



My name is Mary Margaret M. Small. I am currently the program director for the Office of Educational Partnerships at Clarkson University, the North Country regional hub coordinator of the Empire STEM Learning Network, and a member of the Workforce Development subcommittee of the North Country Regional Economic Development Council. I have taught at all levels from elementary through graduate school. I have been a building principal, an administrator for special education, an assistant superintendent for instruction, and adjunct faculty at 3 SUNY colleges and 2 private universities. As a career educator, I have over 4 decades of experiences, observations, and professional readings that contribute to my perspective. I shall focus my comments on the current crisis facing our nation, the lack of a skilled STEM workforce.

If our country and our state are to be competitive in the global marketplace, it is essential that we have sufficient supply of workers who can apply scientific, technological, engineering and mathematical skills in their jobs to solve problems in innovative and creative ways. The 2012 *Engage to Excel* report by the President's Council of Advisors on Science and Technology (PCAST) estimates that over the next decade U.S. colleges need to produce 1 million more STEM graduates to meet workforce needs and keep America competitive in a global economy. Only about a third of the bachelor's degrees awarded in the United States are in STEM disciplines and more than half the graduate students in science and engineering were not born in the U.S. and will not stay in the U.S. after graduation. The 2010 PCAST report *Prepare and Inspire: K-12 Education in Science Technology, Engineering and Math (STEM) for America's Future* suggests that the reason for this lack of STEM majors is two fold: a lack of skills and a lack interest. The two are interrelated. How can educators increase students' interest and engagement so they gain the both the content skills and 21st century work skills?

Enhanced and Embedded Technology

The current generation of students, sometimes referred to as Generation Z or the Net Generation, are digital natives who are accustomed to interacting, collaborating and being entertained in real time, almost instantly, through easy-to-use technology. Cell phones are not devices for talking, but for texting, tweeting, and instantly connecting with events occurring throughout the world. Many preschoolers have mastered the traditional kindergarten curriculum and more before setting foot in a school building. Their "teachers" have been computers, I pads, Nooks, Leap Pads and a host of other electronic devices. If educators are to engage young learners, they must embrace new technologies as legitimate "tools of the trade" and become proficient in their use. Using a Smart Board or airliner is no longer enough or even effective. Technologies need to be embedded in the instructional activities at all levels in all content areas. Using basic software, first

graders can enter numbers and create graphs to illustrate how many students have which type of pet. Fourth graders can use simple sensors to predict and then measure the force of an eruption in a model volcano. This past summer, middle school students who participate in our IMPETUS (Integrated Math and Physics for Entry into STEM) Program collected data about their heart rates using a GLX unit, downloaded it and compared their profile to the roller coaster ride sequence to determine beat/speed relationships. These are a few examples: needless to say there are many, many more. The use of software to graphically display information and the use of instrumentation for data collection and analysis models a real world work behavior. Today's students, the workforce of tomorrow, need to be given the opportunity to develop and practice these skills and use the available technologies as a routine part of their pre-collegiate educational experience beginning in preschool.

Recommendation 1: The embedding of technology into routine instruction will require a comprehensive, supportive, and continuous program of professional development for teachers. The focus must be on the application and integration of emerging technologies into instruction through relevant, hands-on projects. Teachers must become proficient with this infusion of technology or today's students will not be prepared for tomorrow's workforce demands. Teachers are both the agents to change and the agents of change.

Engaging Instructional Strategies

The National Research Council identified the following highly effective and engaging instructional practices: allowing students to “do” science and solve problems; providing structured group learning experiences; using computer technology applications; and promoting active, engaged “hands-on” learning. Research has shown that project/inquiry based instruction that relates to “life world” problem incorporates these effective constructs and deepens the students’ understanding of course content and increases retention of critical knowledge. The project-based group experience necessitates valuing both individual contributions and teamwork for success, thus developing 21st century “soft” workforce skills.

At Clarkson we know the powerful impact project-based learning can have on academic achievement. From 2004 until 2010 we had a National Science Foundation grant that supported graduate students who brought project-based instructional modules into 7 and 8th grade Technology and Science classrooms. The longitudinal data showed that in 5 out of 6 districts the students who engaged in these project-based experiences had achievement levels significantly above the state average. Some as much as 30 points higher. Moreover, approximately 92% of the students indicated in post-surveys that they would rather have the Clarkson Engineering graduate students teach their classes than their teachers because they enjoyed the projects and being able to make/do “stuff” and figure out solutions to problems.

Recommendation 2: The multi-disciplinary project/inquiry-based learning approach is highly effective in advancing content mastery and 21st century workforce skills. This approach should be recognized and promoted as a promising practice. This will require a systemic professional development that includes not only initial teacher training, but administrative support for planning and implementation time. Those teachers who commit the “extra” time and effort to be risk takers should be recognized and rewarded.

Public School Partnerships with Business/Industry and Higher Education

It is not only teachers or instructional practices that need to be reformed or changed. The whole NY State educational system, from SED and SUNY to the Big 5 to the smallest school district such as Long Lake with 71 students, would greatly benefit by adopting a 21st century model of innovation through communication and collaboration. Business and industry and Higher Education are willing and capable partners to effect positive change and impact student success. The Central New York Partnership for Education and Business (PEB) has already formed. In Spring 2012, Executive Director Joe Vargo presented PEB’s STEM Award to Siemens Inc. Account Executive Steve Heaslip noting that “the deep partnership between people in business, education and the community ... is so important to innovation and growth.”

As teachers integrate inquiry/project based experiences in their instruction, business and industry can play a very integral role in providing both the “real life” questions to be addressed as well as resources to help students find solutions.

As the North Country Regional Economic Development Council developed its vision, several industries emerged as potential growth sectors: green energy, bio technology, aerospace and transportation equipment, agriculture and manufacturing. Each of these sectors has a unique set of challenges that can engage and inspire students. Problems such as “Is the Tug Hill Plateau a viable site for a bio-mass converter installation?” or “Can the delivery system for a perishable life saving medication be more efficient?” or “How can our paper production process be leaner?” Real questions: real problems from local industries.

The solutions to these real-world questions can be enhanced by the presence of practicing engineers, biologists, chemists, and other STEM professions in school classrooms as part of the instructional team. They bring their expertise and life experiences which lend credibility to the projects and to their interactions with students. The North Country STEM Learning Network is currently in the process of developing a cadre of industry professionals, led by Corning, Inc., who are willing to participate in problem-based learning activities in our local schools. Another way to inspire students and retain their interest in STEM.

Recommendation 3: Establish a subcommittee of each Regional Economic Development Council for business/industry and education partnerships for the purposes of enhanced communication and expanded collaboration. This committee should be chaired by a

member of the regional STEM Learning Network which is currently charged with developing these collaboratives to promote innovation and economic viability. The efforts and successes of these partnerships should be highlighted at the state level and incentives be awarded.

These partnerships with industry can offer students more than the intellectual development provided by real world problem solving. Job shadowing, internships and field experiences challenge students to develop their interpersonal and communication skills. Being mentored by a STEM professional can be a powerful career shaper. The informal discussions and the work activities build background knowledge about future job possibilities, give context to the students' current academic courses, and most importantly, build the personal attributes that employers are seeking. These job-related experiences help students develop their personal skill set and clarify their goals. Unfortunately, the current structure of high school graduation requirements leaves little room for such opportunities. A one-size-fits-all academic program with rigid requirements does not encourage beneficial partnerships and limits students' ability to make choices. At the university level we have multiple pathways to a diploma. Within a flexible framework students make choices that facilitate their learning and career goals. High school students would benefit from a similar model wherein schools could offer different pathways to a diploma and students could make choices.

Recommendation 4: New York State Education Department should review the current rigid Regents diploma requirements and consider creating multiple pathways to obtaining a diploma. This includes not only a focus on Career and Technical Ed, but also Advanced Placements courses substituting for Regents credits and expanded Early College High School options, both in terms of the number of participating school districts/students and including more and private higher ed institutions.

It is not only students who can benefit from working beside industry professionals. Teachers, school counselors and administrators can all learn a great deal as well. Experiencing first hand the real demands, both intellectual and physical, of the workplace will develop a greater, more realistic, understanding of the situation. This, in turn, will make the educator better able to provide information, encouragement and guidance to students. Externships, internships and job **Recommendation 5:** Develop a state-wide campaign to promote paid STEM internships/externships for educators during the summer months. Create and disseminate electronically a resource guide detailing the opportunities/requirements.

Colleges and universities have human and physical resources that could greatly augment the educational experiences of teachers and students. In the North Country we have 10 institutions of higher education: 4 SUNY Colleges, 3 Community Colleges and 3 private universities.

Over the past 5 years, school districts in St. Lawrence County have lost approximately 20% of their teaching staff through reductions due to budget constraints. Generally those excessed were the last hired- those recently graduated from college, those with the latest

content knowledge. STEM fields, particularly science and technology, change rapidly. Our teachers need to upgrade their content knowledge as well as their technical skills. In addition, the NGSS have an engineering component. Most teachers, even at the high school level, have little engineering background. Higher Ed institution can provide focused, in-depth content workshops, experience with instrumentation and equipment, and first hand research experiences (RET's), among other things. To work beside a real scientist in a high-tech lab can be a rewarding and renewing experience.

Recommendation 6: Require teachers to engage in content-heavy refresher experiences and/ RET on a multi-year (periodic) basis. Perhaps this requirement could be part of a renewable certification reform. Provide the financial resources for the colleges and universities to offer this rigorous updating of knowledge, perhaps through competitive and/or targeted grant process.

Educators are not the only ones who can benefit from the resources offered by the higher Ed institutions. Students, particularly bright ones, can too. Often public school mandates focus on supporting less academically able students and few resources are available for top students or enrichment. This past summer (2012) Clarkson Professor Dick Partch had three high school research assistants in his lab. In the winter we offer high school juniors the opportunity to take a Project Challenge course on 5 Saturdays. We also house The Clarkson School. Admitted students enroll in regular college course to complete their final year of high school and their freshman year of college simultaneously. High school students are eager to engage in research and academic opportunities and to challenge themselves to move to a higher level.

Recommendation 7: Increase programs, such as Early College High School, and remove the constraints that limit students' opportunity to participate, such as income, parents' levels of education or race/ethnicity. Explore creating/funding programs at private institutions.

STEM Learning Network

There is no question that our schools face challenges. However, they do not have to face them alone. The North Country is home to 10 higher education institutions and hundreds of businesses that have human and technical resources which could improve the quality of education and the opportunities available to students. Up until earlier this year, there was no mechanism to open the dialogue and systemically link schools districts, businesses, industries and higher education. In February 2012, as part of its ongoing investment in our local and regional community, Clarkson University became the North Country hub for the Empire STEM Learning Network. This grassroots Network will energize all stakeholders to invest in the educational experiences of our youth and the professional development of teachers to assure that 21st century skills are infused in tomorrow's leaders. In the short time it has existed, the Hub has been productive. Plans are being finalized for three regional professional development events to celebrate National Manufacturing Day in October. It is also establishing a cadre of industry professionals, led by Corning, Inc. and Siemens, Inc., who are willing to participate in problem-based learning activities in our local schools.

The Empire STEM Learning Network has the potential to transform and strengthen STEM education throughout New York State. However as it is currently formulated, it lacks a cohesive structure, sufficient manpower and reliable funding. The STEM Learning Network could be strengthened by being “institutionalized.”

Recommendation 8: Establish a study committee to investigate/explore the options for design, staffing and funding of the STEM Learning Network to retain the grassroots, local initiative, while identifying potential staffing and funding requirements and avenues to meet those requirements.

If our state is going to regain it’s premier place as a leader in innovation, and our country is going to remain competitive in a global marketplace, STEM education must become a priority. We, as educators, business leaders, and politicians, must collaborate and work together to stop the leaks in the skilled workforce pipeline. Changes need to happen if we are to meet the 1 million more STEM graduates that we are told our nation needs. And the changes need to happen soon- as soon as “yesterday.”

In closing, I would like to quote Steve Heaslip, recipient of the 2012 PEB STEM Award. Steve was described as “a passionate and articulate champion of educating and preparing students for success in school, work, and life.” Last winter, he was explaining to me why we needed changes in how we teach, what opportunities we offer students, and why we all needed to work together. In other words, why reform is needed. His answer was quite simple and to the point...and I think you will agree with it. Steve said, “Our kids deserve more: our kids deserve better.”

Thank you.



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Citations for research references provided upon request

