring," one obvious and research-based antidote is to design classroom experiences in STEM, and across all subjects, that challenge and engage students' minds. Powerful learning experiences that require high-level thinking center on application, analysis, evaluation, and design. This seems obvious, but it has been an elusive goal that schools, over the last thirty years, have been unable to achieve with consistency and equity. An important additional benefit is that these activities provide students with the cognitive context for the 21st century skills we want them to develop, such as creativity, problem solving, and critical thinking, skills essential to success in STEM[2].

The Whole Child Education Initiative's call for us to engage and challenge students applies well to STEM. If applied consistently across grades and subjects, students will be inspired to pursue STEM careers in record numbers. In addition, all students will be better equipped to discuss and debate options for solving the complex problems facing us as a nation and a world. These challenges include global climate change; the growing impact of the Internet on society; the increasing demand for efficient, cost-effective, and environmentally-friendly engineering solutions; and the recent dramatic financial instability that has threatened economies at home and abroad.

Educating the whole child means ensuring children are healthy, safe, engaged, supported, and challenged. If we invest our energies here, students will discover the excitement and power of STEM and will be well-equipped to address challenges in our future.

[1]For recent revisions, see Anderson, L. W. and Krathwohl, D. R. (Eds.) (2001). *A taxonomy for learning, teaching, and assessing* or Marzano, R. J. and Kendall, J. S. (2007). *The new taxonomy of educational objectives.*

[2] The Partnership for 21st Century Skills has developed a unified, collective vision for 21st century learning; see http://www.21stcenturyskills.org

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Moving the STEM Agenda:
Synergy Among Stakeholders

By Isa Kaftal Zimmerman

If children are not captivated by science and mathematics when they are very young, the chances they will pursue those subjects in their future are slim. Education in science, technology, engineering, and mathematics (STEM) is part of preparing the "whole child." Currently many elementary students are not getting high quality instruction in math and science, almost none in engineering, and minimal in technology. To alter this condition, everyone who is a stakeholder - the government in its various parts, business and industry, PK-16 educators, parents, and professional associations - needs to be educated about the importance and urgency of STEM education and to advocate for it to begin at the earliest levels of schooling.

Today all professions and jobs require the skills embodied in STEM. Massachusetts' "innovation economy," that is, businesses and industries that discover and develop new products and services, depends on STEM knowledge and skill. Reinvigorating and growing the economy is essential because this controls the opportunities citizens have to take care of their families and homes, to work, to play, to enjoy the arts, and to travel. Since STEM supports the economy, everyone is a stakeholder.

Currently, Massachusetts is not graduating enough STEM-prepared students to feed the economic pipeline. There are STEM positions left unfilled, promising projects left undeveloped, and opportunities for innovation and design left untouched because schools are not engaging the skills, capacities, and passions of the next generation of learners and workers. To ensure students' readiness for these STEM opportunities, schools must provide a strong foundation in 21st century skills – media and technology literacies; communication, collaboration, and problem solving skills; and social and cross-cultural skills. Schools need to emphasize these skills and foster students' interest in STEM from the very beginning - in early childhood centers and in elementary schools. Only then will students be motivated to deepen their knowledge and skills as middle school students, to develop their expertise in STEM during high school and college, and to be ready to drive innovation and economic development in the Commonwealth.

The Commonwealth has multiple responsibilities to improve STEM education and our work begins *now* - by developing STEM education at the lowest grades to ensure expertise and passion for STEM *in the future* and by infusing extra resources and commitment to STEM in high school and higher education to ensure immediate corrections in course. Who needs to do what to achieve the desired results?

Government Stakeholders: Altering the Landscape

Government stakeholders have mandated responsibilities that impact the expectations for educators.

- The **Governor** has an important role in STEM as a standard bearer, demonstrating the centrality of STEM education to the Commonwealth's continuing economic and intellectual health and welfare. The Governor needs to support the Secretary of Education's work with STEM by including funding for STEM programs and laboratories, equipment, and technology in House 1 every year.

- The **Department of Elementary and Secondary Education's** responsibilities include licensing educators and approving educator preparation programs. The Department needs to review its STEM related licenses, create STEM elementary licenses, and expand all licenses to include a technology requirement.

- The **Department of Higher Education's** responsibilities include approving higher education programs of study. The Department needs to ensure that higher education programs prepare pre-service educators to teach STEM in the early grades and to use technology as an instructional tool.

- The **Secretariat of Education**, a recently re-created role which includes budget and policy recommendation, should designate someone in that office to oversee and coordinate STEM in the Commonwealth. This will help prevent unnecessary duplication and will fill in the gaps in programs, projects, and services.

- The **Legislature's** responsibilities include crafting legislation, providing funding, and asserting the importance of the proper conditions for STEM teaching in schools.

Massachusetts STEM Summits:
Creating Change in the Commonwealth

In **2004**, following the U.S. Department of Education's National Summits on Mathematics and Science, Massachusetts took the lead and launched the state's – and the nation's - first STEM Summit. Over 200 people gathered in Newton to discuss "Fueling the Pipeline for the Massachusetts Innovation Economy." The focus was to bring the many stakeholders together to define and discuss STEM issues confronting the Commonwealth.

In **2005**, the STEM Summit II focus was "Building the Community" and participants explored the ramifications of current STEM conditions. The summit moved to Sturbridge, where it has remained, to involve the entire state more conveniently.

In **2006**, the summit's theme was "Securing the Future: Closing the STEM Achievement Gap." Attendees presented and discussed proposed practices and programs that could address problems identified at the previous Summit.

In **2007**, STEM Summit IV, "Accelerating Forward," showcased how far Massachusetts had already come. Summit strands included: Legislation and Advocacy; Working with Data; Engineering for K12 Students; Wingspread-Using Instructional Technology to Teach Math and Science; Mathematics: Foundation for STEM; National Advocacy for STEM; Building Blocks for STEM Change; Clean Energy Growth and New Career Opportunities in Massachusetts; and Understanding Factors that Encourage Career Choice in the Life Sciences.

Following this Summit, a brief indicating the continued urgency to improve STEM education, as well as concept papers to support the strands were posted. A "virtual summit" was made available, as well, for those who were unable to attend and for those present, but who were unable to attend all of the sessions. Approximately 600 people participated in the 2007 summit, again representing all of the key stakeholder groups in the state.

In **2008**, at the STEM Summit V, "Implementing the Plan," participants heard the findings of the preliminary report about STEM priorities for the state, heard about many useful STEM programs and practices available now. At the end of the day many attendees indicated the need for immediate action in developing the state STEM plan.

The next STEM Summit, again in Sturbridge, MA, will be held on **October 2009**. All interested stakeholders – and that means all of us – are invited to engage in the next phase of advancing the STEM agenda.

Members of the Legislature realize their role, given their past support of the Pipeline grants and CITI (Commonwealth Information Technology Initiative)[1] funding. The Legislature has also provided aid to individuals through the STEM Scholar Intern Program and the Commonwealth Covenant Fund Tuition Loan Repayment Program.[2] But it must reinforce the need for coordinated state and school district STEM planning.

The Legislature needs to continue its support of the revitalized Science and Technology Caucus co-chaired by Representative Cory Atkins and Senator James Timilty. The Caucus brings together the various stakeholders to advise the legislature as it acts on behalf of the citizens of the Commonwealth. The caucus is focused at this time on STEM, and particularly on finding connections with

1 Further information available at http://www.citi.mass.edu/

2 Further information available at http://www.mass.gov/?pageID=terterminal&L=3&L0=Home&L1=Affiliated+Programs&L2=Commonwealth+Covenant+Fund&sid=Ctre&b=terminalcontent&f=ccf_about&csid=Ctre

Craig Mello, PhD, University of Massachusetts Medical School and winner of the Nobel Prize in 2006 engaged the 500+ attendees as the keynote speaker at STEM Summit V.

the Governor's Readiness Project proposals and the 21st Century Skills Task Force. The goal is to ensure that any proposed legislative action is coordinated and not competing inappropriately for funding.

Educators: Launching Mutual Efforts

The relationship among stakeholders is mutually necessary and reinforcing. For example, if we start with teaching and learning STEM seriously and rigorously in early childhood and elementary school, then elementary educators are stakeholders who need the proper training and professional development. That, in turn, means that educator preparation institutions need to change the way they currently prepare all educators in STEM but especially elementary educators. They need to revise their curriculum and their own instructional practices to align with 21st century skills and the needs of the marketplace. Additionally, institutions of higher education need to develop new approaches and incentives to encourage students entering from high school to continue their STEM studies. They also need to provide support services so that students do not abandon the fields before they graduate and seek STEM employment. Higher education, like PK-12, must heed the needs of employers and incorporate STEM preparation in courses and programs.

Parents: Advocating and Supporting Change

All parents, especially those with young children, have important roles. Fathers, in particular, have strong influence on girls' interest in STEM[3]. Additionally, it appears these days that many parents in high socio-economic status (SES) communities are encouraging their sons and daughters away from STEM[4]. This undermines efforts to ensure students for the STEM pipeline. In fact, we need to attract all students to enter, remain, and grow in these fields, especially those who are typically under-represented, such as young women and men of color. Parents play a key role in advancing this agenda.

Elementary parents need to be informed advocates for STEM programs – in the regular education program, through after school opportunities, and during vacation time. In Kentucky, the Commonwealth Institute for Parent Leadership helps adults work with educators to strengthen student achievement in STEM by organizing parent math and science nights and designing STEM-related projects and activities in which parents and their children talk about and celebrate STEM (*Education Week*, Sept 10, 2008). Massachusetts could learn from Kentucky.

Other Interested Parties: Organized Stakeholders

Finally, there are other organized stakeholders that represent Massachusetts businesses and professional and parent associations. These groups' efforts can significantly bolster attention to STEM education, mobilize their associations' constituents, and provide schools with important STEM resources and support.

- **Employer associations** have a responsibility to clarify future employment needs and to contribute to the knowledge base so educators can know what to teach. Organizations such as the Massachusetts Business Alliance for Education and the Massachusetts Business Roundtable need to continue reaching out to educators with information and offers of assistance that will support new curriculum development, educate their communities, and create opportunities for educator internship programs in their industries.

- **Professional associations** such as the Massachusetts Elementary School Principal Association (MESPA), Massachusetts Association of School Superintendents (MASS), and Massachusetts Association of Science Teachers (MAST) need to support their membership in advocating and advising about STEM education and preparation. They need to convey the urgency of this agenda and to help members implement appropriate strategies. Articles in association newsletters and STEM-focused professional development opportunities are important first steps and must be sustained over time.

- **PTOs, PTAs, and School Councils**, already designed to advocate for children and schools, need to advocate with their communities and the state government for STEM education starting at the earliest level of education. These groups are in a strong position to spearhead parent education efforts. They can partner with schools to host vibrant STEM-related forums and family events that excite and sustain school and community investment in STEM education.

The Promise of Collaboration

Although it is key that these various groups take action within their own domains, it is also powerful when they launch collaborations that reach across stakeholder groups. LIFT[2] (Leadership Initiatives for Teaching with Technology), now in its sixth year[5], is a strong example of a program that reflects this kind of effective collaboration. Teachers participate in a paid summer internship in a STEM-related company. They then take three courses designed to help them develop curriculum and instructional approaches using 21st century skills. The teachers return to their schools, use the new approaches with their students, and influence other teachers and administrators to do the same. The stakeholders in this case are higher education, businesses, an employer organization, and the Department of Elementary and Secondary Education. Working together, they are having a measurable impact on educators and students. Several hundred teachers have participated in the programs and changed their instructional approaches as a result.

3 University Of Michigan (2007, June 25). How Dads Influence Their Daughters' Interest In Math. Science Daily. Retrieved October 26, 2008, from http://www.sciencedaily.com /releases/2007/06/070624143002.htm

4 Private communication with John F. Hodgman, UMass Lowell

5 LIFT[2] http://www.lift2.org/

EDC Preliminary Presentation at STEM Summit V: Implementing the Plan

Excerpts from Talking Points

+ Expectations for action are high *in* Massachusetts and *for* Massachusetts.

+ Massachusetts has achieved new levels of readiness for action and is well-positioned for progress. Massachusetts now has:
  - Broad-based interest from stakeholders;
  - A Secretary of Education who understands the importance of STEM;
  - New leaders at all three state educational agencies;
  - A number of significant reports like the Readiness Project that describe the case and the needed action; and
  - The involvement of Massachusetts' many STEM-rich organizations, corporations, and universities.

+ The major stakeholders have discussed the issues and arrived at consensus about the following central issues. Massachusetts needs:
  - Better coordination and coherence at the state and local levels;
  - Improved STEM career counseling for students;
  - Improved teacher preparation in STEM content areas;
  - Greater alignment between the PK-12 and higher education systems; and
  - More rigorous teaching and learning of STEM in the earliest educational environments – pre-school and elementary school.

The Summit honored twelve organizations/individuals who contributed to all five past STEM Summits by participating or partnering or planning or presenting, a continuous commitment recognized by a Certificate of Appreciation.

A second example of a particularly robust collaboration is found in the work of a group that is advancing the development of a state-level STEM plan. In 2005, after STEM Summit II: Building the Community, over fifty committed volunteers representing various STEM stakeholder groups came together to develop an action agenda aimed at creating a pipeline of students who would be interested in, qualified for, and pursuing careers in the STEM fields. After a year and a half of development, the group brought an outline for action to the Goddard Council[6] to encourage their support for the development of a state-level plan. This outline presented a rationale, mission and vision, and goals and objectives, as well as addressed points of consensus, stakeholder involvement and support, components of a state-level plan, organizational alignment, public support, and data collection, evaluation, and assessment. Subsequently, the Goddard Council commissioned a report from Educational Development Center (EDC).[7] EDC's charge was to identify the half dozen major STEM priorities that the Council should pursue. EDC's preliminary report was presented and discussed at the October 2008 STEM Summit V: Implementing the Plan (see boxed insert "Massachusetts STEM Summits").

Discussions among Summit V attendees around the report's findings generated a groundswell of interest and energy for developing and launching a comprehensive strategic plan for advancing STEM in the Commonwealth. This effort-to-date confirms that collaborations among stakeholders can and do make a difference.

In a state as fiercely independent as Massachusetts ('if it isn't invented here, it isn't worth pursuing' as the popular saying goes), duplication of program and curriculum development, services, and projects will never be eradicated. But when stakeholders collaborate to fill the gaps and eliminate unnecessary redundancy, share and build upon their collective resources and expertise, and act in concert toward common goals, we move ahead more effectively for the success of all of our students.

Education is everyone's responsibility. STEM education, in particular, is in everyone's interest and must be everyone's concern.

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6 The Goddard Council, created as part of the Pipeline Fund in 2003, is comprised of 27 high-level representatives from business and industry, state government, and PK-12 and higher education. The Council advises the Board of Higher Education and the legislature on STEM workforce development programs and policy. For more information, see http://www.mass.edu/forinstitutions/prek16/goddardcouncil.asp.

7 See http://main.edc.org/newsroom/press_releases/getting_serious_about_science_education_massachusetts for a prior report that identifies STEM issues.

Moving Towards the 21st Century STEM Classroom

By Gerald Chertavian

Increased attention is being paid in Massachusetts to the kinds of skills students need to possess to be successful in the new millennium. There is growing awareness that basic literacy and numeracy skills alone are not enough to prepare students for good jobs and post-secondary education. Tomorrow's jobs require a broader set of skills. The Partnership for 21st Century Skills defines these skills as:

- Initiative and self-direction;
- Critical thinking and problem solving;
- Creativity and innovation;
- Communication and collaboration;
- Social and civic responsibility;
- Media, information, and technology literacies;
- Social and cross-cultural skills; and
- Life and career skills that support flexibility, adaptability, productivity, accountability, and leadership.

These skills are the foundation of science, technology, engineering, and mathematics (STEM) learning and teaching.

Moving in this direction will require us to rethink how our public schools are organized. We must reconsider what kinds of learning experiences our students need. In the process, we must consider additional and alternative ways to assess our students' proficiencies. By extension, we must revisit what essential skills and knowledge our teachers and school leaders need in order to move in this new direction.

The 21st century classroom offers a chance to bring these new proficiencies to the fore. Teachers will have the opportunity to connect learning more explicitly to the outside world. The learning environment will extend beyond the walls of the school building so that students can engage in real-life problem solving. Students will share what they know using a variety of electronic media. Broadening and balancing our approach to assessment will allow teachers to orient instruction toward engrossing hands-on, project-based learning experiences.

Imagine a team of eleventh grade students talking with engineers from General Electric about their preliminary design for a holographic television. Or envision a class of fifth graders building a robot designed to do their chores around the house. Consider a group of students in third grade uploading a movie they made in class about exotic reptiles studied on the class website. Or finally, imagine a group of first graders taking, uploading, and printing digital photographs of objects in the playground that match the shapes they are learning in class. These are the types of learning opportunities envisioned for students in a 21st century classroom. How can we get there? And what does it mean for teachers of science, technology, engineering and math?

There are many ways for school leaders and STEM teachers to begin the process of creating 21st century learning experiences for their students. Educators must first challenge their assumptions about what students need to know in an ever-evolving, technology-rich society. This will require hard questions about teachers' pedagogical skills to engage a diverse population of students, and about the types of assessments being used to measure student progress and performance. Teachers and school leaders will need to take a critical look at their own depth of knowledge about the skills students need to master and will need to reflect on their own relative comfort in facilitating this learning process. Based on such self-reflection, administrators and STEM instructors need to identify and procure the necessary resources for supporting students' attainment of 21st century skills. In addition, they may need to pursue new directions in professional development to meet the challenge.

Change represents a complex endeavor requiring the engagement of multiple stakeholders. Teachers, of course, are the critical front line in terms of advancing the 21st century educational agenda. But everyone needs to be engaged: students, parents, community agencies, the legislature, businesses, and educators.

Partnership, initiative, and adaptability are critical skills for attaining this directional shift in schools - as are the other 21st century skills. Those who lead must use the very skills being advocated. Leaders must be the lead learners, as well. Is there any better way to illuminate the road ahead of us?

Gerald Chertavian *was born and raised in Lowell, Massachusetts. With an MBA from Harvard Business School, Gerald combined his entrepreneurial skills and his passion for working with urban young adults to found Year Up in 2000. Year Up is recognized by Fast Company and The Monitor Group as one of the top 25 organizations in the nation using business excellence to engineer social change. Contact Gerald at gchertavian@yearup.org.*

Opportunity to Learn Audit:
Elementary School Science

The Rennie Center for Education Research & Policy
Cambridge, MA

In June 2008, the Rennie Center published a research report titled, Opportunity to Learn Audit: Elementary School Science. The report was designed to examine the disparities between elementary schools that perform well on the 5th grade science MCAS and those that perform poorly. Most importantly, the report identified the promising practices of schools with high percentages of low-income students that are beating the odds and succeeding at educating students to high levels in science. The report was also intended to shine a light on the importance of ensuring that all students in the commonwealth have access to high quality elementary science instruction. It is effective elementary science programs that provide the foundation for a sound K-12 education in science.

In the report, we studied five of the highest performing elementary schools in the state and five of the lowest performing. We found significant disparities in opportunities to learn science among these two groups of schools.

The federal No Child Left Behind (NCLB) legislation and state accountability systems have created external incentives to improve student achievement in science in addition to English language arts (ELA) and math. In 2010, Massachusetts will require all 10th graders to pass one of the science MCAS tests (in biology, physics, chemistry or technology/engineering) in order to receive a diploma. Yet, to date, schools have increasingly placed their emphasis on math and ELA, to the detriment of science. There also exists a substantial racial/ethnic achievement gap in the sciences, just as there is in math and ELA. English language learners, those who are African American or Hispanic, and students from low-income homes are all falling well below the standards for proficiency set by the state. Given that the state holds all students accountable for their performance in science, this report examines whether all students are receiving equitable opportunities to learn and succeed at science. The report identifies what top-performing schools do to support science instruction and to draw out considerations for policymakers at the district and state levels.

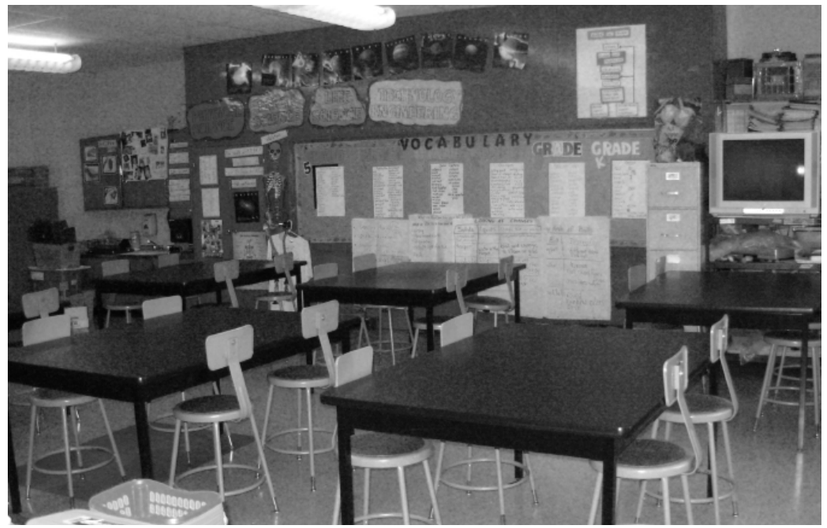
Themes Across the Schools

In the report, we studied five of the highest performing elementary schools in the state and five of the lowest performing. We found significant disparities in opportunities to learn science among these two groups of schools. It is important to note that we also identified three schools, with diverse populations of students and high percentages of low-income students, in which students' performance in science was high. Case studies of these three schools were also included in the report.

Based on our analysis, we found that, overall, students in top-performing schools had greater opportunities to learn science as compared to low-performing schools in the following areas:

- More time on science.
- Teachers who specialize in science.
- School leadership focused on science.
- Regularly scheduled support from district science coordinators.
- Science materials housed at the schools (rather than at the district).
- Professional development in science.
- School budgets for science materials.
- Higher levels of parent involvement in and advocacy for science.
- Accessibility to natural resources.

A science lab at the Arthur Talmadge School, Springfield



Recommendations

While this study was based on a small sample of elementary schools, and may not be easily generalized to wider populations, clear trends did emerge. The following are some recommendations based on this study's findings and designed to improve the quality of and access to science opportunities for all students.

For school and district leaders:
School and district leaders will need to:

- Make science a high priority in schools and across the district.
- Promote the integration of science with math and literacy.
- Set and monitor guidelines for time on science.
- Develop and monitor adherence to science curriculum that is mapped to state frameworks.
- Support, document, and–if necessary–mandate science-related professional development for elementary school teachers.
- Identify teachers with high levels of interest in science.
- Solicit engagement of local business and community leaders in science.

For state policymakers:
Providing more resources and ensuring that all elementary students in Massachusetts have opportunities to learn science and to achieve at high levels will require coordinated efforts by both state legislators and the Department of Elementary and Secondary Education. The following are recommendations for consideration by both state legislators and the Department.

- Support expanded school day initiatives and encourage more time for subjects like science, especially for low-income and minority students.
- Provide mentoring and support for elementary teachers to become school-based science resource specialists.
- Provide broad, fundamental professional development that is aligned with state frameworks in science for elementary teachers, giving preference to low-performing schools that agree to send a critical number of teachers.
- Provide technical assistance and training on integrating science, literacy, and mathematics instruction.
- Support enrichment opportunities for low-performing schools that lack active parent and community engagement in science.
- Provide a supplementary materials budget to under-resourced schools.

Case Studies

The following are two short case studies profiling the science program at one of the schools that is beating the odds, as well as at one of the highest performing schools.

Case Study: Arthur Talmadge Elementary School, Springfield, MA

Introduction

Located along a major route in Springfield, the Arthur Talmadge Elementary School is surrounded by a large playground, wooded lot and a neighborhood of single-family homes. Talmadge is home to 271 students from kindergarten through fifth grades. With its diverse population and high percentage of low-income students, Talmadge is doing what other schools have not – proving that all students can achieve at high levels. In 2008, 91% of Talmadge students, 79% of whom are classified as low-income, passed the 5th grade science MCAS test.

Table 1. Student Demographic Information

African-American	Asian	Hispanic	White	Other/ Multi-Racial	English Language Learners	Special Education	Low Income
28%	1.5%	31.7%	28.8%	9.3%	3.7%	15.1%	79%

Clear Focus on Science

Talmadge has made science a clear priority for students and teachers. All students from kindergarten through fifth grade receive four hours and ten minutes of science instruction each week throughout the whole school year.

Curriculum

The Springfield Public Schools has developed a district-wide K-5 science curriculum and pacing guide aligned to Massachusetts science frameworks that covers September through June and includes one mid-term and one final exam for each grade level. Talmadge School uses this curriculum guide school-wide. Teachers at Talmadge employ a range of curriculum materials that includes teacher-developed science activity kits and published science texts and materials. The science kits are the heart of the curriculum as they foster inquiry-based, hands-on learning.

Staffing

Talmadge has also made a commitment to science through its staffing. The school has a full-time resource teacher who focuses exclusively on science. All students receive instruction from this dedicated science resource teacher, except for one science unit, which is taught by their regular classroom teacher. Talmadge's science resource teacher often collaborates with classroom teachers on the planning and teaching of this one unit. The district, too, provides an elementary science coordinator who is available to come into schools to teach lessons upon request and oversees the district's elementary science-related professional development. Talmadge's long-time science resource teacher became the district science coordinator in school year 2007-2008. *(con't)*

In 2008, 91% of Talmadge students, 79% of whom are classified as low-income, passed the 5th grade science MCAS test.

Arthur Talmadge Elementary School, Springfield, MA (con't)

Facilities

Talmadge's focus on science is also evidenced by its science lab. The science resource teacher is located in a science lab that is equipped with lab tables, a computer, and a Smartboard with on-line streaming capability, which science resource teacher Kathy Balakier remarks that she "uses everyday" to bring science concepts to life for all students K-5. The school also has its own supply of microscopes, scales and other equipment critical to executing authentic lab experiments.

Instruction

At Talmadge Elementary, science instruction is hands-on and activity-based. The science resource teacher and classroom teachers use science kits that include experiments and activities to foster an inquiry-based approach to learning science. Science is also integrated into lessons in other subject areas throughout each grade level. Both the art and physical education teachers often weave science into their instruction through collaboration with the science resource teacher and classroom teachers.

Enrichment Opportunities and Parent Support

Talmadge students have access to a nature trail and woodland community behind the school. A professor from Springfield Community College designed a course to accompany the nature trail that is now used throughout the school. Staff at Talmadge also take advantage of various resources in the community including an annual fifth grade trip to the Springfield Science Museum, and to the Environmental Center for Our Schools (ECOS) at Forest Park, a hands-on environmental science program in which each 4th – 7th grade Springfield student and her/his teacher spend two school days.

Talmadge also has an engaged parent community. With funding provided by the Parent Teacher Organization (PTO), Talmadge runs an Elementary Science Olympiad program for grades K-5 which takes place during the school day. Students develop science investigations on various science areas and present their findings to other grades, becoming teachers for one another. The PTO also provides funding for science-related field trips and for a science-related after-school program called "Mad Science", which provides one-hour science programs focused on a particular area of science, such as rocketry, magnets, polymers and the science of toys. This program has been extraordinarily popular with students and provides another vehicle for sparking students' interest in science.

Case Study: Cottage Street Elementary School, Sharon, MA

Introduction

Nestled in a well-maintained neighborhood, Cottage Street Elementary School serves 440 students from kindergarten through fifth grades. Located in the affluent town of Sharon, Cottage Street's student population is largely of white students and includes a low percentage of low-income students. Cottage Street's 2006 Composite Performance Index[1] score of 96.2 for 5th grade science MCAS places it among the top performing elementary schools in the state.

At Cottage Street, it is obvious that science is a top priority. Beginning in kindergarten, students have 30-40 minute science lessons three times a week. By fifth grade, students spend 40 minutes of each day learning science. A separate classroom is used as a dedicated science lab and is well-stocked with supplies and materials for experiments in grades K-5 – a manifestation of the intense emphasis the school places on science.

Table 1. Student Demographic Information

African-American	Asian	Hispanic	White	Other/ Multi-Racial	English Language Learners	Special Education	Low Income
10%	13%	3%	75%	5%	3%	11%	7%

Curriculum and Instruction

The Sharon Public Schools have developed an elementary science curriculum aligned to Massachusetts science frameworks at each grade level. Each summer, a team of elementary school teachers works to update and improve the science curriculum. In the summer of 2007 alone, teachers developed or revised eight science units. The district science coordinator explained, "We are constantly revising our science curriculum units and ensuring that we are responding to ongoing changes in the world. For example, we have updated our ecology unit to include a greater emphasis on teaching students about global warming."

In addition to continuous attention to refining science curriculum, Cottage Street revamped its entire curriculum to adhere to Understanding by Design (UbD).[2] A key component of UbD is "backward mapping" – the process of planning lessons by starting with the specific goal for what students are expected to learn.

The science curriculum at Cottage Street is sequenced so that every grade-level teacher teaches the same content at the same time. Thus, students progress through each grade, building upon what they have learned the year before. Teachers can be confident that students have all been taught the same content in prior grades.[3] Moreover, all the teachers at Cottage Street employ a uniform method of teaching science lessons. As a result, students become familiar and comfortable with the sequence of each science lesson as they progress through each school year and each grade. *(con't)*

1 The Composite Performance Index (CPI) is a measure of the extent to which students are progressing toward proficiency. The CPI is a 100 point index that combines the scores of students who take standard MCAS tests (the Proficiency Index) with the scores of those who take the MCAS-Alternate Assessment (MCAS-Alt).
2 Understanding by Design was developed by Grant Wiggins and is a framework for designing curriculum units, performance assessments, and instruction that is intended to lead students to deep understanding of the content being taught.
3 It is important to note that Cottage Street's mobility rate is less than 1%, so the vast majority of students have attended a prior grade at Cottage Street.

The foundation of Cottage Street's science curriculum is hands-on science kits that are teacher-developed. These kits include experiments and require that students engage in hands-on activities so that they learn science through doing it. Teachers at Cottage Street have also been working to integrate English language arts and science. Faculty members use their budget for non-fiction literature to purchase grade-level appropriate science books at various reading levels.

Staffing and Professional Development

All of Cottage Street's fifth grade teachers describe science as a priority and have a clear love of the subject. The fifth grade teachers use a rotation schedule for science, allowing one teacher to focus on science. Supplementing regular visits to the science lab, each teacher fills her classroom with ongoing science experiences that students can observe and/or participate in throughout their regular school day – in addition to the time already allotted to learning science. One teacher commented that, "If I could teach the entire curriculum through science, I would." In these teachers' classrooms, students are conversant with and excited about science – they are eager to discuss their experiments and hypotheses with visitors.

At Cottage Street, it is obvious that science is a top priority. Beginning in kindergarten, students have 30-40 minute science lessons three times a week. By fifth grade, students spend 40 minutes of each day learning science.

The district, too, provides additional staffing for science. Sharon has a part-time K-5 science coordinator who visits Cottage Street once or twice each week. The science coordinator works with teachers to provide resources and mentoring, especially to new teachers.

Facilities and Materials

As mentioned, Cottage Street has a dedicated science lab. The lab is the size of a regular classroom and is stocked with science materials and kits for each grade level, K-5. The floor-to-ceiling shelves that cover three of the classroom's four walls are organized by parent volunteers. These parents also ensure that the kits include all of the necessary supplies and materials.

Cottage Street also makes use of technology in their science instruction. Classroom teachers use document cameras to observe a gerbil's behavior, examine leaves and identify the parts of a flower. Teachers use online streaming and access Teachers' Domain, an online repository of media resources in science, engineering, and technology. Cottage Street students engage in science-focused web quests, an inquiry-oriented lesson format in which most or all the information that learners work with comes from the web.

Like all of the top-performing schools studied, Cottage Street has its own nature trail and pond. Students make use of these resources for inquiry-based lessons and experiments in the life sciences.

Enrichment Opportunities and Parent Involvement

Cottage Street has an active Parent-Teacher Organization (PTO). Once a month the PTO sponsors a science-related enrichment activity for a different grade level. PTO funds also support field trips, which parents often coordinate and attend. In addition, Cottage Street parents run a composting program in the school's garden. The garden is tended by kindergarten and fifth graders. Finally, Cottage Street has a partnership with the Moose Hill Wildlife Sanctuary, Mass Audubon's oldest sanctuary and one of the largest. This partnership is supported by a grant from the Massachusetts Cultural Council. Staff from Moose Hill come to Cottage Street and provide workshops for students.

Commentary

By Larisa Schelkin

*MASCD has invited **Larisa Schelkin** to provide commentary on Jackie's story. Ms. Schelkin is the CEO, President, and Co-Founding Director of the Diversity & Outreach in Math and Engineering (DOME) Foundation. She also serves as the Chair of the Society of Women Engineers National Multicultural Committee and is a member of the Massachusetts STEM Summit Executive Committee and the Massachusetts STEM Caucus. She is also a member of the American Society for Engineering Education Northeast Women and Underrepresented Groups in Engineering and the Asian Women Leadership Network (AWLN).*

Thanks to Jackie for writing this amazing story and opening her heart for us all. When I read stories like Jackie's or when I meet with students with similar backgrounds, I am proud of and amazed by their strengths, their passion, and their ability to overcome many obstacles to reach their goals. It makes me proud of our country, but at the same time, it makes me realize how much work is ahead of us in our joint efforts to make sure that every child has access to a great education and all of the opportunities it provides.

Jackie's parents seem caring and devoted. I am sure they would appreciate the opportunity to participate in (complimentary) workshops provided by different professional associations and non-profit organizations – if they would only have the information on where/when/what and how.

PK-2 students would benefit tremendously (sadly, Jackie didn't have this opportunity) – from programs like **Engineering is Elementary** (EiE) (see more at **http://www.mos.org/eie/**). This program, developed by the Museum of Science, has launched a series of books for young children which have been written by staff and reviewed by engineering, cultural, and literacy specialists. The series helps cultivate children's understandings of engineering and technology and the role these disciplines play in society in a fun and engaging way. We are fortunate to have this unique opportunity in our own state. People from all around the world come to Boston to learn more about this great program!

I am happy to know that Jackie had a great math teacher. A great teacher often plays a major role in any student's life – I would even say a defining role. This is reflected in **Goal 2 of *Ready for 21st Century Success:*** Ensure that every student in the Commonwealth is taught by highly competent, well-educated, strongly supported, and effective educators (www.mass.gov/Agov3/docs/Readiness%20Final%20Report.pdf)

Jackie's Story

By Jackie

Jackie's story illustrates how one young Hispanic woman from a low-income family recently navigated the hurdles and incentives of the educational system in an urban district in Massachusetts and gained acceptance, with a major scholarship, to a reputable math and science higher education program, again in Massachusetts. She is now in her first year of college. Her story highlights ways in which educators and policy makers are making a difference, as well as ways in which there is still much work to be done.

Growing up in an urban district in Massachusetts, I loved reading, writing and everything artistic and creative. My father was a corrections officer at a state prison and my mother was a Spanish interpreter for the local hospitals. With three siblings, my family did not have money to spare, yet we didn't miss out on much because we lived next to a public park, so we spent most of our time there. When my father could, he would bring us out to Six Flags or we traveled to Texas and Canada, but those trips were during the summer and infrequent. Despite our limited budget, my father still managed to excite my interest in books. My mother tried to pass down her love for math by teaching me fractions, but unfortunately, it was before I had mastered the basics of arithmetic so it actually didn't help me very much. Both my parents wanted my siblings and me to be smart and to be able to go to college one day.

Stories and Social Life: The Early Years

In elementary school, none of the teachers could capture my interest for that long unless it involved reading. I was often lost in the clouds, dreaming of the other worlds that I'd read about. I didn't have many friends to hang out with after school, but during recess I was fairly popular because I was always willing to get down and dirty with the guys and play their games instead of trying to make them play mine. I ended up in the nurse's office semi-regularly. I had one special friend who was like a sister to me because of all the time we had spent together. We were friends from second grade through junior high and into freshman year of high school. Of course things change when you go to a new school.

When I went to junior high, I made a few new friends and had a lot of fun learning to socialize. My English teacher, as usual, held my attention more than any other class. I liked our math teachers very much, but our science teachers seemed incompetent. It got bad enough that the students caused our seventh grade science teacher to transfer out in the middle of the school year and the next teacher didn't seem to know what he was talking about either. I spent most of these classes daydreaming, writing, or talking with my friends. Daydreaming actually played an important role in my learning. I have come

Finding My Way To STEM

to believe that daydreamers, contrary to how teachers or parents describe them, are often engaged in creating visions of their futures. My opinion is that, as a result, they plan better than their peers.

Even though I had friends in junior high, I often liked to be a solitary figure, choosing more often to daydream than to spend time with others. My friends were actually poor examples of how children should be in junior high. At that age, I was exposed to others who were smoking pot and cigarettes, as well as drinking. I was often the designated "chaperone" because I was stubborn enough not to want to act the way they did under the influence, yet I did not want to leave them to their own devices. Even from a young age, I attracted peers who needed solidity in their lives and I seemed to be able to provide that with my carefree attitude and ability to keep to my own beliefs.

A Shift in Course: The High School Years

Entering high school was a life-changing experience. Art and science came together in a way that caught my interest, but my attention in math class dropped. My ninth grade biology teacher loved to assign us projects that involved making our own books that we had to illustrate, as well as writing our own stories to describe how cells managed to receive nutrients, and even making our own models of the interior of cells. My teacher saw that I did well in her class and that I took interest in the subject, so she nominated me for a position in the Advanced Placement (AP) Biology class. I wasn't sure that I wanted to have that much responsibility for taking a college level course, but my teacher's encouragement bolstered my confidence.

During my time in AP Biology and Human Physiology in tenth grade, I began to realize that my earlier dreams of becoming an author were impractical because it seemed it would be a never-ending struggle to make a living. By the end of my sophomore year, I determined that I wanted to have a career in the sciences and had already planned the courses that I was going to take for the next two years. My interest in math did not peak again until I entered Advanced Algebra and Pre-calculus the following year, but my attention to the sciences continued to grow when I also took Physics the next year.

Junior year was very interesting when it came to developing my fascination in the sciences and I couldn't wait to start my Chemistry course. Unfortunately, the teacher was unable to provide the stimulation I needed and the course requirements seemed too light to prepare me for AP Chemistry in my senior year, so I went to both the AP Chemistry and AP Biology Department Heads to receive extra work.

Commentary

(cont')

"The school, the state, the country that empowers, nurtures, enables imagination among its students and citizens, that's who's going to be the winner."

- Author and columnist Thomas L. Friedman, Journal of the American Association of School Administrators, February 2008 (Ready for 21st Century Success, p. 9)

Jackie, as well as all children (especially children from underprivileged families), would benefit from innovative after-school programs. We are fortunate to have many great engineering and technology companies in Massachusetts, as well as excellent institutions of higher education, that are also committed to supporting K-16 education. Many have developed unique programs for K-12 outreach, including partnerships during the school year, as well as many excellent summer programs for students. Active and innovative partnerships among K-12 educators, industry, and academia make a tremendous difference in students' lives. This is reflected in **Goal 4 of *Ready for 21st Century Success:*** "Unleash innovation and systemic change throughout the Commonwealth's schools, school districts, colleges, and universities as well as in the partnerships and collaborations among education institutions, communities, businesses and nonprofits" (**www.mass.gov/Agov3/docs/Readiness%20Final%20Report.pdf**). Contact your local institution of higher education, businesses, and/or museums to explore the possibilities.

Our student populations are becoming increasingly diversified requiring a diverse educator workforce. To support this shift in student and educator demographics, we need to improve significantly our multicultural awareness and knowledge. Cultural competence is an essential part of our success. Appreciating, valuing, and incorporating diversity and building inclusive schools provides the foundation for our future.

Internships for high school students and summer internships for teachers are tremendously powerful and cannot be overemphasized. For more information, contact your regional employment board.

Also, check the "**Extraordinary Women Engineers**" project, a national initiative to encourage girls to consider pursuing a degree and subsequent career in engineering: **http://www.engineeringwomen.org**

I am thrilled that Jackie had an opportunity to participate in this program. Many science and engineering professional societies in Massachusetts have K-12 outreach programs, mentorship programs, and programs for parents, students, and educators. These societies include the **Society of Women Engineers** (SWE), **National Society of Black Engineers** (NSBE), **Society of Hispanic Professional Engineers** (SHPE), **American Society for Engineering Education** (ASEE), **Association for Women in Science** (AWIS), **American Society of Civil Engineers** (ASCE), and **American Society of Mechanical Engineers** (ASME), for example. They are also a great resource for information on diversity and inclusion. They provide important connections for educators and assist with collaborative projects. Most importantly, they all are deeply committed to helping educators, parents, and students and are always looking for new approaches and innovative ideas.

We must ensure that parents are getting this information on time and assist them, if needed, with the application process, including applying for financial aid. If Jackie and/or her parents could have had access to this kind of information, she would have benefitted greatly from participating in any of these programs.

I agree that joining the military is one of the great ways to succeed in life, but still, we need to do a much better job working with parents and students so they receive real-life advice on all options available for their children and how realistically they can go to college and gain a great education. There are non-profit organizations that might help (for example, see information about **Bottom Line Foundation** at **http://www.bottomlinefoundation.org/**, whose mission is "to impact lives that are disadvantaged and have been disregarded, giving them a chance, a reason, an opportunity to be or become relevant to the society").

Some data:

- 59% of parents think an advanced degree beyond a college bachelor's degree is necessary to have a job in science and engineering ;
- 64% of parents were surprised to learn that seven in ten Americans working in science or engineering today have a bachelor's degree or less education;
- 88% of parents say that now knowing seven in ten Americans working in science or engineering today have a bachelor's degree or less makes them think science and engineering hold realistic job opportunities for their children;
- 88% of parents feel the science and engineering community needs to do a better job telling today's students about these job opportunities.

(**http://www.bayerus.com** - *Science and Engineering Careers for their Children: Fantasy or Reality?* a parent study)

Later that year, I was invited to participate in a grant-funded project with a nearby state college which was designed to interest more females in the sciences. Six students from our district and six others from a neighboring district used the sciences in this project once a week for about eight weeks. We worked on two experiments using a chemical called phenyl salicylate that acts the same as sunscreen. We also presented our findings to other professors and our teachers in the main hall of the college science labs using posters that we had made. The lab allowed us to use real science equipment and was exciting hands-on work. This experience solidified my interest in the sciences as a career.

Considering the Future: Finding the Path to College

Ever since junior high school, my father had told me that the only way that I was going to be able to go to college was to join the military, so I was a member of the Naval Junior ROTC program in our school district. I spent three to four hours after school every day involved in activities such as drill and color guard. These allowed me the opportunity to practice a variety of leadership skills. Over several years, I won many awards and was eventually considered for the Commanding Officer position. By the time I had completed my junior year in high school, however, I had decided that I didn't want to go this route. Through conversations with friends, online searches, and college fairs at my school, I learned about other ways that I could go to college.

I finally started to be a bit more social in my senior year. Throughout high school, I didn't have a "best" friend so, again, I spent much of my time alone, working on my studies and hanging out with my boyfriend. I just wasn't willing to hang around kids who wasted their lives on weed and drinking to escape their problems. When I had finally figured out what I wanted to do in life and I had a vision of where I wanted to go to college, I was able to have images of these things to smile upon; they led me forward. I found a great group of friends in my AP classes. They rarely drank because they were just trying to have fun while maintaining a focus on their studies and they handled their lives without the added stress of drugs and drinking.

Connections & Reflections

Throughout high school, I had a boyfriend who was a little older than I was. By the time I had reached my junior year, he had began attending a local college specializing in engineering. He knew what I wanted to do and encouraged me to take the proper classes. I wanted to go to the same college that he was attending because it had the combination of math, science, and hands-on work that I was looking for. The idea of doing lab work in their new science building was very exciting to me. Also, the idea of being a biomedical engineer meant that I wouldn't just "make," I could design and create. The best parts of my world growing up could finally fuse, and college courses could lead me to a career doing the kinds of work I had always loved.

As the oldest child of four in my household, I had to take every advantage that I could, not only to set an example for the others, but to save my parents some money. Luckily, being an Hispanic female with an interest in the sciences was a benefit – others were interested in encouraging my goals. I received a large scholarship to attend the college I had chosen and they connected me right away to supports specifically organized for students of color. This provided a clear pathway for my next steps.

New Challenges: First Semester

My first semester at college has been a huge wake-up call and is definitely not anything like high school. Things have been so much harder. I am currently working in the Student Counseling Center as an office assistant, the first paying job I have ever held. I am also the swim team manager and most of my friends are on this team. Socially, I am doing much better than I did in high school because now I live within walking distance of my friends. For the most part, I have been able to let go of my "tough" image that I needed in high school and am more of a normal college kid.

Academically, however, I need quite a bit of work. This college has shorter, more intensive courses than many schools. During my first term, I took Physics 1, Calculus 1, Beginning Swimming, and Intermediate Spanish. I only passed Swimming and Spanish. To my surprise, I learned that it was actually common for many students to fail at least one or two of their first classes here. A number of my friends failed at least one class, as well. I realized a little too late that I actually needed to pay attention in class and to study more often. Luckily, a grade of C or below takes the course off of your record - a blessing and a curse, I believe.

When I failed Physics and Calculus, I took the chance to rethink my major. I had originally wanted to go into biomedical engineering, before I realized how much I was really not a math person. I spent at least a week comparing the requirements of different majors and considered again what I wanted to do as a career. I am currently taking Calculus 1 for biology and management majors, Intro to Biology, and Spanish Intermediate 2. So far, I have been doing pretty well. Life at college is much different than I expected and I'm doing things I've never done before. This experience is already a great one and there is still much to come.

***Jackie** is the author of this story, but to protect the identity of others mentioned here, she has elected to be identified by her first name only and to refer to schools in more general terms. Readers are encouraged to contribute their own commentary and to interact with Jackie, as well as other readers, via the MASCD blog, "Jackie's Story" at www.mascd.org.*

Mentorship and a team-study environment are very important for students of any age, but especially in these critical years when they need role models and mentors. One of the great examples I know is the **Posse Foundation** (**http://www.possefoundation.org/main/learn/index.cfm**)

The Posse Foundation identifies, recruits, and trains student leaders from public high schools to form multicultural teams called "Posses." These teams are then prepared through an intensive eight-month Pre-Collegiate Training Program for enrollment at top-tier universities nationwide to pursue their academics and to help promote cross-cultural communication on campus.

Jackie's first semester stumbles are not unusual for students who represent the first generation in their families to attend an academic higher education program. Jackie and others like her often come from PK-12 schools which have not provided a strong enough foundation to support success. The major concern is that this lack of preliminary success will discourage her from continuing.

There are higher education programs that can help (see below). The best approach is to provide mentoring and tutoring supports before students leave high school, but another approach is to ensure mentoring and tutoring as soon as they enter higher education so they can catch up and successfully adjust to the college environment and expectations. Naturally, students would also benefit from effective bridge programs that bring university mentors and supports into the high school, as well as continued high school mentoring relationships into the university. Faculty members and professionals in the field, for example, are now offering essential mentoring to students, inviting them into their work environments as a means of supporting sometimes challenging transitions along the STEM pipeline. These bridges acknowledge our shared investment and collective power to ensure students like Jackie experience success along their career trajectories.

One national best practice program is the **Computer Science, Engineering, and Mathematics Scholars** (CSEMS) program at Tufts University (see more at http://www.cs.tufts.edu/research/csems/). This program provides Tufts students with scholarships that replace the need to seek employment during the academic year. CSEMS at Tufts promotes the academic advancement and degree achievement of talented undergraduate students from potentially low-income backgrounds, with a particular emphasis on minority and female students.

Engineering New Forms of Learning and Collaboration in Andover

By Claudia L. Bach and Lisa Glickstein

Four students cluster together around a black lab bench, intent on a dissection. This isn't a biology class; it's engineering, and these students are dissecting a small wind-up toy bird that, until a few minutes ago, was clicking across their bench. Students first observed the wind-up toys and speculated on the hidden inner mechanism. Now they will see if their ideas are correct, figure out how the toys actually work, and discuss the design process. During their nine week rotation, students observe, sketch, write specs, build prototypes, test and analyze data, and redesign and revise machines, including bottle rockets and wind turbines. Some designs work; others don't perform as planned. Students learn about the man-made world and also come to see engineering as a model for how to take calculated and healthy risks.

All middle school students in the Andover Public Schools now receive instruction in engineering as part of the Integrated Arts curriculum. Each rotation of our engineering course includes 34 (50 min) class periods. Thus, every student receives 85 hours of engineering instruction in grades six through eight. The grade six syllabus includes four major themes: 1) Introduction to Engineering: Wind-Up Toy Surgery; 2) Levers & Gears; 3) Engineering Design Process: Bottle Rockets; and 4) Wood Construction Project. Each theme takes from four to sixteen classes. Explicit connections are made between engineering, math, and science strands. In grades seven and eight, students similarly cover between three to five major themes per year. These currently include Wind Turbines, Steam-Powered "Putt-Putt" Boats, and Architecture and Construction.

The Andover Public Schools currently employ three full-time dedicated engineering teachers. Dan Miley, a former engineer and trainer who came to science teaching as a second career, piloted the current grade six engineering curriculum at West Middle School across all three grades in 2005 – 2006. This curriculum is currently in its fourth year in Andover and has now been differentiated for the upper grades. Mr. Miley was joined in 2007 – 2008 by Steve Cogger. Mr. Cogger has a similar background in engineering, but less direct prior teaching experience. In his initial year, Mr. Cogger implemented the grade six curriculum at Doherty Middle School across all three grades, as Mr. Miley had done originally at West Middle School. This year, Mr. Cogger has differentiated the curriculum and is teaching three separate curricula to the different grade-levels. Finally, this year Andover Public Schools has hired a new engineering teacher, Laurie Farrell, for Wood Hill Middle School. Ms. Farrell is also a former engineer and has been an active parent in the schools and, lately, an instructional assistant at the elementary school level. At Wood Hill, she will implement the grade six curriculum across all grades during the 2008 – 2009 school year. She is expected to differentiate grades seven and eight implementation so that by 2009 – 2010, the Andover Public Schools will have full implementation of its engineering program at the middle school level.

We have approached funding for our engineering program strategically, but still have hurdles to cross. Initial funding for the conversion of the old Industrial Arts lab at West Middle School was a kind gift from Raytheon, a company that has a long-standing interest in STEM education. With its presence in Andover, the company has been a natural and valued early partner in this project.

Alternatively, the school's former principal, Denise Holmes, funded Mr. Miley's teaching position internally, with engineering taking the place of instructional music in the Integrated Arts rotation. Thus, this salaried position has always been funded by the Andover Public Schools' general fund budget. The decision to eliminate this music offering was not an easy one and we discussed it at length. At the time, since engineering was so new and unknown to our students and parents, we believed that we would have an easier time requesting funding in the following years for a music teacher than for the engineering teacher. Although we include the music position in our budget every year, so far, with annual cutbacks, we have been unable to get this music position restored.

The decision to eliminate this music offering was not an easy one and we discussed it at length....we believed that we would have an easier time requesting funding in the following years for a music teacher than for the engineering teacher....so far, with annual cutbacks, we have been unable to get this music position restored.

Renovation of the Industrial Arts lab at Doherty Middle School was funded with gifts from several of the local school foundations, led by the Andover Coalition for Education and including the Andona Society and the Doherty Parent Advisory Council. Initial year funding for Mr. Cogger's salary was a kind gift of Merrimack College, a small, comprehensive, modern Catholic center for higher education located in North Andover. Merrimack College has its own Engineering Department and curriculum, as well as a general mission to act as a major educational resource for the Merrimack Valley community.

Most recently, Andover Public Schools in cooperation with the Brookline and Worcester Public Schools and Northeastern University received a grant from the Massachusetts Department of Higher Education STEM Pipeline Fund to strengthen and implement the engineering curriculum. This grant funds a portion of Ms. Farrell's salary and provides supplies for the Wood Hill Middle School program. It also funds professional development for all three teachers in Andover, including summer institutes with lectures and support from Northeastern's Center for STEM Education. Wyeth and Philips Medical, two other companies with local presence, will provide some teacher and student career experiences as part of this project, as well. Mr. Miley, Mr. Cogger, and the balance of Ms. Farrell's salaries, as well as funds for expendable supplies, are now paid for by the Andover Public Schools' general fund budget.

Chief among the roadblocks to the development of this program was the dearth of engineering curricula aimed at and appropriate for middle school students, such as that developed by the Museum of Science or Project Lead the Way (http://www.pltw.org/). The second challenge was creating a niche for engineering in the already packed schedule; science teachers on the instructional teams are already pressed to cover the science strands. Thus, it was important to find a lead teacher who could design the curriculum, who had real-world engineering experience, and who had a rapport with middle-school students. Finding qualified engineering teachers still remains a challenge. Funding a stand-alone course in the Integrated Arts rotation, rather than units delivered as part of the science curriculum, has required all of the partnerships and state support described above. The decision to give up a music course for engineering was also a challenge. As part of the STEM Pipeline Fund grant, Brookline is piloting the use of engineering modules within the science curriculum. The success of this approach and the ability of non-engineers to effectively deliver a true engineering experience will be evaluated. Furthermore, it remains to be shown conclusively that this Integrated Arts course, delivered apart from math and science instruction, significantly raises interest in engineering careers and student achievement in engineering, math, and science. Students are certainly engaged in the course, and it has received a large amount of community interest and support, but the program is too new yet to measure its long-term impact.

We hope that our experience can inform other districts in setting up their own engineering courses. First, we strongly believe that setting up an independent course is preferred, in combination with

STEM Question & Answer # 1

How can we forge STEM-related links between businesses and a school and/or interested teachers and classes?

It is always important to identify individuals who can introduce schools to potential employer partners. Parents who work for companies in the community or region are often a good place to start. Community leaders can also be a good source. Before approaching potential partners, it is important to develop an "inventory" of regional potential employer partners, including both large and small businesses, health care institutions, colleges and universities. In addition, there needs to be a "menu" of two to four ways schools want their employer partners to help. These should be practical and somewhat modest tactics that employers feel are "doable" in the short term. Knowledge of the particular companies is essential before approaching them.

STEM Question & Answer #2

Why is there an emphasis on the introduction of minority students into the scientific professions, with a specific emphasis on women, African-American and Latino students?

There is a need for more people, especially women and underrepresented groups of students, to prepare for and enter STEM fields. This is driven by a desire for equity, demographic factors, the value added to the education of all students when they learn in a diverse community, and the development of a high quality workforce.

More than 80% of the new entrants to our labor force are women or minorities. Hispanic and Asian populations are increasing ten times faster than the White population. The African-American population is growing more than five times faster than the white population. Diversity in the American workplace is not just a goal, it is a reality. The challenge is to prepare students from all races and backgrounds to work effectively and collectively in increasingly diverse workplaces. Since our general high school graduating population is projected to begin declining in 2010, we will need to attract to STEM every young person who is able and motivated.

hiring teachers with real-world engineering experience. While hard to find, these people are out there. During the first summer, our engineering teacher worked closely with our math and science teachers to align his curriculum with the other two disciplines and this collaboration still continues. The engineering teacher was able to reinforce content in the science curriculum. This has been helpful to students; in fact, they were able to answer some MCAS questions because of the engineering curriculum. However, it is important to note that, because the engineering course occurs on a rotating nine-week basis, the engineering, math, and science teachers cannot actually coordinate their lessons. Although the engineering teachers do not want to work separately, they must often do so because the Integrated Arts schedule and math and science schedules are different.

Second, it is important to bring together myriad local and regional partners, including school or other local foundations, colleges and university partners, and local industry to find funds and other resources. We recommend our grade six curriculum for initial implementation within other districts or schools and it can be taught at any level in grades six through eight. We hope to grow our capacity to share our engineering curriculum with other districts, and to continue to lead in implementing the state's vision for delivering high quality instruction in this critical area.

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***Lisa Glickstein**, Ph.D., is Grants Coordinator for the Andover Public Schools. Prior to holding this position, she was an academic scientist for over fifteen years and developed and implemented research projects on immunology and infectious disease. Lisa works with teachers and administrators to develop their novel curricular ideas into program projects, obtain funding, and begin implementation.*

The mission of the Massachusetts Association for Supervision and Curriculum Development is to promote quality teaching and learning in Massachusetts by fostering instructional and curriculum leadership. The purpose of MASCD *Perspectives* is to share diverse experiences and perspectives of educators across the Commonwealth and to stimulate discussion and further thought on educational topics relevant to this mission. Educators are invited to join MASCD by going to www.mascd.org.

A Call to Action:
Investments to Advance the STEM Talent Pipeline

By JD Chesloff and John F. Hodgman

Employers are very concerned about attracting more young people into careers involving the study of science, technology, engineering and mathematics (STEM). Data show they have a reason to be worried: other nations around the world are investing in education and research and challenging U.S. leadership. While countries such as China are graduating four times as many engineers as the United States, the number of engineering degrees awarded in the United States is down 20% from the peak year of 1985. In a 2005 report entitled "Tapping America's Potential,"[1] and a subsequent progress report released this year, a coalition of business organizations issued a national call to action citing warning signs that America's traditional leadership in the STEM fields is eroding. The report warns that "if we take our scientific and technological supremacy for granted, we risk losing it."

The countries with whom we compete for workers, for ideas, and for innovations are identifying their best math and science students, educating and nurturing them in STEM fields so they are prepared for the global marketplace. To remain competitive in the future, we need to be making similar investments in the United States, and in Massachusetts, in particular. Currently, we are not.

At an Innovation Summit convened at MIT two falls ago, Susan Hockfield, the President of MIT, called upon all the stakeholders in innovation to engage in a common dialogue, calling for "new links between research and development, between the academy and business, and between the public and private sectors." Innovation, defined by the Council on Competitiveness as "the intersection between imagination, insight, ingenuity, invention and impact," will only be advanced with strong leadership, collaboration, planning, and then implementation – roles the employer community is willing to accept.

The concerned employers include those that might be expected - a broad array of Massachusetts technology and life science firms. But they also include traditional businesses using information technology tools – such as construction and manufacturing – as well as health care organizations and educational institutions. In fact, the Commonwealth's innovation economy of today and tomorrow is dependent upon having highly qualified and plentiful STEM talent in order to be competitive in the global economy.

According to the College Board, 20.5% of Massachusetts' students who took the 2008 SAT indicated an interest in pursuing a career in the STEM fields, well below the national average of 26.3%. Among the competitor states, North Carolina was the only one with a significant increase in the number of its students choosing STEM fields. In 1999, there were 15,229 and in 2008 the number had increased to 17,466, 30.9% of its test takers. In contrast, Massachusetts' numbers marginally increased from 12,480 in 1999 to 12,592 in 2007, a lower percentage than states such as Illinois, Minnesota, Virginia, Pennsylvania, New Jersey and New York.[2] The number of students from Massachusetts colleges and universities studying in STEM fields declined from 1993 to 2007, while the number rose nationally.[3]

While engineering degrees at the national level have decreased by 20% since their peak in 1985, it is important to understand more recent trends in Massachusetts among all STEM fields. According to College Board data, the following table indicates the change in interest in STEM majors among Massachusetts SAT test takers between 2008 and 1999 which was the high point in student interest just as the "Internet Bubble" was about to burst and many dot.com companies crashed.

Biological Sciences	- 20.1%
Computer Sciences/IT	- 50.5%
Engineering & Eng. Technologies	16.8%
Health Professions	19.2%
Math & Statistics	100.5 %[4]
Physical Sciences	- 7.4%

1 Full report is available at: http://www.tap2015.org/

2 John Hodgman, UMass Lowell

3 Ready for 21st Century Success: The New Promise of Public Education (The Readiness Project Report, June 2008, available at: http://www.mass.gov/Agov3/docs/Readiness%20Final%20Report.pdf).

4 In 1999, there were 198 test takers planning on majors in mathematics. In 2008, there were 406, a 100.5% increase. However, the number of students choosing math majors is relatively small, 3% of all STEM fields.

While there has been a steady increase in interest in STEM majors from the lowest point in 2003 (10,911 or 19.5% of all), we still have a long way to go to get back to the 26% in 1999. If we were to reach this goal in 2010, we would need to have about 3,200 more students planning on STEM majors than in 2008.

In order to get to this goal, the average number per high school would be about 8 more students. For larger high schools it would be about 20 to 25. For medium size high schools, it would be 14 to16. These are manageable targets if all the interested parties worked together to achieve them.

New Incentives: From Social Responsibility to Media Campaigns

Today's employers are much more attuned to the need to be viewed as good civic partners. Many are becoming more active philanthropically and are incorporating their corporate social responsibility (CSR) agendas into their business models. In addition to altruistic motivations, this trend is supported by "enlightened self-interest." In recent years, the majority of college graduates indicate they want to work for firms that have a reputation as good civic partners. A recent survey of young adults in Massachusetts conducted by MassINC found that nearly three-quarters of young adults believe it is very important to work for an employer who is respectful of ethical values, people, communities and the environment. As part of their CSR strategies, organizations and employers that depend on STEM prepared employees are becoming more active in partnerships with educational institutions, for example, to assure a long-term supply of this talent.

A recent survey of young adults in Massachusetts conducted by MassINC found that nearly three-quarters of young adults believe it is very important to work for an employer who is respectful of ethical values, people, communities and the environment.

In addition, as employers increasingly look for workers who possess the skills necessary to fill the jobs of the 21st century economy, they are becoming more and more involved in efforts to build public support for making improvement in STEM performance a priority, motivating students to study and enter STEM careers, and upgrading math and science teaching to foster higher student achievement.

There are several ways in which employers are, and could be, making investments in strengthening the STEM talent pipeline. These include:

1. Ensuring high level executive participation in policy development, goal setting, and advocacy efforts at the state level in order to make the case for the investment of public resources and the importance of accountability in developing effective plans and strategies to improve STEM education;
2. Encouraging employee volunteers to work with schools in practical roles such as classroom guest speakers, mentors to STEM teachers and students, organizers of company tours, and other roles that provide links between STEM education and industry;
3. Improving PK-12 STEM teaching by providing externships for teachers to learn about business' use of and need for STEM, and promoting market and performance based compensation and incentive packages to attract and retain effective STEM teachers;
4. Encouraging Massachusetts students to stay in Massachusetts by providing internships and other immersion experiences such as job shadowing for high school and college students;
5. Working with school districts to develop new curricula and/or to provide curriculum resources; and,
6. Building the STEM infrastructure by advocating for increased public and private investment in contributing lab equipment, software, training materials, technical instructions, as well as financial resources to help underwrite specific partnerships with schools.

Many of these activities may be part of an organization's formal Corporate Social Responsibility program and, therefore, represent both corporate investments, as well as employee incentives. Many such programs have been identified by the country's leading corporate executives through the Tapping America's Potential initiative - a longer range strategy to both maintain and improve American's global competitiveness and preeminence as innovators.

While employers view their current and future workforce needs as the key incentive to help with the STEM talent pipeline, educational partners need incentives and support to make this a priority, as well.

Incentives for school district leaders might include:

1. Linking some of the current state financial aid programs to local plans that encourage more students to pursue STEM studies;
2. Committing new financial assistance over time from the Commonwealth for STEM infrastructure to school districts that have a STEM strategic plan;
3. Providing opportunities to work with business leaders and employee organizations and other partners such as higher education to develop STEM curricula and provide professional development at all levels of the school system, e.g. Massachusetts Intel Mathematics Initiative (http://www.doe.mass.edu/omste/news07/mimi.html) and Intensive Immersion Institute in Mathematics and Science (http://www.edutron.com/0/about.htm);
4. Ensuring broad dissemination of STEM reports that include practical recommendations for districts and schools.

Incentives to attract and sustain STEM teachers and guidance counselors might include:

1. Differentiating compensation for high demand areas such as math and science;
2. Offering summer externships with employers that provide exposure to the world of STEM careers and that pay attractive stipends;
3. Ensuring small financial grants and equipment to advance innovative STEM classroom curricula and instruction; and
4. Implementing recognition and award programs to underscore significant accomplishments, such as the "Above and Beyond" teachers grants sponsored by the Massachusetts Technology Leadership Council (http://www.masstlc.org/wor/edfoundation/).

Incentives to interest students in STEM might include:

1. Targeting financial aid to help students prepare for, enter, and stay in STEM college-level programs;
2. Providing internships with STEM employers;
3. Launching a marketing campaign designed to help middle and high school students overcome negative biases against students who may be perceived as STEM "nerds";
4. Encouraging students to participate in science and engineering competitions as keys to creativity and innovation; and
5. Enabling students to work with civic and other local organizations to help solve community problems.

A Steady Commitment from Stakeholders

In the final analysis, improvements in the STEM talent pipeline will not happen by "natural causes." They will require the creativity, problem solving skills and steady commitment of a variety of stakeholder groups – including employers, educators, colleges and universities, and government – over many years. The general public needs to be educated about the importance and urgency of this issue. More students need to be motivated to enter the STEM fields and more qualified teachers need to be developed to teach them.

As Tapping America's Potential (2005) notes, employers are increasingly interested in hiring people who not only can execute well, but can also create the next wave of innovation. To remain economically viable in the future, Massachusetts must provide incentives and investments in the STEM pipeline. These can no longer be delayed.

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Standards that Work:
Teachable, Actionable, Measurable Standards for 21st Century School Leaders

By Rebecca Gajda and Matthew Militello

K-12 education must be infused with 21st century knowledge and skills if students are to succeed with rigorous higher education coursework, engage in a globally competitive workforce, address complex societal issues, and assume the responsibilities of citizenship. The school principal plays a central role in ensuring that students' learning experiences align with real world expectations for teamwork and communication, problem solving and innovation, and new forms of information and media literacy. However, current Massachusetts standards for principal preparation and licensure do not ensure that principals are capable of cultivating school learning environments that advance the knowledge and skills required of 21st century graduates. Fortunately, significant revision to these outdated standards is underway.

Lack of Meaningful Standards for Principals

Well-written standards for principals are a powerful lever for ensuring this shift toward 21st century learning in schools. Those responsible for the preparation of future principals look to state standards as a guide for determining the scope, sequence, and content of leadership preparation programs. In our case at the University of Massachusetts Amherst, the state approves our principal preparation program based on its capacity to create opportunities for students to demonstrate competency in the Massachusetts Professional Standards for Administrators (MA-PSA). Adopted by the Massachusetts Board of Education in 2001, and amended in 2003, thirty-six standards representing key knowledge and skills for administrators are distributed among five domains:

a) Leadership,
b) Administration,
c) Equity,
d) Community Relationships, and
e) Professional Responsibilities.

These five domains and associated standards do not provide a clear guide for a new generation of administrator preparation programs. Instructors are not able to use these standards for much more than checking off "yes, met" or "no, did not meet" on a candidate's application for licensure. Moreover, the standards are written in broad terms that address multiple administrative positions, and thus, are not specific enough to be measurable. Though mandated by state statute, the MA Department of Elementary and Secondary Education (ESE) Bureau of Educator Licensing has not been able to use the standards to develop a valid assessment of candidate knowledge. Finally, for those considering whether to become school principals, these standards provide minimal information about what will be expected on the job. In sum, the current standards are inadequate for use by both Massachusetts DESE licensure personnel and administrator preparation program faculty, who use these standards for the design of preparation programs, as well as the assessment of principal candidates.

Massachusetts ESE staff, educator preparation personnel, practitioners, and policy makers have recently recognized that our current version of professional standards for administrators does not live up to modern leadership expectations. Consequently, an internal rationale coincided with an external push to create new standards that would enable the training and development of principals capable of leading schools in the 21st century.

Shoring Up the Principal Pipeline for the 21st Century

Research indicates that the leadership of a school principal is a key factor in school effectiveness, second only to the role of a student's classroom teacher (Hallinger & Heck, 1996; Leithwood, Seashore Louis, Anderson, & Wahlstrom, 2005). Nationally, there is a crisis in the principal pipeline. There are too few individuals seeking to become licensed as an administrator; students in preparation programs report being unsatisfied with the experience; many who earn a license do not seek a position as principal; administrative turnover and burnout are rampant; and the number of principal positions needing to be filled will grow 20% in the next five years (Mitgang, 2003; Pounder & Crow, 2005; Roza, et.al. 2003). We believe that teachable, actionable, and measurable standards for administrators can have a significant positive effect at four critical junctures of the principal pipeline.

Recruitment and Succession Planning

Massachusetts' standards for principals should enable teachers and others with leadership potential to acquire an early and accurate understanding of the principalship in the 21st century. Potential candidates should no longer have to rely on anecdotal stories (often negative) and limited personal observations of building-based leadership to decide if becoming a school principal is a desirable objective. School district leaders should be able to use principal standards in the recruitment and succession planning process, particularly as a tool for communicating with aspiring leaders to entice them into seeking administrative positions and obtaining the appropriate preparation and training.

Current Massachusetts standards for principal preparation and licensure do not ensure that principals are capable of cultivating school learning environments that advance the knowledge and skills required of 21st century graduates.

Program Development for Training and Preparation

Twenty-first century administrator standards should provide significant guidance about the appropriate curricular content and learning experiences for administrative training programs. Faculty members for educational leadership preparation programs should use teachable, actionable, and measurable standards to develop a shared understanding about the types of programs that they need to design for those seeking a principal's license. Elements of the standards can be addressed, spiraled, and sequenced purposefully throughout the program, as opposed to courses being offered based on the individual desires of available instructors. In addition, teacher educators should use the standards as a tool for introducing the field of administration to teacher licensure candidates. Students enrolled in professional preparation programs predicated on teachable, actionable, and measurable standards are more likely to understand and appreciate what they are expected to learn, thus improving their training experience.

Program Accreditation and Candidate Licensure

Teachable, actionable, measurable state standards for administrators also enable the development of valid and reliable candidate performance assessments (i.e. program-based portfolios, a statewide competency exam, and the alternative/peer review process). Educator preparation and licensure personnel should be able to use the standards to judge program quality more authentically and to assess the capacity of candidates to facilitate the development of 21st century K-12 teaching and learning environments.

Supervision and Mentoring Practices

Quality administrator licensure standards can provide district-level staff developers with a better sense of their new principals' knowledge and skills, from which to launch subsequent professional development. Superintendents

STEM Question & Answer #3

On a practical level, what does effective STEM education look like in grades PK-12?

In the earliest grades, classroom experiences need to center on engaging young children in ongoing concrete experiences with numbers, physical objects, and the natural world. Teachers must be attentive to children's natural sense of inquiry in STEM-related areas and must learn how to extend and deepen these investigations so that all children's excitement and curiosity are nourished. Concrete STEM investigations should be evident in every classroom.

At grades 3 through 6, hands-on science investigations are central, led either by classroom teachers who have been trained in science or by specialists who teach those classes while the classroom teachers watch and learn. The same applies to engineering since the two are closely aligned at this level. It also means providing ubiquitous access to technology for both students and teachers.

At middle school, it means that every student should take math and science with a hands-on approach, both as stand alone subjects and as interdisciplinary subjects. At the high school level, it means increasing the STEM requirements for graduation, ensuring that every student has four years of math and science, has the opportunity to take engineering courses, and uses technology to learn.

should use licensure standards to gain a clear sense of what newly hired administrators know and are able to do. They can then frame subsequent models of supervision and mentorship more accurately to address the standards, thus helping to bridge the gap between preparation and performance-evaluation systems.

Recent Improvement in the Quality of Massachusetts Standards

Since February of 2007, personnel from the Center for Education Policy at the University of Massachusetts Amherst and the MA DESE have engaged in a highly collaborative and comprehensive process to transform the MA-PSA into teachable, actionable, measurable 21st century standards. This process is conceptually grounded in the curriculum development framework of "backward design" (see Wiggins & McTighe, 2005). We began by determining what is essential for modern principals to know, understand, and be able to do. We conducted focus groups with multiple stakeholders, including the Springfield Public Schools, Boston Public Schools, and Education Personnel Advisory Council (EPAC)[1], to inform the revision of the standards and to share the work as it evolved. Additionally, we solicited feedback from a broad spectrum of currently practicing teachers and administrators across the state using a web-based survey. Throughout the process, the new standards have been continuously refined using the research on effective leadership (e.g. Marzano, Waters, & McNulty, 2005), the elements of professional standards currently recommended by professional organizations (ISSLC, 2007), research on the content of high quality preparation programs (e.g. Darling-Hammond, LaPointe, Meyerson, & Orr, 2007), and the performance expectations of a 21st century society (Partnership for 21st Century Skills, 2004).

To date, the standards improvement process has produced a backward-mapped, evidenced-based and stakeholder-approved articulation of what modern principals do along with the requisite 21st century knowledge and skills necessary to carry out those practices successfully. The five MA-PSA have been re-conceptualized into four overarching professional standards: Instructional Leadership, Organizational Management, Community Partnerships, and Self as Leader (Gajda, et al., 2008).

Each of the four proposed MA Standards for Principals includes the title of the standard and brief description of how the standard promotes the success of all students. Following this description, key practices are listed. Key practices articulate the high-leverage performance behaviors that those aspiring to become school principals should be expected to demonstrate in order to obtain an initial license. Here we list each standard along with its brief description and one example of a key practice.

Standard 1: Instructional Leadership
The principal promotes the success of all students by cultivating a shared vision that prioritizes the core technology of schooling: teaching and learning.

> Key Practice (example): Candidates will articulate a personal vision for learning that prioritizes 21st century learning and teaching as the core work of the school and plans for the facilitation of its development.

Standard 2: Organizational Management and Operations
The principal promotes the success of all students by ensuring management of the organization, operations, and resources for a safe, efficient, and effective learning environment.

> Key Practice (example): Candidates will describe school improvement initiatives, both individual teacher practices and school-wide programs (e.g. STEM), and ways for implementing and evaluating them.

Standard 3: Community Partnerships
The principal promotes the success of all students through partnerships with families and community members that support the mission of the school.

> Key Practice (example): Candidates will develop a plan for ensuring public relations and community support for the school, in consultation with central office.

Standard 4: Self As Leader
The principal promotes the success of all students by consciously engaging in reflection, development, and renewal.

> Key Practice (example): Candidates will embrace technology as a means for instruction, management, and community outreach.

1 EPAC is the Massachusetts Education Commissioner's advisory board; membership is comprised of the leaders of most major educational associations in Massachusetts including superintendents and elementary and secondary principals.

Throughout the development of the proposed Massachusetts Professional Standards for Principals, our team has asked stakeholders to consider several criteria against which the current and proposed standards should be judged. The figure below compares the current and proposed standards in relation to these criteria. Substantial feedback from the field confirms that the proposed standards are empirically grounded and high-impact, clearly articulate key practices that candidates should demonstrate, create a clear sense of what the job of the modern principal entails, and are useful in the design of 21st century leadership preparation and training. Thus, we believe we have reached an important milestone in the development of new Massachusetts standards for principals.

High Quality MA Standards for Principals – Project Working Assumptions/Criteria	**Current MA Professional Standards for School Administrators**	**Proposed MA Professional Standards for Principals**
Identification of empirically grounded and high impact domains of school leadership?	NO	YES
Clear articulation of 21st century key practices that candidates for licensure must demonstrate?	NO	YES
Potential/aspiring leaders can gain a clear and inspiring sense of responsibilities and priorities of the modern principalship?	SOMEWHAT	YES
Useful in the design of principal preparation program curriculum (content-knowledge to be conveyed, instructional strategies, structure, candidate assessments)?	SOMEWHAT	INITIAL INDICATION YES
21st century key practices are reasonable and assessable - can be demonstrated by candidates and measured?	NO	TBD
21st century key practices can be demonstrated by candidates and measured at point of licensure by the state?	NO	TBD
Useful framework on which to base program accreditation and state approval process?	SOMEWHAT	TBD
Useful in district-level hiring, supervision, and mentoring practices?	NO	TBD

Although considerable progress has been made, not all of our criteria for high-quality administrator standards have been attained. The new MA-PSA need to be piloted in order to determine whether the standards are in fact measurable, as well as useful in recruitment and succession planning, to program development and accreditation, and in supervision and mentoring practices. To these ends, the new standards are currently being used as part of the district-based principal preparation programs in the Springfield and Boston public school districts and in the campus-based principal preparation program at the University of Massachusetts Amherst. The proposed standards are posted on the MA ESE website and opportunities for additional public feedback and comment will be made available by the ESE in the Spring of 2009[2].

Conclusion

Teachable, actionable, and measurable principal standards can act as catalyst for innovation and a primary policy lever for school improvement in the 21st century. According to the Partnership for 21st Century Skills (2004), the leading advocacy organization focused on infusing 21st century skills into education, there are six elements of a modern education:

2 On October 22, 2008, an update was posted on the ESE website: http://www.doe.mass.edu/boe/docs/1008/item6.html

1) Core subjects such as mathematics, reading, and art;
2) 21st century content areas critical to success in communities and workplaces today that are underemphasized in schools, such as global awareness, financial, economic, business and entrepreneurial literacy, civic literacy, and health and wellness awareness;
3) Learning and thinking skills such as problem solving, communication, creativity, and collaboration;
4) Information and Communication Technology (ICT) literacy and the ability to use ICT to develop 21st century content knowledge and skills;
5) Life skills such as leadership and self-direction; and
6) 21st century authentic assessments that formatively and summatively measure the previous five key elements.

We believe that the standards development process currently underway in Massachusetts will have a positive impact for students and the Commonwealth. It will influence the recruitment of future school leaders, improve the practices of principal preparation programs, create valid measures of leadership for districts and the Commonwealth, and increase the collective capacity of Massachusetts' principals to create and sustain the six elements of 21st century teaching and learning environments. The success of STEM initiatives relies on strong leadership in schools. The revision of the Massachusetts administrator standards is a key step in ensuring 21st century opportunities for students and new possibilities for the Commonwealth.

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Leadership for Student Success in STEM

By Isa Kaftal Zimmerman

Skillful and knowledgeable leaders are essential to sustain and support skillful and knowledgeable teachers. This is especially true in STEM because of the constantly changing and complex knowledge base and the intense and expensive infrastructure dependency. In addition, school leaders need to partner with business and industry to prepare students for the 21st century workplace. The separation between education and business is disappearing; cooperation is becoming a necessity, and for some, the norm.

School and district leaders can take action to increase students' success and opportunities with STEM.

On a district and state policy level:

1. Identify and promote policies and practices that support STEM professional development programs and integrate authentic industry applications into standards-based curriculum.
2. Develop and implement strategies to improve STEM instruction and student performance through embedded professional development that connects the 21st century workplace to classroom instruction.
3. Encourage the active engagement of business and industry to expand teachers' knowledge of key trends driving our knowledge-based economy and the implication of these trends when preparing students for 21st century careers.
4. Encourage professional associations to provide professional development for school and district leaders that will strengthen their ability to present a compelling case to school boards and other policy makers regarding their investment in STEM-related technology infrastructure and teacher education.
5. Work with local institutions of higher education to influence the quality and substance of educator preparation in STEM.
6. Adopt successful practices and programs; avoid re-inventing curriculum which is already available and has been proven successful elsewhere. (See "Opportunity to Learn Audit: Elementary School Science" and "Engineering New Forms of Learning and Collaboration in Andover" in this issue.)
7. Advocate for STEM initiatives and professional development in and through professional associations.

STEM Question & Answer #4

Are some businesses already providing major support for STEM and how can we learn about them?

There are many employers who are engaged in supporting the STEM talent initiative. A collaboration among the Massachusetts Technology Leadership Council, Massachusetts Medical Device Industry Council (MassMEDIC), Massachusetts Biotechnology Education Foundation (MassBioEd), The Engineering Center, and the Massachusetts Networks Communications Council has created a vehicle to identify best practices in employer-school partnerships. The web site is currently under construction, but should soon be available. There are many supporters of the STEM Summit who can be seen at www.masssachusetts.edu/stem/.

On a school and district level:

1. Follow up personally with a teacher after observing the teacher working at his/her business externship or observing the teacher's presentation to colleagues about his/her externship.
2. Invite one or more teachers to present at a School Committee meeting.
3. Highlight the experience of STEM teachers at a parent meeting, then explicitly ask parents to promote externships in the companies where they are employed.
4. Write about STEM initiatives in newsletters and other print publications; post information on the school web site; use local television to spread the word.
5. Publicly encourage new STEM initiatives and instructional risk taking and follow-up with visible and tangible support.
6. Schedule time for teachers to discuss, implement, and assess STEM initiatives.
7. Budget for technology infrastructure, as needed, for STEM instruction (e.g. science probes, specialized software, video-microscopes).
8. Identify and pursue grants and other outside funding resources and ensure that these applications are submitted.
9. Attend industry functions, meetings, and briefings to create new networks and opportunities for your school.
10. Observe a teacher delivering a STEM curriculum unit or lesson and discuss with the teacher afterwards.
11. Sponsor teacher STEM presentations to local businesses through the Chamber of Commerce or other local associations of business leaders.

The key is to be proactive, knowledgeable, and supportive of STEM teaching and learning - as early in teachers' development as during teacher preparation, hiring, and induction and as early in students' development as during pre-school and elementary school.

MASCD Influence & Advocacy Update

MASCD's Influence & Advocacy Committee has been working on a number of initiatives in recent months. Even though we are in difficult financial times and little legislation that aids education is moving forward, it is critical that we continue to advocate for children, especially as potential budget cuts loom.

In September, a group of MASCD members participated in ASCD's annual LEAP Conference and Hill Day. MASCD Executive Director Mary Forte Hayes, MASCD President Dennis Richards and board members Peter Holtz, Ruben Carmona, and Peter Badalament met with Representative Nikki Tsongas, as well as senior policy advisors in several other Congressional offices to advance the ASCD and MASCD legislative agenda. This agenda includes incorporating multiple measures of achievement in the reauthorization of No Child Left Behind, initiating innovative high school redesign, developing supportive schools, and creating programs to improve teacher quality.

MASCD is an active partner in the Working Group for Educator Excellence (WGEE), which continues its efforts to advance the Act to Ensure Educator Excellence. Again, in these tough times little has changed on Beacon Hill, but the bill known as H451/S284 has received a favorable report in Committee and has widespread support among legislators. When the time is right, we will be well-positioned to move forward on this vital initiative. In the interim, the WGEE will partner with the Department of Elementary and Secondary Education (ESE) to articulate the knowledge base on teaching in order to align the 10 levers that influence teaching and leading. The WGEE will also propose pilots that could be implemented in Readiness Schools.

MASCD is currently working to engage groups around the state to adopt the Whole Child Compact - all children healthy, safe, engaged, supported and challenged (www.wholechildeducation.org). As part of this effort, MASCD intern Sarah Krongard is working on student outreach. The goal is to have students across the state initiate conversations in their local schools and communities leading to greater awareness of the tenets of whole child education and passage of whole child resolutions. A student summit is planned for March to train students in leading community conversations and becoming catalysts for change.

If you have not already done so, sign up to be an MASCD Educator Advocate! Simply go to the MASCD website (www.mascd.org), click on "Policy and Advocacy" and select Educator Advocates. You will receive occasional timely Influence & Advocacy Updates and Alerts on pending issues.

If you are interested in getting more involved with Influence and Advocacy, please contact Peter Badalament at pbadalament@colonial.net.

STEM Question & Answer #5

How are STEM efforts affected by the current economic climate?

State funding for Pipeline grants is not available. This has been a source of revenue for regional STEM projects. State monies for infrastructure and scaling up existing successful programs will not be requested at this time. However, the Goddard Council will continue to meet and plan, as will the STEM Summit planners, so that when money is once again available, the Commonwealth will be in a strong position to move ahead quickly. As presented in this issue of *Perspectives*, there are many ways educators can begin to strengthen STEM teaching and learning without additional funding.

MASCD's strength is in its membership, so please keep your membership current. (Check the date above your name on the mailing label.) You may print a form from http://www.mascd.org or pay through the ASCD joint dues program. Thank you for your continued support. Volunteers are welcome and appreciated in all committees. If you are interested in volunteering, please contact any of the persons listed at top right.

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