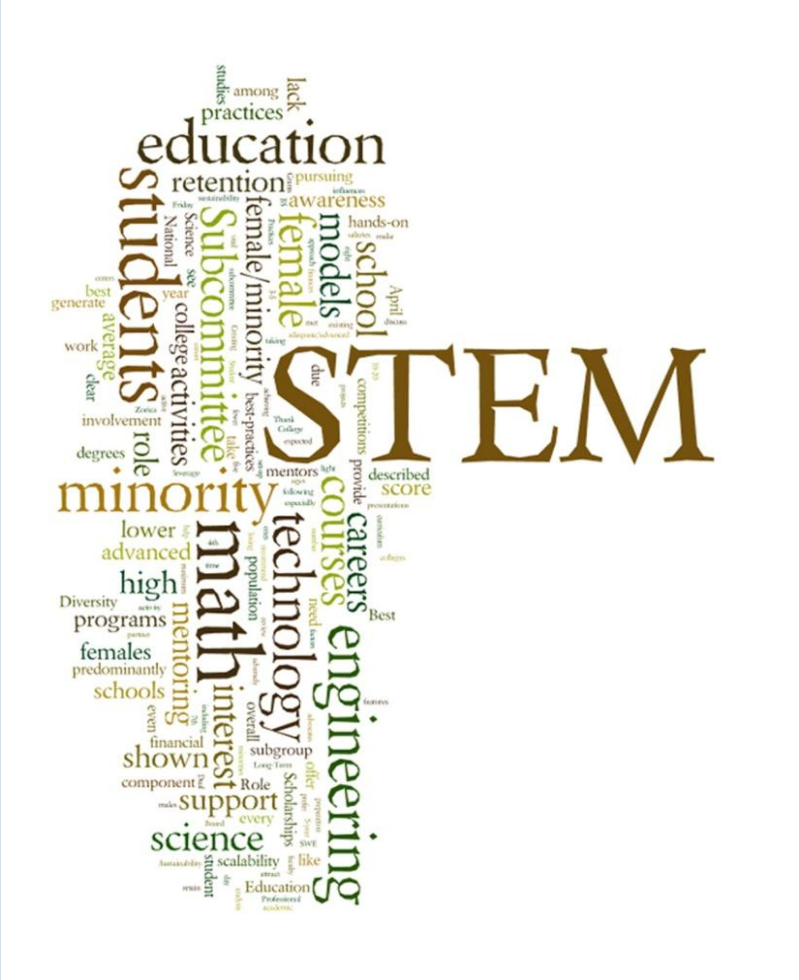
Report on the 2010 Massachusetts' STEM Summit VII

"The Massachusetts STEM Plan: A Summit Mapping the Commonwealth's STEM Future"

A Summary of Key Ideas from the Six Strand Workshops



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> **Melissa Keohan** (Curriculum & Assessment Strand), **Dr. Daniel Zwillinger** (Data Strand), **Kurt Mittelstaedt** (Diversity Strand), **Wayne Risas** (Infrastructure Strand), **Carolyn Ottney** (Public Awareness Strand), **Kathieann Kraus** (Teacher Development Strand) under the leadership and coordination of **Terri Munson**, Raytheon Integrated Defense Systems Stand & Deliver Mentoring Program Coordinator;

working together with Massachusetts STEM Summit Executive Committee members & its Chairs, **Adam Freudberg**, Massachusetts Governor Office, **Dr. J. Lynn Griesemer**, Associate Vice President for Economic Development, Executive Director, UMass Donahue Institute, **JD Chesloff**, Deputy Director, Massachusetts Business Roundtable and the Chairs of the Strands accordingly:

I. Curriculum & Assessment Strand: **Christos Zahopoulos**, Associate Professor, Engineering & Education, and Executive Director, Center for STEM Education, Northeastern University; **Deborah Boisvert**, Executive Director, BATEC Center for IT, University of Massachusetts Boston and Ronit Carter, Educational Consultant

II. Data Strand: **Jean M. Supel**, Research Manager, UMass Donahue Institute Research & Evaluation Group

III. Diversity Strand: **Larisa K. Schelkin**, CEO & Co-Founding Director, DOME Foundation, Inc.

IV. Infrastructure Strand: **Patrick Larkin**, Director, John Adams Innovation Institute/Deputy Director, MTC; **Jim Stanton**, Director, The Technology Initiative, MSW REB

V. Public Awareness Strand: **Joyce L. Plotkin**, Chair, The DIGITS Project; Pres. Emerita, Mass Tech Leadership Council; **Barnas G. Monteith** Advanced Diamond Solutions, Inc.

VI. Teacher Development Strand: **Yvonne Spicer**, VP, NCTL, Museum of Science; **Sandra Ryack-Bell**, Executive Director, Museum Institute for Teaching Science

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THANK YOU!

Massachusetts STEM Summit Executive Summary

The Massachusetts STEM Summit, titled "The Massachusetts STEM Plan: A Summit Mapping the Commonwealth's STEM Future", was held on Tuesday, September 28, 2010, at the Sturbridge Host Hotel & Conference Center in Sturbridge, MA. The Massachusetts Governor's STEM Advisory Council, the STEM Business Leaders' Coalition, the Massachusetts Business Roundtable and the University of Massachusetts UMass Donahue Institute were the Summit hosts.

Massachusetts is the epicenter for scientific and technological innovation that has produced some of the most learned researchers, professionals and global business leaders of all time. It is also the hub of instruction with renowned educational institutions. At the Massachusetts STEM Summit, over 500 educators representing schools, non-profits, government, and industry grouped into six themed strands to discuss and capture ideas to improve science, technology, engineering and science (STEM) education in Massachusetts. The strands included 1) Curriculum, 2) Data, 3) Diversity, 4) Infrastructure, 5) Public Awareness, and 6) Teacher Development. The key findings of each strand are summarized in the attached reports.

The idea behind the Massachusetts STEM initiative is to provide a vision to the students across the state, encourage them to become globally competitive, and bring them on par with their ambitious peers through their personal and professional development.

The main concern to begin STEM development, as identified by the Curriculum Strand, is defining STEM literacy. It is also necessary to determine a relationship between science, technology, engineering, mathematics while designing a curriculum that caters to the needs and interests of students. The relationship should be such that it arouses students' natural curiosity in STEM. The regions under study for successful implementation of the STEM plan include Boston, Central, Metrowest, Northeast, Pioneer Valley, and Southeast, Cape & Islands.

The important drivers to STEM success are high quality teachers, motivated and diverse students from underrepresented groups, and robust curriculum practices and standards. Teachers should be trained through residency programs and professional development seminars and workshops, and provided financial support to retain them. Creating model classrooms with student centered instruction and externship programs will be beneficial.

The Infrastructure Strand afternoon session successfully elicited a wide range of excellent ideas addressing five key questions: What are the standards for defining "Excellent" Regional STEM Collaboratives? What key factors should be considered in determining regional priorities? How can the Statewide STEM Operations Board best provide assistance to the Regional STEM Collaboratives? What assistance might Regional STEM Collaboratives need to scale Best Practice programs in their region? What are the most effective strategies for sustaining multi-sector engagement in Regional STEM Collaboratives? The Infrastructure Strand was instrumental in formulating policies and practices that need to be in place to meet STEM goals and ensure its sustainability. A responsive governance model under strong leadership is needed to channel the goals of the strands, drive the mission related to student achievement, and inspire best practices. A clear need for designing one centralized all-inclusive website is seen as necessary to serve as a common reference point to all STEM activities.

The Diversity Strand identified the role of government, industry, non-profit, schools and partnerships to promote STEM education through tax incentives, mentorships for girls and minority students, and growth of STEM. The role of non-profits is critical in all aspects in the development and promotion of STEM. Further, partnerships are essential for increasing participation in STEM disciplines by underrepresented populations. Therefore, if we plan to increase and encourage such partnerships, we need to provide education and support in partnership development, diversity and inclusiveness. The establishment of a clearing house for sharing ideas and resources will also aid in this effort.

Again, a good understanding of STEM and its related careers is equally important to build student interest. This requires efficient marketing and PR activities that concentrate on building awareness among mentors, students, teachers and the community at large. It is also necessary to set milestones and communicate the goals and progress to stakeholders to maintain their enthusiasm. The Public Awareness Strand unveiled the details of its proposed WOW campaign, designed to increase the interest of middle school students in STEM careers. Some summary findings of the major concepts include: "Empowering Children to Take Ownership", "Sustaining the Public Awareness Campaign", "Mobilizing Parents and Teachers As Enablers", "Engaging On a Local Level: Ensuring Equal Access to the Message" and "Measuring Campaign Success".

STEM data collection and analysis is instrumental in driving change. Creating a dynamic collection and reporting relationship between schools, districts, regions and the state is absolutely essential if we are to meet our goals.

In conclusion, a strong commitment is required from all STEM touch-points to bring about breakthrough results in student participation and fluency in STEM subjects. Real world learning opportunities with sound direction are the best ways to excite students and advance their motivation for STEM applications.

Curriculum Strand

Participants at the summit identified the key concern of STEM development to be defining 'STEM literacy'. As Nobel Laureate Physicist and founder of the Illinois Math and Science Academy, Leon Lederman has defined, STEM literacy in a knowledge-based economy is the ability to adapt to and accept changes driven by new technology work, to anticipate the multilevel impacts of their actions, communicate complex ideas effectively to a variety of audiences, and perhaps most importantly, find "measured yet creative solutions to problems which are today unimaginable."

Schools are an important driver towards increasing STEM literacy and building student interest in STEM fields. From a curriculum standpoint, the cause of concern is to determine the type of elective courses to be included, its credit details for students and their assessment pattern.

The key objective is to find a relationship between science, technology, mathematics and engineering, to design a curriculum that balances them in the right proportion. This should be included under best practices of STEM curriculum and some common standards should be set for its assessment and evaluation. In the long run, this will facilitate good comparison between the curriculums of STEM to the national boards.

Some important recommendations from the brainstorming session have been listed below:

1. Redesign school curriculum with partnership with higher education/data systems and research to increase standards of science and mathematics subjects to align standards for K-12. These standards need to be grade specific with emphasis in depth with PK-8
2. Look at existing assessment methods and determine its success rate. If below 70%, then reassess these methods and realign them to fulfill educational objectives
3. Propose ways to assist struggling learners with activities like summer sessions, tutoring and outside school training (OST) programs
4. Spread awareness of the benefits of pursuing STEM career – in terms of long term financial security, satisfaction and reputation
5. Encourage volunteers to work for STEM initiatives with youth and OST professionals involved in professional development programs
6. Determine the funds and resources for STEM teachers
7. Network and advocate at school board meetings to press for more STEM education
8. Conduct meetings with superintendents and curriculum coordinators to discuss increasing STEM instruction in school along with externships in STEM fields

Launching a STEM certification for students should be considered to enhance student knowledge and skills in STEM fields. This should be supported by proper coaching from teachers and professionals and special incentives should be given to students taking this exam. This will improve student curiosity in STEM and boost their career choices.

Boston, Northeast, Pioneer Valley, Metrowest, Central, Southeast and Cape islands were the regions under study. The STEM Summit participants from each of these Regions provided their suggestions. The result of successful implementation of the plan, as perceived by the participants, varies by Region.

Boston & Metrowest	**Northeast & Southeast, Cape & Islands**	**Central & Pioneer Valley**
• Increased enrollment in STEM courses with teachers recognized and supported as professionals • More STEM companies and non-profits move to MA and large pool of volunteers partner at the community • Increased funding into student development, non-profit participation and teacher externships • Consistency of curriculum across districts/state with project-based, experiential learning • More MA (esp. female) students pursuing STEM fields and careers • Fewer unemployed MA students **Resources to be tapped** • Corporate sponsors, University mentors, STEM employees and retirees • Institutions like Harvard, MIT, Boston Science Partnership, TERC • Organizations like Raytheon, MITS,CONNECT, Genzyme, Natick Labs, Intel • Community clubs like Elks, Rotary, Lions, Chamber Commerce, Science Clubs for Girls	**Northeast** ▪ More students show interest in STEM fields with more teachers recruited from STEM graduates ▪ Increased registration ("sign-up") for STEM classes ▪ More students taking upper level STEM courses ▪ Grad students partner to teach high-level topics like math, robotics, computer science **Southeast, Cape & Islands** ▪ More business partnerships with elementary schools ▪ Increased connection of higher education with technical students ▪ Popularity in after school programs such as robotics, mathematics etc. **Resources to be tapped** **Northeast** ▪ DESE scholarships for teachers ▪ UMass Lowell, NECC ▪ Higher education and community college outreach ▪ Science curriculum specialists	**Central** ▪ Higher percentage of female students graduating in STEM ▪ Students engaged in STEM at every level with proficient STEM teachers ▪ Up-to-date curriculum resources ▪ Mentors for both students and teachers **Pioneer Valley** ▪ Paid internships to college students ▪ Increase enrollment of girls in AP/college programs ▪ District-wide recognition of STEM ▪ Advisory board in school and district **Resources to be tapped** **Central** ▪ Central MA STEM Network ▪ Collaborate with other school districts and train educators **Pioneer Valley** ▪ Local colleges ▪ Business community projects with grants and expeditionary learning ▪ Technology resources with multiple modes of learning

In conclusion, the nature of STEM involvement is important while defining and designing the curriculum with equal resources at each community. Giving a vision to the students – a vision of their future with STEM will not only ensure their personal and professional growth but also progress their options for STEM related careers.

Data Strand

The Data Strand is instrumental in driving changes or improvements in data collection. This means creating a dynamic collection and reporting relationship between regions and the state.

The data strand discussed the objectives and grouped ideas based on their key stakeholders – government and higher education, business, K-12, and, importantly, students.

1. For government and higher education, the most important action is to identify data to define goals and progress to stakeholders and the public: to report progress so that the stakeholders stay engaged.

2. K-12 in collaboration with the educational division in government and business should design a growth model of longitudinal nature for students. This will be useful to compare and contrast the development in students through their entire education.

3. Better allocation of resources to collect data across districts, based on regional zones and budget for STEM supplies and equipment will aid in success of STEM initiatives.

4. The evaluations for administrators and teachers should be aligned with the core objectives of the State STEM Plan. Provide expert mentors and professional development training for teachers and principals. This training can be both online i.e. web-based and in-person workshops.

5. Ongoing training to teachers, administrators on data analysis should be provided within a collaborative to establish a common frame of reference. Also, identifying the strengths of the collaborative network members will help in developing expertise through sharing.

6. When mandating testing, it is important to avoid over assessing and burning kids out. This could have an impact on their motivation and determination towards learning STEM courses.

In conclusion, it is important to define what can lead to a successful level of STEM enrollment and put a common set of data in place. All this with an open communication will pave way to thriving development of data.

Diversity Strand

The session was led by Kurt Mittelstaedt, a Raytheon Six Sigma Blackbelt, working together with the Raytheon team-coordinator, Terri Munson and the Chair of the Diversity Strand, Larisa Schelkin. Participants responded to the following questions devised by the Diversity Strand planning committee:

Partnerships

- What ideas do you have for new partnerships that promote STEM interest for diverse students?
- What existing partnerships that promote STEM interest for diverse students could be expanded?
- How do we encourage and incentivize partnerships to promote STEM careers for diverse students?

Exposure and Awareness

- How can we increase student internships for diverse students to promote STEM careers?
- How can we increase teacher externships for teachers of diverse students to promote STEM careers?

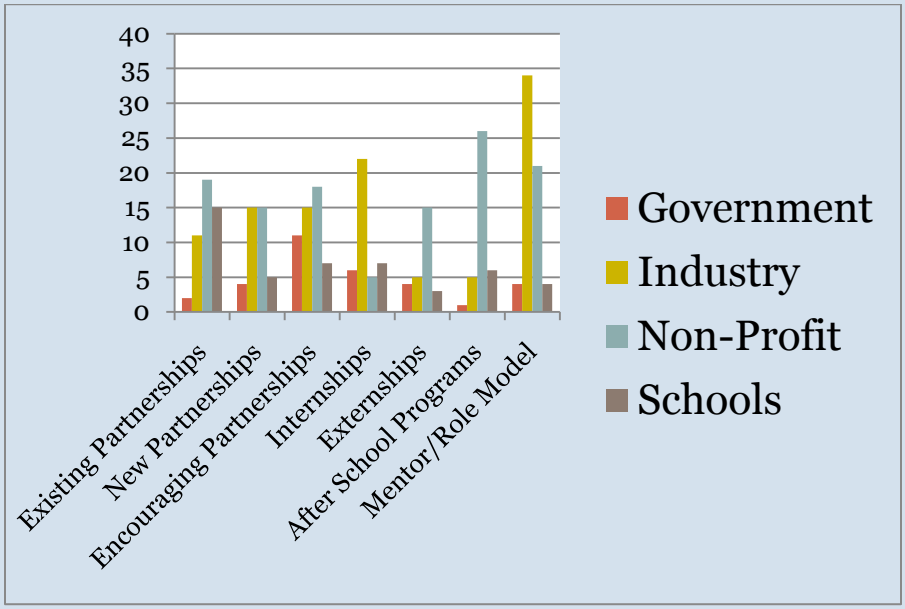
After-School Programs and Enrichment

- How do we build networks of afterschool programs that promote STEM careers for diverse students?

Mentorship and Role Modeling

- How do we increase employee engagement as mentors and role models for diverse students?

Three hundred (300) ideas were generated during the session and are attached. The ideas were grouped based on who can best implement the ideas: government, industry, non-profits, or schools. The follow charts shows the distribution:



Based on the chart and back up suggestions, we learned that:

Government can play a significant role by encouraging partnerships mostly through tax incentives.

Industry plays a key role as a source of employees to volunteer as mentors and role models for girls and minority students. Industry can encourage and reward employees to increase the number of volunteers and have a significant impact on the STEM Plan. Not surprisingly, industry is key to internships for these students. And finally, industry plays a key role as a partner to non-profits and schools to promote STEM education.

Non-profits are essential in every aspect of implementing the Governor's STEM Plan as far as diversity is concerned. Non-profits are often the liaison between industry and non-profit organizations and between industry and schools.

The schools should be commended for their enormous contributions and should understand that volunteers for mentoring and after school programs are there to supplement and augment the work that teachers do in the classroom every day. However, schools have less impact in making changes in this area because they teach all students in the schools equally and do not offer special programs for minorities and girls. They are often the recipient of volunteer work and non-profit run programs to benefit their students.

Partnerships are essential for increasing participation in the science, technology, engineering and mathematics (STEM) disciplines by underrepresented populations. Therefore, there is a strong

need for educating educators on partnership development & diversity and inclusion in STEM; as well as establishing a collaboration clearing house & sharing the resources & ideas.

The attached data can be grouped in many different ways to learn other valuable information. This data is now available for experts to evaluate and utilize in the implementation plan. The Diversity strand team is grateful for all the hard work and enthusiasm on the part of the participants.

Infrastructure Strand

The main objective of the infrastructure strand was to determine policies and practices that need to be in place to meet STEM goals and ensure its sustainability. The participants in the Infrastructure Strand identified some important targets and priorities.

- Regional STEM Collaborative Standards
- Key factors for regional priorities
- Creation of Statewide STEM Operations Board
- Assistance for scaling best practice programs
- Strategies for sustaining multi-sector engagement

Regional STEM Collaborative Standards

It is necessary to have a strong leadership board, which represents a cross-section of members from all areas and constituencies; to channelize the goals of the strand and drive the mission related to student achievement and inspiration in STEM. The goals should be similarly measured by region and a comprehensive evaluation criteria set up for each. Transparency at each step is a requisite to ensure healthy progress.

A responsive governance model should be created with best practices in mind. The short and long term goals should be clearly articulated and the annual action plans implemented using this model. A point person should be appointed for each region. The model should be designed in collaboration with the key point person from K-12, schools and companies. At every interval, milestones should be defined, performance criteria defined and the results measured and tracked over time.

The key factors to be considered while defining regional priorities should include workforce needs. A gap analysis will help understand the current resources and enhance links between teachers, faculty and corporations and non-profits. The programs designed need to be innovative enough to ensure cross region participation and representation.

Statewide STEM Operations Board

The board will assist in identifying potential regional partners who are already engaged in this initiative. It will also create statewide standards and selection criteria for best practice programs. Secure funding is another important initiative to support dissemination of important STEM messages using marketing communication tools viz. marketing, advertising and promotional and public relational activities on a regular basis. Periodic discussion groups in regions will serve as an open forum for exchange of ideas between regions as also to monitor and track progress in time. The above initiatives will thus augment administrative support systems to propagate best practices.

Best Practice programs

The key to scaling best practice programs is creating an online database of 'go-to' experts – specialized personnel who should be consulted upon a given particular issue/ situation. A template for best practice implementation should be created that will serve as a reference point. Links to STEM network websites, collecting and collating data on programs/activities across regions along with good quality marketing materials will ascertain good communication of STEM activities to the audience and build interest. To model integrated teaching in STEM, teachers should be trained and evaluation experts brought in. To further garner the results of STEM programs, regional employment occupation trends should be identified and regional STEM / technology application fairs for member districts conducted

The most important strategy is to *generate awareness and clarity about services offered by regional STEM collaborative*. Other strategies for sustaining multi-sector engagement include –

- Designing one centralized all-inclusive website will serve as a common reference point to all STEM activities
- Creating a sense of ownership among stakeholders to enable shared decision making and adaptive goals that cut across multiple sectors with benefits to these sectors and incentives to stakeholders
- Establishing a mentorship pipeline to produce opportunities for education sector stakeholders and motivate them to get involved in volunteer capacity
- Securing funds, regular meetings, events and workshops needed to sustain momentum
- Appointing a sector-specific contact person in regional STEM Collaborative

In conclusion, the infrastructure plan will be instrumental in developing long-term reliability and credibility to STEM growth.

Public Awareness Strand

At the 2010 STEM Summit, the Public Awareness Strand unveiled the details of its proposed WOW campaign, designed to increase the interest of middle school students in STEM careers. The WOW campaign highlights the energy and excitement of Massachusetts professionals engaged in a broad range of STEM careers from forensic chemists involved in CSI activities… to engineers designing the next generation of video games… to scientists exploring the frontiers of medical research.

Core elements of the WOW campaign include: a) a series of short web-based or distributed DVD videos of Massachusetts WOWsters – a diverse group of STEM professionals from a wide age range, representing a variety of careers from all regions of the Commonwealth, who may from time to time engage students live in-person as well, b) posters of WOWsters with various photos of their careers along with inspirational messages for classrooms throughout the Commonwealth, and c) a social media website, allowing students to collaborate, enter video and other competitions and inspire each other. It has been proposed that this campaign be supported by a diverse student advisory group, in order to ensure proper input from the core target audience, as the campaign evolves.

Panel discussions followed the showing of the first two produced videos: Catherine Reyes Spencer, a medical student/researcher from Harvard University, and Nigel Jacobs, from the Boston Mayor's Emerging Technologies office, along with a discussion of the background marketing research. A group of marketing, PR, and media experts discussed various ways to promote, enhance, and implement the public awareness campaign across the state. Audience input was solicited to gather the widest possible set of actionable ideas.

The panel and follow-on discussion identified key priorities for the implementation the WOW campaign, guided by the following questions:

1. How do we empower kids so that they "own" this campaign?
2. How do we sustain this to maintain momentum throughout the year . . . and beyond?
3. How do we mobilize parents and teachers as allies and enablers of this campaign?
4. How do we engage on a local level thereby ensuring equal access and success across geographic/socioeconomic boundaries?
5. What does success look like? How do we measure it?

While there were approximately 200 highly valuable individual suggestions, the following represents a summary of some of the concepts which received the most support during the moderated discussion.

<u>Empowering Children to Take Ownership of the WOW Campaign</u>

- Institute student advisory boards to provide input to the campaign, direct from the target audience
- Appropriate messaging is very important, to ensure that the importance of STEM reaches all students, and that the message is not geared toward adults

<u>Sustaining the Public Awareness Campaign</u>

- Working with public officials, companies to ensure ongoing continuation on a local level
- Regular speakers and other audience-interactive events, throughout the Commonwealth
- Ongoing public and private funding
- Sharing of best practices between various programs
- Engaging the media, both a local and statewide PR campaign
- Making sure that the public is aware that bolstering STEM education is in fact a public good, and a taxpayer choice

Mobilizing Parents and Teachers As Enablers

- Engaging parents and teachers, with education campaigns about the value of STEM education
- Hands on activities, for teachers and parents to share with students
- Create and provide materials/brochures, for both informal and formal education

Engaging On a Local Level: Ensuring Equal Access to the Message

- Media, i.e. community access TV
- Increased after school / informal education opportunities
- Local businesses as partners to disseminate the message

Measuring Campaign Success

- SAT survey data
- College major enrollment data
- Graduation surveys
- Continuous collection of data, from elementary through career choice, to ensure that students are not lost to other careers after higher education

In conclusion, the proposed Massachusetts STEM Council Public Awareness campaign is crucial to generating more student interest in STEM majors and careers; this campaign will not succeed without the direct input of target aged-students, the support of teachers and parents, buy-in and assistance from local business and policy partners, and increased and continued funding.

Teacher Development Strand

Teacher development is vital for the growth and sustenance of STEM as they plant the early seeds of critical thinking abilities in young school going children. They are one of the most important stakeholders in STEM. The STEM Summit Teacher Development Strand participants have identified important goals, set priorities & provided the following suggestions for their strong professional development:

1. Expand Teacher Residency programs for postgraduate secondary teachers and support the redesign of their programs to align with the national model for teacher residency and the US Department of Education's (USDE) Teacher Quality Partnership Program. Partnering with industry mentors is an important step in this initiative.

2. Develop "UTEACH" type programs (started by University of Texas at Austin) as an incentive for undergraduate STEM majors to complete teacher licensure programs. The success of UTEACH programs can be replicated to retain these learners.

3. Strengthen STEM requirements for elementary teacher preparation programs by emphasizing a higher level understanding of mathematics and science. In addition, STEM career externships for teachers should be aimed towards providing real world experiences.

4. Strengthen the STEM background of Early Education and Care (EEC) teachers with the following strategies:
    a. Address compensation issue by linking increased STEM credentials to salary increases.
    b. Organize stage plays that are age appropriate and aligned with core competencies developed by EEC. This is an excellent way to start the STEM discussion with young children. In this, focus on day care teachers as they are the first to encourage natural curiosity and influence students to pursue STEM.
    c. Continue to conduct in-house workshops, short term training programs for elementary educators and conduct follow ups to support them. Creating mentor and specialist teachers for EEC and Out-of-School Training (OST) programs and engaging older students to become the link between teachers and the younger ones will only facilitate STEM.
    d. While building up the system for teachers, we need to include mentors in day care and out-of-school trainers through vocational high school programs. Best practices from those schools that have showed significant improvement in academic success can serve as role models. In addition to credentials, teacher skill and efficiency should be taken into account during salary increments.
    e. Creating specialties in EEC/OST similar to Supplemental Education Services (SES) with STEM being one of them will help to incorporate STEM in all aspects of the

curriculum. Candidates should adhere to preset requirements before becoming pre-school teachers. Child-care providers should be trained hands-on instead of the conventional lectures. Incentives like free materials, stipends, training equipment, supplies for attending training sessions can also be given.

5. Develop and implement a marketing campaign to recruit STEM Teachers. The important strategic priority is to market STEM, provide merit-based compensation to teachers and generate teaching resources from business networking and schools.

   Let seasoned STEM teachers mentor potential STEM teachers and use college STEM undergraduates to offer STEM focus groups. Test high school students and have colleges give grants or loans or even free education to STEM students. Balancing seniority with qualifications would also be needed during hiring and professional development. Efficient licensure pathways, along with strong financial incentives will also be very useful, e.g. fellowship programs for PhD students.

   Industries can offer semester-long teaching sabbaticals to their STEM employees who apply for the opportunity. In this way, the students will learn from experts who are working in a STEM career and who will share their enthusiasm and knowledge of the field. The STEM employees return reenergized and can be even more effective back on the job.

6. Building on the existing database systems, Graduate Degrees for Minorities in Engineering and Science (GEM) and the Massachusetts Education Career Center (MECC), maintained by the Department of Elementary and Secondary Education and creating a one-stop clearinghouse for potential and current STEM teachers can go a long way in sustaining STEM activities. 'Race to the Top' report includes recommendations on revamping and revising the current system.

   The above idea needs to be promoted and made accessible to career changers, the public, and colleges and universities students. Database should include programs leading to initial and professional licensure, professional development for existing teachers, information about scholarships and financial support for aspiring STEMers. It should link teachers and school systems and adapt to regional needs. Stakeholders for the database include teachers, prospective employers, parents, those interested in volunteering in schools, mentors, students, retired teachers for consultants.

   Compare state efforts for STEM with other states. E.g. New York has a systematic workforce development one-stop clearing house, Massupt.org has an effective job posting site, EEC registry taps into already established networks for promotions. Also, EEC includes salary, incentives, and sabbaticals for EEC &OST professionals and aligns EEC licensure with DESE.

7. Provide financial support through grants and social support through informal meetings, feedback sessions, STEM workplace visits and community based programs, for teacher mentoring programs within school districts.
8. Rehire excellent STEM retirees to mentor the new teachers and exchange their tacit knowledge and provide program guidelines. Mentoring should be combined with industry experience to motivate teachers. Rubrics should also be developed to assess workforce's needs.

9. Create a structure that recognizes teachers as professionals in their field and provide opportunities for networking between schools and school systems, novice, experienced and veteran teachers to share best practices. Creating model classrooms with student centered instructions and externship programs will be beneficial. Teachers can be evaluated through both essays and online objective tests. These evaluations should be based on skill and efficacy and linked to salary/financial compensation to ensure quality.

   In addition, develop better connections between existing statewide PD organizations like MAST, MABT, NSTA, corporate partners and leverage their visibility for STEM initiatives by paying for membership costs of STEM teachers. Pair a STEM teacher with a STEM worker to exchange ideas, share resources and secure industry underwriters for recognition.

10. Develop a state-wide system of accountability and recognition of a career ladder for STEM teachers along with providing quality professional development programs and opportunities for teachers.

In conclusion, allocating sufficient time and resources towards healthy development of teachers is an important step towards building a strong foundation of STEM.