



Massachusetts STEM Pipeline Regional Networks: Promising Practices and Lessons Learned

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Executive Summary

The University of Massachusetts Donahue Institute (UMDI) has served as the external evaluator to the Massachusetts STEM Pipeline initiative since 2007. Complementing the data collection and reporting activities undertaken to date as part of the evaluation plan, the present study explores one particular component of the Pipeline initiative: regional networks. The study is built on the assumption that, after several years of involvement with the initiative, networks across the Commonwealth possess a rich set of experiences and that reflections on those experiences will yield findings of interest to a broad range of practitioners and policy-makers.

Methodology

The purpose of the study is to capture lessons learned and promising practices associated with successful approaches to designing, implementing and sustaining STEM regional networks. Through close collaboration with the director and staff of the STEM Pipeline Fund, research questions and data collection and analysis plans were developed. A research summary was prepared and distributed to study participants.

Individual interviews were conducted with members of four regional networks (Central, MetroWest, Berkshires and Northeast), including representatives from higher education, the K-12 spectrum, chambers of commerce, regional employment boards and business and industry. Using a semi-structured format, study participants were asked to “step back” from their current practices and to take a retrospective look at their experience over the past few years.

Key Findings

The study revealed the following key findings, which are developed at greater length in the body of the report.

I. Supporting Factors: Lessons Learned

Various factors are widely credited as supporting the networks’ success. These factors include characteristics of the grant itself as well as the configuration of the roles played by key partners. Overall, the regional approach to identifying and addressing problems is seen as an effective strategy for mobilizing resources, building relationships and fostering sustainability.

- **The networks achieved credibility and legitimacy because the goal of educational innovation was linked with the promise of economic development.**

Launched and recapitalized under Massachusetts 2003 and 2006 Economic Stimulus legislation and administered by the Massachusetts Board of Higher Education, the Pipeline fund catalyzed partnerships between multiple constituencies in the form of regional networks. Challenges that in the past have plagued broad-based educational initiatives were mitigated by the structural conditions of the grant:

- a) Housing the initiative in the Board of Higher Education helped to minimize the effects of a historical cultural disjunction between the private sector and the K-12 arena. That is, in contrast to prior efforts that had linked education and economic development through the K-12 system, the Pipeline networks were led by colleges and universities rather than school districts. Casting the Board of Higher Education as the principal interlocutor between the education sector and the private sector contributed to a growing public

awareness of the linkages between the two sectors. Industry was more inclined to participate in a broad-based conversation that was led by individuals with recognized expertise in STEM content areas than with leaders from the K-12 arena, and higher education representatives brought to the table an organizational structure and set of resources that accommodated the processes of developing vision and goals on a regional scale.

b) Mandating the participation of business and industry representatives communicated the vision that workforce development would be effectively achieved through a collaborative effort that harnessed the business community's inherent interest in the "products" of their local educational systems. Over time networks developed a shared set of assumptions and common language that defused longstanding debates over the goals of education (e.g., to produce citizens or workers or consumers) and instead forged common ground. While networks largely cite recruiting and sustaining industry participation as an ongoing challenge, the Pipeline network grants helped to "tip the balance" so that business and education increasingly recognize their shared interests in an agenda that centers on a technologically-literate, highly-skilled citizenry workforce.

➤ **The regional approach to educational innovation and economic development fostered collaborative relationships, which members cite as significant benefits of the Pipeline networks and a key to the sustainability of efforts.**

The grant was structured so that multiple stakeholders would identify and address the needs of their particular region. This approach is largely perceived to have been effective, not only because it acknowledges that "one size does not fit all" but also because it fostered dialogue about STEM goals.

- Most networks did not execute a comprehensive needs assessment per se, but they all launched exploratory conversations that have been sustained over time, *even without funding* in some cases, to stay abreast of evolving needs and develop responses.
- The relationships formed under the aegis of the networks have in many cases contributed to a climate in which principal stakeholders in STEM arenas have developed high levels of comfort and familiarity with one another. In many instances they have a track record of pooling their resources—staffing, intellectual and financial resources—to create products and services that surpass the potential of each member organization acting alone.
- The network members' cumulative experience has led to the establishment of norms of collaboration rather than competition, such that members share information easily and work toward a shared goal instead of carving out individual "territories."
- The existence of a longstanding group of professional collaborators is beneficial to the extent that a) more experienced colleagues are readily available to mentor younger and more junior colleagues through routine interactions; b) individuals who relocate to a new area are received by a professional community that welcomes them, in contrast to other communities that may be perceived to be exclusive or "hard to break into"; c) because partners do not work in isolation, they have ready access to funders or donors who are positioned to help transform their dreams into reality. Ideas are generated through sustained dialogue among partners, which helps ensure that visionaries and managers share a common understanding of the needs and potential solutions; and finally, d) some employees within a system (e.g., local school district or college or university) will tend to prefer not to relocate when possible. Some of these individuals will change positions within their organization but still remain central to STEM work. The regional

network structure serves as a mechanism *to keep these individuals connected and focused* on a common goal and also *to preserve the historical knowledge* that resides in their individual and collective experiences.

- **The roles played by the Department of Higher Education and the external evaluator reinforced the networks and supported the advancement of STEM agendas. An integrated model that maximized the strengths of the Department and the evaluator fostered cross-fertilization among the regions and contributed to statewide capacity-building.**

The networks were strengthened by the coordinating role played by the Department of Higher Education, including site visits from DHE representatives and statewide meetings that brought leaders of all networks together. Statewide meetings convened by the Department kept the regions abreast of policy developments and thereby prepared the networks to play important roles in emerging STEM agendas. Additionally, the meetings were structured so that networks examined challenges and emerging solutions, learning from one another's experiences and adopting and adapting approaches and practices that they would otherwise not have considered.

The external evaluator collaborated closely with the Department, participating in statewide meetings and maintaining ongoing communication with the networks. The evaluator's role was crafted such that data analyses and summaries of the networks' standardized reports helped to foster a statewide perspective on STEM issues and strengthened network leaders' and members' awareness of and responsiveness to the needs, and strengths, of their own contexts. Viewed as a partner in the work, the evaluator supported and informed the continued evolution of the initiative and provided the tools needed for statewide dialogue and continued capacity-building.

This model granted validity and legitimacy to the networks' undertakings. Network members derived continued inspiration from indications that their efforts were not isolated and limited to one segment of the Commonwealth, but rather were part of a broader movement to advance STEM agendas on a larger scale.

II. Promising Practices

Formal organizational structures and processes differ somewhat between networks; largely, the networks are described as relationships, collaborations, or connections between people and institutions. Typically, informants report some difficulty in identifying exactly what the network is and is not, but overall they describe a commitment to share resources in the pursuit of a common goal, which network members believe they are more likely to attain by collaborating than by working independently.

- **Passion and effective management are key to recruiting and sustaining participation.**

Networks demonstrate a strong combination of visionary leadership and effective, thoughtful management practices. Overall, the networks are highly participatory and reflect democratic principles and practices.

- Network directors and others sought broad-based participation from a cross-section of constituencies *and* created a framework or rationale to guide decision-making.
- Networks recruited and worked to retain a broad cross-section of representatives from various sectors to play leadership roles in the network (e.g., by sitting on steering committees and advisory boards).

- Some network directors adopted a proactive stance toward managing the membership.
- Most directors focus on employing effective meeting facilitation strategies. They use strategies designed to maximize the utility of meetings, such as clear agendas, which are distributed in advance; strict adherence to timeframes; and incorporation of advisory board input into agendas. Also, some networks rotate their meeting venues, so that members are exposed to one another's work and share a sense of ownership about the initiative rather than routinely conducting the meetings at the lead agency's offices.
- Directors describe a need for good administrative practices within the network. They demonstrate an ability not only to articulate a comprehensive vision for their region, but also attention to management and administrative procedures that support day to day progress toward that vision. For example, they ensure that administrative systems between different organizations are reconciled so that routine tasks are carried out efficiently (e.g., getting invoices paid without undue delay). Additionally, they make intentional use of technology such as videoconferencing features, so that communication between members is not adversely affected by geographic distance or time constraints.
- A full-time director position is a valuable component of most networks' operating structure. The value of the full-time commitment is two-fold: to articulate the message that the work of the network is a high priority and to ensure that due diligence is granted to the necessary aspects of network maintenance (e.g., communication, website updates).

➤ **Effective school-business partnerships require time, personnel and careful planning.**

Network members describe a process of continually exploring the inherent connections between the private sector and K-16 education. Some industry representatives express a sense of urgency about the need to “grow their own” local workforce, while others express a commitment to “being a good neighbor.” The study identifies a few factors that contribute to successful collaborations between education and industry:

- A point person: Networks thrive when business partners assign a liaison whose routine job responsibilities include attending to the work of the network.
- A “do your homework” attitude: Industries respond best to inquiries from individuals who are familiar with their organization and its priorities, and who have articulated a clear role for them to fill.
- An effort to plan and carefully structure the experiences of bringing school and business representatives together: In cases where internships or other collaborative efforts are undertaken, industry representatives appreciate efforts to minimize disruption and maximize anticipated benefits (e.g., some organizations have developed selection criteria and other protocols to identify appropriate candidates for their internship experiences).

III. Challenges and Potential Solutions

The study addresses four sets of challenges to network development and growth; approaches to these challenges are explored. The four challenging areas are: participation of the business community; tension between planning and spontaneity; sustainability of efforts beyond funding; and assessing impact and moving toward scale-up.

- **Securing the participation of business and industry in the networks has been and remains an ongoing challenge: revised approaches to planning and evaluation are suggested.**

An unsteady economic landscape further complicates a challenge inherent in the call for the business community's involvement in broad-based STEM and STEM education initiatives. Networks continue to explore approaches to fostering mutually beneficial partnerships with their neighbors in the private sector. In addition to the strategies detailed above, some study participants identify a need to convey to business partners a "sense of urgency" about STEM issues and to develop enhanced approaches to STEM planning and evaluation across the state with an eye toward better measuring progress toward goals and demonstrating results. These challenges notwithstanding, the study suggests that, overall, the business and education sectors now share more common ground than ever before, having begun to craft reciprocal goals and strategies in support of a shared vision.

- **Planning vs. spontaneity: Planning grants facilitate sustained interaction among network members and their continued capacity to generate ideas.**

Some network members describe a tension inherent in a process that includes participation and the spontaneous generation of ideas as well as a commitment to accountability. In some cases advisory board members identify challenges and opportunities that did not figure in original proposals or other formal planning documents. In some cases the network membership at large generates similar ideas. Study participants suggest that planning grants (to help ensure, for example, that meetings are held regularly, thereby facilitating routine sharing of ideas among all constituencies) and/or other funding mechanisms that support emergent designs accommodate the constraints and possibilities of a given network's situation.

- **Sustainability is one element of an ongoing conversation.**

Networks have adopted varying approaches to ensuring that their efforts continue beyond the life of the grant. Largely, they report that considerations of long-term sustainability have become integrated into their routine, ongoing conversations. Against this backdrop, a few key strategies are employed:

- Network members keep themselves apprised of upcoming opportunities and reflect on them as part of their regularly scheduled meetings. They assess in advance whether options, such as various funding streams, solicitations, or potential projects, align with the direction the group is pursuing.
- Some networks invite their local evaluator to participate in routine meetings to help the group assess what works and what does not and to incorporate that perspective into decision-making.
- In the face of declining resources, one network appealed to members, many of whom made financial contributions.

➤ **How to prioritize: Calls for a common agenda (“Everything isn’t local”) and scale-up**

Given the broad range of needs within each region, some participants describe the potential to be engaged in multiple activities without demonstrated evidence of effectiveness.

- One set of proposed solutions is to capture the needs of the end-users (e.g., colleges who train students and businesses who will hire their graduates) and communicate those needs at the regional and statewide levels. Some participants believe that efforts such as the STEM Pipeline Indicators framework¹ will help to convey a sense of urgency about particular needs within a region.
- Some networks describe an explicit attempt to maximize the impact of their individual programs. In these instances the statewide network forum has helped educators and business representatives move from a segmented to a more comprehensive approach; that is, they situate their individual efforts within a broader conceptual framework and set of goals, such as making high school students aware of STEM opportunities in their local areas.
- Some network members suggest the need for a coherent statewide plan or agenda to ensure that networks not only address local needs but also that their effective practices be replicated on a broader scale. “Everything isn’t local,” said one network member. Some call for a common evaluation template or other structure that would help assess the effectiveness of their efforts. Additionally, some network members point to a need for increased opportunity to share practices, thereby increasing networks’ capacity to identify and address STEM needs in their regions and also aligning efforts statewide.

IV. Implications

What does the experience of Pipeline networks suggest for policy-makers, legislators, STEM experts, educators, business representatives or others who may wish to replicate similar models? Which factors would enhance the likelihood that the lessons articulated in this study could be generalized to other settings and/or translated into practice?

➤ **“Amplify the message”: Increase public awareness of the needs and opportunities in all STEM areas.**

The most robust theme to emerge from this study is the call to increase public awareness of the needs and opportunities that present themselves in a variety of STEM areas. The phrase “amplify the message” was used by a number of speakers to describe a need to increase the visibility of the work that has been undertaken thus far by the regional networks and also to communicate the message that STEM issues are a high priority in each region and across the state. Other phrases typically used include the need to create a “regular drumbeat” and the need to cast STEM issues as “mission-critical.” A variety of strategies to “amplify the message” were suggested by participants, including:

- Change the nomenclature from “STEM” to a more recognized word or phrase.
- Accord recognition to local leaders in the field (e.g., create various STEM awards and give them periodically to local leaders who have somehow made a difference in STEM fields in the region).

¹<http://dl.dropbox.com/u/3561120/MASSIP%202009%20Full%20Report%2012-16-09.pdf>

- Use tools such as op-ed pieces in local newspapers.
 - Create regional scorecards that demonstrate areas of need and are tied to an annual report that proposes recommendations.
 - Use frameworks such as the STEM Indicators that help to create a systemic or comprehensive understanding of the needs.
 - Increase media coverage of successful collaborations with the private sector.
 - Develop public service announcements that describe the exciting career opportunities available in each region and the steps to necessary preparation.
 - Assign senior-level government leaders (e.g., secretariat) to STEM planning tasks, including the crafting of a coherent statewide STEM plan.
 - Promote and support science instruction in the elementary grades, understanding that mathematics and literacy tend to be prioritized in elementary classrooms and the time allocated to science instruction may be reduced proportionally.
 - Encourage participation in professional associations and presentations at large-scale conferences, to “get the word out” about STEM activity in Massachusetts.
 - Develop “planning grants” funding mechanisms to allow for spontaneity, continued meetings of network members and an increasing track record of success.
 - Shape an expanded role for the Department of Higher Education to include capacity-building for regional STEM leaders so that they are equipped to carry the agenda forward. Invite consultants with relevant expertise to help expand regional leaders’ skills sets and knowledge base so that they are positioned to a) identify the needs in their region and pursue appropriate responses to challenges, and b) develop sustainability plans that will ensure long-term survival and impact of their efforts.
- **Build on the legacy of regional networks’ shared history: Articulate a statewide agenda, craft roles for multiple constituencies and establish a systematic approach to evaluating impact and scaling up successes.**

A secondary theme to emerge from the study is the very strong legacy of network members’ history of planning and collaboration. The regional networks exist now as collaborations between stakeholders who share common goals and interests. After years of collaboration, members of the regional networks now enjoy trusting and mutually beneficial relationships; their organizational practices are sound and efficient and reflective of democratic principles. The study reveals calls for a coherent, coordinated statewide plan that articulates broad goals and espouses systematic approaches to measuring progress toward those goals. The regional networks are poised to be vital partners in the next phases of STEM development in the Commonwealth. The study suggests that one of the key legacies of the Pipeline grant is that it nurtured sustained conversation about STEM issues within and, to a lesser extent across, the regions. As demonstrated in the body of the report, sustainability has largely become a taken-for-granted component of the ongoing dialogues within regions. The 2006 Call for Proposals anticipated that “...by bringing together key regional stakeholders, the Networks provide a vehicle to address and communicate topics of regional concern such as industry training, grant opportunities and events.” Having fulfilled this promise, the regional Pipeline networks are now positioned to be key vehicles for the next phases of continued STEM conversation.

I. Introduction to the Study

The University of Massachusetts Donahue Institute (UMDI) has served as the external evaluator to the Massachusetts STEM Pipeline initiative since 2007. Complementing the data collection and reporting activities undertaken to date as part of the evaluation plan, the present study explores one particular component of the Pipeline initiative: regional networks. The study is built on the assumption that, after several years of involvement with the initiative, networks across the Commonwealth possess a rich set of experiences and that reflections on those experiences will yield findings of interest to a broad range of practitioners and policy-makers.

Methodology

The purpose of the study is to capture lessons learned and promising practices associated with successful approaches to designing, implementing and sustaining STEM regional networks. Through close collaboration with the director and staff of the STEM Pipeline Fund, research questions and data collection and analysis plans were developed. A research summary (Appendix A) was prepared and distributed to study participants prior to interviews.

Research Questions

The study addresses the following primary questions:

1. Supportive factors: What are the factors that contributed to effective design and implementation of regional networks? Over time, how did these factors inter-relate and with what effects?
2. Challenges: What challenges did the networks confront, and how were they addressed? Which barriers were successfully overcome and in what ways? Which challenges persist, and in what ways have they affected planning processes?
3. Promising Practices and Lessons Learned: What lessons have STEM experts, educators, private sector constituents and others learned about bringing relevant stakeholders from a region together for the purpose of effecting positive change? What decisions contributed to networks' successes? What are the "take-home" messages about approaches to designing and creating regional STEM networks?
4. Implications: What does the experience of Pipeline networks suggest for policy-makers, legislators, STEM experts, educators, business representatives or others who may wish to replicate similar models? Which decisions, choices or other factors would enhance the likelihood that the lessons articulated in this study could be generalized to other settings and/or translated into practice?

Data Collection and Analysis

Individual interviews ranging from 45 to 90 minutes were conducted with members of four regional networks (Central, MetroWest, Berkshires and Northeast). Using a semi-structured format, study participants were asked to "step back" from their current practices and take a retrospective look at their experience over the past few years. Participants were guided to reflect on their initial involvement with the network and to describe and explain the

evolution of the work, moving chronologically from earliest involvement to the present. Participants were also guided to articulate implications for the future that were grounded in their experience.

Interviews were audio-recorded with participants' consent and transcribed. Through an iterative process of multiple close readings, cross-cutting and network-specific findings were identified. Participants' feedback on these findings was solicited prior to completion of the report to ensure accuracy and reliability of findings.

One additional interview was conducted with an individual who provided consultancy services to the Board of Higher Education during the initial phase of the initiative.

Additionally, selected documents such as network reports and report updates were reviewed to provide background and contextual understanding of each network.

Organization of the Report

The report is organized to address multiple purposes. The Executive Summary is shaped as a stand-alone section and as such, provides the reader a comprehensive look at the study's intent, methodology and key findings.

A two-page Background section summarizes the broad outlines of the guiding principles and funding mechanisms that comprise the Massachusetts STEM Pipeline Regional Networks initiative.

The next section consists of approximately three-page descriptions of each of the four networks. Generally, these descriptions are organized by the following categories: Structure and Major Activities; Private Sector Involvement; Challenges and Big Picture. These brief descriptions endeavor to "tell the story" of each of the networks in a succinct format, setting the findings in context.

The Discussion section synthesizes the findings articulated in the four narratives and presents a few additional findings that extend beyond the purview of individual regions. This section is organized by topical sub-headings. The reader who seeks a general understanding of the study's findings may wish to turn to this section first and to refer back to the four narrative descriptions as time allows.

The report concludes with two sets of appendices. Compilations of membership lists, detailing the individuals and organizations that comprise each of the four focal networks, are included as Appendix A. Highlights of each of the four networks' activities and accomplishments, prepared by the network leaders, are included as Appendix B.

II. Background: Overview of the Massachusetts STEM Pipeline PreK-16 Regional Networks

In response to a recognized need to foster innovation and global competitiveness within the Commonwealth, the Massachusetts legislature developed a series of steps to increase the supply of talented and well-prepared workers in the science, technology, engineering and mathematics (STEM) fields. The 2006 Massachusetts STEM Pipeline Fund Call for Proposals summarizes these measures as follows:

The 2003 Economic Stimulus legislation included a provision of \$2.5 million for the Massachusetts Mathematics, Science, Technology and Engineering Grant Fund, (the STEM Pipeline Fund) and appointed the Board of Higher Education (BHE) as the administrator. The Economic Stimulus Act of 2006 recapitalized the STEM Pipeline Fund in the amount of \$4 million, reaffirmed the BHE responsibility for administering the fund, and established the Robert H. Goddard Council to create a long-term statewide strategy for STEM educational and workforce development in the Commonwealth.

The broad purpose of the STEM Pipeline Fund legislation (Section 30 of the Economic Stimulus Act) is to “increase the number of students who participate in programs that support careers related to science, technology, engineering and mathematics.” This broad purpose has been translated into the following goals of the STEM Pipeline Fund:

- *Increase the number of Massachusetts students who prepare for and enter STEM careers;*
- *Increase the number of qualified STEM teachers in the Commonwealth; and*
- *Improve the STEM educational offerings.*

The Board of Higher Education released an initial round of STEM Pipeline planning grants in the spring of 2004 to establish seven Regional PreK-16 networks. These networks were conceived as follows:

The Networks integrate the STEM efforts of public and private PreK-12 schools and districts, public and private higher education institutions, business and industry, and non-profit organizations. This membership includes those who recruit, prepare, employ and support teachers, those who teach, and those who seek to employ graduates of Massachusetts’ schools, colleges and universities. Membership in the Networks is open to all, and collaboration among regional stakeholders is encouraged; this commitment will continue. (2006 Call for Proposals)

In the summer of 2004, the networks were invited to propose projects that met the goals of the STEM Pipeline Fund and aligned with regional needs. Proposals were reviewed and ultimately a variety of teacher- and student-centered projects was funded, serving teachers and students from 230 schools in 115 districts.

In the fall of 2006, another round of funding was designated to further some of the activities and successful practices implemented previously. The 2006 Call for Proposals also signaled a renewed interest in engaging traditionally underrepresented groups in STEM fields. The following eligibility criteria are articulated in the 2006 solicitation:

- *Strong lead partner with history of commitment to regional collaboration and to STEM education;*
- *Engagement of existing or successor Regional PreK-16 Network that includes area public and independent K-12 schools and districts, public and independent higher education institutions, community organizations and employers;*
- *Existence of a Network Advisory Council comprised of regional K-12, higher education, employer representatives and other key stakeholders to provide the Network with strategic guidance; and*
- *Presence of ongoing dialogue and research among K-12, higher education, employers and other stakeholders to determine regional workforce and education needs in STEM; and*
- *Plan for continued outreach and membership development with an emphasis on employer members.*

Guidelines for successful proposals are delineated in the 2006 solicitation as follows:

- I. *To further some of the activities of the Regional PreK-16 Networks and the successful practices established through the STEM Pipeline Fund, including:*
 - *Innovative approaches to the goals of the STEM Pipeline Fund;*
 - *Inter-regional transfer and statewide replication of exemplary programs and materials; and*
 - *Developing a multi-year Regional Network Strategic Plan which aims to address regional workforce and education needs and plans for the Network's role in the region.*
- II. *To propose an organized, regional, collaborative approach to one or more of the goals of the STEM Pipeline Fund that will satisfy all of the following criteria:*

Network Development

- *Broad base of partnership and collaboration;*
- *Development of Network Advisory Council;*
- *Active employer participation in Network activities;*
- *Adherence to Regional Network Strategic Plan;*
- *Outreach to continue Network membership development;*
- *Marketing of Network through electronic and print materials; and*
- *Funding matches, both cash and in-kind.*

Projects and Participants

- *Elementary, middle and high school students at key points in development of STEM interest;*
- *Teachers, administrators and other appropriate stakeholders in K-12 systems;*
- *Balanced district participation, including districts with greater than 21% (state average) of 10th grade 2006 math MCAS scores falling in the "Needs Improvement" category;*
- *Attention to recruitment of female and minority students;*
- *Active employer participation in project activities; and*
- *Measurable objectives with methods to evaluate outcomes.*

III. Overview of the Focal Networks

This study explores the experiences of four of the regional networks. Highlights of these networks are presented below.

A. The Central Massachusetts Regional Network

The Central Massachusetts *2009 Mid-Year Report Update* includes the following overview:

The most important work of the Network has been to develop itself so that it and the goals of its partner organizations are aligned and working in concert. Year to year and month to month the impact of the Network broadens. Its most important long-term accomplishment to date is developing strong linkages to other like-minded educational stakeholders. Business especially has developed closer ties with K-12 institutions due to the Network. This could not have happened without the staff and structure of the Network. The Network is really the glue that allows central MA to leverage its own resources to improve STEM education and outreach. The advisory board is the engine that drives it all.

The Central Massachusetts STEM Pipeline Network evolved largely as a natural outgrowth of the relationships and collaborations that were fostered under a National Science Foundation Systemic Statewide Initiative (SSI) of the early to mid-1990s. The lead partner of the Regional Network, the director of the Regional Science Resource Center at the University of Massachusetts Medical School, was highly involved in the SSI (Partnerships Advancing the Learning of Mathematics and Science or PALMS) and cites the “hospitable environment” created under PALMS as critical to the Network’s success. Working relationships were formed over the years, trust was built, communication between partners became easy, and partners became familiar with one another’s interests and expertise. The director describes the Pipeline work as a “continuation of that work, only under a different umbrella.” Contrasting the earlier work with the more recent (Pipeline) work, she describes two major differences:

1. The needs of the region have changed somewhat—it is now middle school teachers rather than elementary teachers who seek professional growth in STEM, and having developed competency with a standards-based environment and curriculum, teachers now expect and benefit from higher quality professional development offerings.
2. The business community is now much more involved in education. Two factors principally account for this change: business involvement was mandated through the Pipeline solicitations; and the initiative was housed in the Board of Higher Education rather than the Department of Education. The BHE locus helped to mitigate a traditional obstacle to collaborations between schools and businesses—a perceived cultural disjunction between the private sector and the K-12 arena—and harnessed the business community’s inherent interest in the “products” of the educational system (graduates, the future workforce).

Structure and Major Activities

While the task of documenting “the network” is difficult since it is described largely as a collection of relationships, the Central network’s structure incorporates elements of three separate mechanisms:

1. The Central Massachusetts Curriculum Coordinators Council, which has been in place since PALMS: Approximately 100 persons are on the mailing list, while about 25 persons attend meetings, which are held quarterly during the school day. Their mission is to keep abreast of and discuss current issues, especially districts' needs with respect to teacher growth, and to explore potential collaborations. With the arrival of Pipeline funds, the network director opted to continue to rely on this committee, rather than creating a new structure, because of its perceived value in identifying professional development needs in the region and the commitment of those who provide professional development to develop appropriate and high quality offerings. The intent was to use already extant resources, rather than creating new ones that would ultimately be redundant.
2. A sub-set of the Central Massachusetts Curriculum Coordinators Council, the Coordinating Council: Operating during the three years of the grant, this council was comprised of approximately 12 people from the most interested school districts. Their mission was to identify the steps needed to complete various funding proposals, and then to continue the ongoing planning of professional development over the life of the grant.
3. The network advisory board: The board is comprised of a cross-section of stakeholders within the region, including business—the chairperson of the board is the Intel education manager—higher education, the major K-12 school districts, and non-profit organizations. In collaboration with the director, the board's role is, to play a key part in ongoing planning processes and contribute thinking about the network's development and evolution. The director describes the board as “passionate” and “innovative” and generative of multiple ideas.

Examples of the Central Massachusetts regional network's principal emphases include professional development to large urban districts in the region and career awareness initiatives geared toward middle and high school students and their “career influencers” (e.g., parents, guardians, teachers, guidance counselors).

Private Sector Involvement

Two factors are largely believed to account most significantly for successful collaborations between education and the private sector in the region:

1. Two of the network's largest industry partners (Intel and EMC) have created positions dedicated to working with educational initiatives.
2. A number of institutions of higher education with close ties to the private sector (technical high schools and polytechnic institutes) are actively involved in planning and carrying out work undertaken through the Pipeline initiative.

Additionally, some interviewees believe that the network not only enjoys greater involvement from the business community than earlier initiatives have seen, but also that a balance has been tipped to the extent that the onus no longer falls solely on schools and that instead, businesses now seek access to schools. The network is a mechanism that provides that access. Consequently, business representatives have developed a realistic understanding of life in schools, having had a glimpse of the realities of teachers' work (e.g., managing students' behavioral issues, negotiating impractical schedules). One interviewee commented, “Before, businesses were just money people to the districts. Districts heard ‘business’ and saw dollar signs. But now, business is involved in discussions, involved in the softer things... *in* schools, more, really.”

Additionally, one interviewee who has been successful in securing private sector involvement in STEM work uses the following strategy: identify individuals in a given organization who possess the desired skill sets before approaching the CEO or other senior leader. While this strategy requires a certain level of “homework,” it tends to increase the likelihood that a CEO or other senior leader will be predisposed to support the network’s endeavors.

Challenges

The biggest challenge that network members identify is the question of how to derive the greatest gain from all the intensive, high quality work being undertaken. While they are generally comfortable that their range of experiences and set of network members continues to expand, there is also some sense that the network could be better recognized and that the issues they are confronting warrant greater public attention, and perhaps investment, than seen to date. They discuss the need for greater public awareness: the need to create a “regular drumbeat” so that, within the region (“in our own backyard”), STEM is recognized as a high priority. Proposed solutions include:

- changing the nomenclature from “STEM” to a more recognized word or phrase
- according recognition to local leaders in the field
- using tools such as op-ed pieces in local newspapers
- creating regional scorecards that demonstrate areas of need and are tied to an annual report that proposes recommendations
- using frameworks such the STEM Indicators² that help to create a systemic or comprehensive understanding of the needs
- shaping an expanded role for DHE to include capacity-building for regional leaders.

Big Picture

Overall, the Central Massachusetts network is an example of a coherent set of practices and approaches that reflect collaborative planning conducted by a core group of stakeholders who have developed, over time, an understanding of one another’s—and the region’s—needs and strengths. Reflecting on the various STEM collaborations undertaken between a school district, higher education institutions, and businesses, the director commented:

The thing about working for years in a district is that you get depth in a district.... People who were curriculum coordinators become superintendents.... So over time we’ve developed multiple contact points. It’s always the same faces. People may jump from one position to another or even one district to another, but it’s the same people. Everything is local. That’s an argument for the regional approach; people don’t want to relocate.

With respect to sustainability, the network members acknowledge multiple factors that contribute to widespread uncertainty about future funding scenarios, but at the same time they describe ongoing planning and grant-writing processes. Perhaps more importantly, they describe a sense of confidence that they are well-prepared to respond to opportunities that may present themselves, because, as one interviewee said, “We have the relationships, and the shared history, and we’re working toward a common goal.” Additionally, noting that the advisory board continued to meet even during periods of reduced or interrupted funding, the director observed that those moments actually provided a window into the value of the network: “If we’d had continuous funding, I never

² <http://dl.dropbox.com/u/3561120/MASSIP%202009%20Full%20Report%2012-16-09.pdf>

would have found out how valuable the advisory board is. They said, ‘Well, we’re going to meet anyway.’ Schools like the PD they provide and they [business representatives in particular] like coming to the schools.” Finally, members of the network have found opportunities to support one another’s initiatives, independent of external funding sources. For example, the Worcester Public Schools is preparing a list of equipment needs at each of the middle and high schools, and the director of the Worcester Technical High School is helping to identify supporters for each school who will work with donors and/or make donations of equipment.

B. The Berkshire Regional Network

The Berkshire region of Massachusetts possesses a unique historical and cultural identity. Far removed from the urban centers of the eastern part of the Commonwealth and separated from its neighboring regions by distance and a mountain range (the Berkshire Hills section of the Appalachian Mountains), the Berkshire region is notable for a spirit of collaboration among its 32 towns. As a region, it consists of only one county and so is served by only one governing body in some instances (e.g., there is only one regional employment board, one economic development council and one chamber of commerce³).

The Berkshire Compact for Education⁴

One of the key policy directives in the region is the Berkshire Compact for Education, a countywide initiative focused on promoting learning in the Berkshires. Launched in 2005 and spearheaded by the president of the Massachusetts College of Liberal Arts (MCLA), Dr. Mary Grant, the Compact brings together approximately 70 representatives of the Berkshires' education, business, legislative, cultural, municipal, and health and human services sectors. Responding to the needs of an evolving economy, the Compact is geared toward establishing a norm that students will pursue 16 years of education or career training.⁵

The STEM Pipeline initiative is situated within this broader context and aligns well with the goals and purposes of the Compact. MCLA is the lead partner for the Compact as well as for the Pipeline grant and has worked closely with network members to ensure continued coherence between the two. For example, when responding to the STEM Pipeline RFP, MCLA and its STEM partners made a concerted effort to use the goals as stated in the RFP to continue to shape and refine an emerging, common vision for STEM activities in the region.

Structure and Major Activities

In 2004, when the first round of STEM Pipeline funding became available, MCLA president Grant tapped the newly appointed dean of academic affairs, formerly a biology professor, to lead the planning efforts and chair the Pipeline network. The dean organized a two-day summit designed to identify needs in the region and establish a planning process and organizational structure. That summit brought together some 50 representatives from diverse fields, including higher education (e.g., Williams College, MCLA, and Berkshire Community College), the Regional Employment Board, the private sector, K–12 administrators, including superintendents, as well as teachers spanning the elementary, middle and high school range. Many of these individuals and organizations had had prior experience working together through various organized STEM initiatives, such as PALMS (see above) and the Berkshire Applied Technology Council,⁶ and through smaller-scale collaborations. Based on the assumption that their efforts would be more robust if they worked in concert rather than isolation, the group developed an initial planning grant and organized a steering committee charged with developing further plans to address needs in the region, with an eye toward avoiding duplication of effort. The overall focus of the strategic plan is science education for K–16 students.

³ Two Chambers were merged in 2000, for the purpose of strengthening the capabilities of all of the Chambers across the region.

⁴ Originally titled the "Berkshire Compact for Higher Education," the name of the Compact was recently changed to the "Berkshire Compact for Education," to better reflect its scope and purpose. The latter formulation is used in this report.

⁵ See *The Berkshire Eagle*, March 28, 2009

http://www.mcla.edu/news/berkshirecompactforhighereducationtackleseducationgoals_57/

⁶ This is a cross-cutting group of regional employers and educators, focused on the skills sets needed for various niche manufacturing fields and the design and delivery of relevant technical learning opportunities for the Berkshires workforce.

Many of the initial steering committee members have remained in that capacity since inception. The network Chair describes the group as “very dedicated” people who are “passionate” about science in particular and STEM matters in general. They meet once or twice a semester, including having met during periods when funding was not available.

The Pipeline supports a full-time coordinator position, who, in addition to day to day management, assumes responsibility for the Pipeline website⁷. Along with other relevant content, the website catalogues professional development opportunities in the region. The network has provided educational opportunities for teachers and students across the region: a STEM newsletter is linked to the website, and an email distribution list about professional development opportunities for teachers and opportunities for students is circulated to more than 700 STEM educators. Over the years, key projects have included career fairs, science fairs, the Starlab portable planetarium, and *Got Math?*, an elementary and middle school project focused on students’ and teachers’ understanding of applications of mathematics in the real world.

Private Sector Involvement: “A lot more common ground”

The director of the Chamber of Commerce sits on the network’s steering committee. He perceives a shift in the relationship between the private sector and industry over the past few years to the extent that tensions about whether education should produce good citizens or good employees have diminished. “We’ve found more common ground now,” he says, “with all of us recognizing that yes, education will turn out good citizens, but that at some point those citizens are going to work.” Additionally, he notes that two characteristics of the Berkshires region in particular tend to heighten the business sector’s interest in education:

1. *Urgency to “grow our own” workforce*: as noted above, the region operates somewhat autonomously due to distance from other regions in the Commonwealth and formidable geography. Also, the region has a rural character, lacking a vibrant “night life” setting that would be attractive to a younger population and lacking a viable road system that would facilitate commuting to work from nearby cities such as Springfield or Albany. Business, therefore, recognizes a need to develop a local workforce, given anticipated difficulties in recruiting from the outside as well as compelling reasons for young, talented residents of the region to leave and resettle elsewhere.
2. *Increasing need for STEM-savvy workforce*: Manufacturing companies in the region invested funds over the past few years to be competitive in the global arena. Largely, those funds were used to procure equipment. With that equipment came the need for training, and today that training is more complicated than it used to be, requiring skills and knowledge in the STEM fields. “It’s not just a matter of pushing a button,” explained the Chamber director.

One additional factor contributes to business representatives’ interest in working with the education sector: an overall recognition that STEM is critical to the economic livelihood of the region. The Chamber recently surveyed the business community about their needs, and the results showed that the greatest need was no longer to address the high cost of energy, as in the past, but rather now to focus on STEM areas. “In this economy,” the director said, “the importance of STEM is not only for businesses to enhance their productivity but now to just help them keep their heads above water.” The Chamber is now trying to identify the jobs in Berkshire County that are most dependent on STEM initiatives. Additionally, the chair of the STEM Pipeline is part of a STEM SAT advisory group. The chair has shared the SAT data collected by the UMass Donahue Institute with the Berkshire Compact

⁷ http://www.mcla.edu/About_MCLA/Community/stempipeline

subgroup on Workforce Development as a way to increase understanding of the alignment between students' interests in STEM areas and industry's needs.

Direct involvement from the business community in Pipeline activities has included participation in the career fairs, assistance with the regional science fairs (approximately 65 business and industry employees volunteer to serve as judges) and a partnership with Berkshire Community College for the *Got Math?* program.

Challenges

As noted, the region's geography is a defining characteristic. The region spans more than 900 square miles, with a possible driving time of approximately one and a half hours from the north to the south. From the start, the question of how to involve stakeholders from all corners of the region in Pipeline development and evolution was raised, especially the question of how to involve representatives of the (furthest removed) south county. In response, the strategic plan was written to focus on educating students *from across the whole county* in science. Also, the group has begun to make greater use of technology, including tools such as videoconferencing, so that individuals could commit to participating in meetings without incurring excessive driving time. Two representatives from the south county now sit on the steering committee.

The role of the steering committee has evolved over the years, with variation in the extent to which the group plays a listening role—by, for example, being exposed to updates—or a more proactive role, helping to set the direction of the network. The local evaluator has been instrumental in bringing to the attention of the steering committee considerations about the impact of the various activities. Also, as the steering committee evolved, it became increasingly clear that the members who participated actively did so because they were passionate about the topic, while some members demonstrated somewhat less availability for the network. In some cases the chair asked those individuals if they were still interested in participating or if they preferred to have someone else designated to participate.

One challenge associated with a vibrant, active network is documenting all the activities of the network and, in particular, keeping records up to date. The website is designed to provide timely, relevant information to teachers; posting of all those activities constitutes a significant time investment.

Like other networks, the Berkshire network faces concerns about sustainability. Largely, the strategy in place in the Berkshires is to keep abreast of current and emerging needs so that STEM offerings continue to demonstrate effectiveness. Also, the network is comprised of representatives of organizations that have access to multiple funding sources. Through close communication the network members carry out a commitment to draw from extant and future funding sources to create activities that are complementary and align with a shared vision for STEM across the region. For example, MCLA recently received federal funding to support a Berkshire County Regional Science Center. Network members anticipate that the resource center will attract new funding and create expanded opportunities for students and teachers in the region, complementing efforts that were begun with Pipeline funding.

Big Picture

The Berkshire region is distinctive not only for its location and geography but also for the history of collaboration that organizations across the region have demonstrated. As described above, a number of factors account for a collaborative tradition and sense of unified purpose across the region, including merged legislative and administrative structures and visionary leaders who bring together relevant individuals and groups under formalized agreements. Within this landscape STEM has achieved a relatively high level of visibility and public

awareness. Manufacturing and other business and industry units look to higher education and K–12 representatives to help meet their workforce needs in the face of an adverse economy; and educators embrace a strong commitment to creating a culture of learning that takes into account every student’s readiness to succeed at whatever post-secondary option they choose. Over the past few years, the Berkshire Compact for Education has served as one unifying structure for these purposes and a conceptual home for STEM agendas. One higher education representative reflected on the role of STEM in the region and in the Berkshire Compact in particular, as follows:

...I think STEM embedded in this Compact is really, really strong. I think the Berkshires probably leads the way, and part of it goes full circle to where we started. Because we are a definitive region where our Regional Employment Board, our county, our political representatives, the geography ... all of these sort of overlap. And so I think it’s like a Berkshire brand—Berkshire Compact is almost like a Berkshire brand—and we have all of these components, with STEM being one of the strong ones, a piece of that. So it’s a very interesting dynamic in terms of how that works. I know in other parts of the state that that’s just not the same. I know that the STEM region is not the same as the workforce investment region is not the same as a tech. prep. region is not the same geography that might serve community college. There might be four community colleges all competing for the same students. We don’t have those issues here.

Additionally, network members report that a number of factors inherent in the structure of the Pipeline grant contribute to the regional Pipeline’s success:

- Coordination provided by the Department of Higher Education, including site visits from DHE representatives and statewide meetings that foster cross-fertilization across networks, and
- The external evaluator’s role, including the networks’ submission of standardized reports and the evaluator’s analyses, which contribute to a statewide perspective on STEM issues

Together, these factors grant validity and legitimacy to the network’s undertakings. Berkshire Regional Network members and the greater public at large derive continued inspiration from indications that their efforts are not isolated and limited to the western segment of the Commonwealth, but rather are part of a broader movement to advance STEM agendas on a larger scale.

C. The MetroWest Regional Network

The configuration of the MetroWest regional network has changed over time. Originally, the MetroWest network encapsulated the entire Greater Boston area. That area was large and was populated by many diverse interests, so the network experienced a somewhat difficult start-up. In 2007, a few strong proponents of the network, led by Dr. Timothy Flanagan, President of Framingham State College, advocated that the Greater Boston area be divided into two sections, and the Department of Higher Education concurred. The network was then reconfigured to serve 43 cities and towns in the area west of Boston, and a “re-start” period was launched. A full-time director was hired; the director brought over thirty years of experience with several of the region’s science and technology firms, including Hewlett-Packard and PerkinElmer.

Structure and Major Activities

In 2007, the newly hired director set the network on an initial recruitment and organization-building phase. He was guided by Dr. Flanagan and an informal working group that had been in place since 2003 (actually the first members of the network). Dr. Flanagan publicly articulated the position that as the lead agency for the network, FSC was committed to the network’s mission and operations “for the long haul.” Familiar with the unpredictability of state funding and the Commonwealth’s history of oscillating support to various educational innovations, Dr. Flanagan publicly affirmed the College’s commitment to a regional approach and to the belief that the likelihood of success was greatly enhanced by collaboration between members of the higher education, K-12, business and industry, and economic development communities. He saw the network as one more opportunity to carry out a longstanding belief: “We achieve more by working together than working alone, regardless of how hard we work.” In retrospect, Dr. Flanagan observes that one of the key roles for a lead agency to play in collaborative efforts such as the Pipeline networks is to foster trust between the partners. In particular, he suggests demonstrating that their efforts will not be “flash in the pan,” but rather sustained over time and systematically evaluated to ensure that the most promising practices are supported and integrated into a statewide set of knowledge and practices.

The director reached out to K-12 school systems, including those that had been involved with earlier STEM programs, as well as organizations with an inherent vested interest in advancing a STEM agenda (e.g., chambers of commerce, relevant businesses, and Natick Army Labs, a group that is responsible for STEM advocacy for the Department of Defense across the northeastern section of the U.S.). The overriding objective was to develop a “critical mass,” targeting those initial members’ needs and anticipating that word of the network’s effectiveness would then spread to colleagues and associates.

The director focused as well on developing governance and operational structures for the network. He formed two committees, an executive committee and an advisory board. The executive committee is comprised of some of the more experienced network members; they provide day to day guidance and respond to the director’s requests for advice or counsel. This group meets monthly. The advisory board is the name given to the entire membership. They meet quarterly; meeting venues rotate from one meeting to the next so that members are exposed to one another’s work.⁸ A schedule of regular meetings is published one year in advance. Attendance at quarterly meetings is reportedly fairly good, consistently 25 persons at a minimum and often 35 to 40.⁹ Meetings are planned for not more than one and a half hours, and timeframes are adhered to. Some members have reported that

⁸ The director explained this philosophy as follows: “Moving the meetings around on this quarterly basis to give exposure to other constituencies, I think, helps build some of those relationships and bonds that help bring some of these programs together. It sparks ideas and so on and so on.”

⁹ While the network has grown to include, officially, approximately 50 members, attendance records display a range of participation patterns in meetings: some organizations send more than one representative, while other organizations are members in name only and so do not send any representatives.

they made valuable professional connections at the meetings. The director believes that the regularity and predictability of the executive committee and advisory board meetings have been key to the network's success: "[these characteristics] are what provides the backbone strength of the organization."

After the organizational structures were put in place, the group prepared a long-range plan—a strategic look at how to guide their efforts and projects, primarily focused on teacher professional development. The network is described by the director and others as “a democratic organization.” A democratic process for decision-making is used to address issues ranging from the choices of which proposed projects to pursue, to the determination of agenda items for regular network meetings. The director acknowledges moments in the past when potential projects were nearly rejected by the membership—including projects that have since proven highly effective and positive—but affirms that the value of discussion among the membership outweighs any particular pre-determined outcome.

Key project areas have included: 1) the care and handling of laboratory animals—this is a major field in a region that has significant biotech research and where the need for personnel who can interact with laboratory animals in ways that respect very strict research protocols is high. Projects have been implemented with Norfolk County Agricultural High School, Massachusetts General Hospital, Mass Bay Community College and Tufts Veterinary School; 2) Saturday STEM Academies, a project implemented with Olin College in Needham, giving underserved middle school students in the MetroWest schools exposure to STEM careers and strengthening of academic skills; and 3) contributions to an already extant STEM project—the Leadership Initiatives for Teaching and Technology or LIFT² project¹⁰—via strengthening its engineering career exposure component.

Challenges

Engaging industry representatives in the network has been somewhat challenging. Some network members find that a sluggish economy offers little support for the argument for a long-term investment—that is, improved STEM education will yield a better prepared workforce, but that workforce will not be available for years.

Like other networks, the MetroWest network faces concerns about sustainability. Following the democratic processes in place within the network, the director brought to the membership's attention in 2009 the need for additional funding given declining resources from the state. The director, supported by the executive committee, reported to the membership their ongoing efforts to secure additional funding as well as the need to appeal to the members to contribute funds. Two possible strategies for how to proceed were considered: a) establishing a tiered fee structure whereby organizations with greater ability to pay were assessed higher fees or b) requesting that organizations contribute an undefined amount, taking into account their financial status as well as their perceptions of the value they derive from the network. The advisory board voted, and the vote was nearly unanimous in favor of the latter method on the rationale that organizations would contribute on the basis of what they could afford while retaining a commitment to not forcing anyone out. This decision reflects the network's mentality that “it's more valuable to have them as a part of the network than to establish a strict structure that would exclude them.” The decision also allows for the possibility that some organizations would be in a position to contribute a significant amount, perhaps even more than a dues structure would ever suggest.

Ultimately, the results of the appeal were largely favorable. Approximately 25% of the member organizations stepped up and contributed. (Again, the director notes that this number is somewhat deceptive, given that approximately one-third of the member organizations are members in name only and so were not in attendance when the vote was taken, therefore having no particular buy-in to the approach.) Some of the organizations that

¹⁰ <http://www.mass.edu/forinstitutions/prek16/pipeline0811projects.asp>

would have been expected to afford more did in fact contribute on the high end of targets that were set, while others declined to contribute. “Pleasant surprises,” however, were seen in the form of contributions from school districts who value the network and the benefits they derive from participation in it and somehow found a way to contribute.

Additionally, the network has been pursuing alternative funding sources, including STEM education funds through the Department of Defense/Natick Laboratories for teachers’ professional development programming. The network is also working on collaboration with Framingham State College to lay the groundwork for a program for elementary school teachers to earn a masters degree with a concentration in STEM areas.

Some network members suggest as well the need for a coherent statewide plan or agenda to ensure that networks not only address local needs but also scale up their effective practices. “Everything isn’t local,” said one network member. Some members call for a common agenda endorsed by senior government leaders that would a) include systematized approaches to evaluation in order to assess the effectiveness of the networks’ collective efforts, b) cast and coordinate roles for multiple constituencies in a statewide STEM endeavor and/or c) attribute to STEM a sense of urgency and priority that has been lacking from public debate thus far. Additionally, some call for greater public awareness campaigns, designed to cultivate enthusiasm for STEM career opportunities in Massachusetts and demonstrate linkages between those opportunities and secondary and higher education fields of study.¹¹

Private Sector Involvement

The MetroWest region is populated with a number of life sciences industries, including Perkin-Elmer, a business that plays a key role in the network. As part of the LIFT² project, the firm hosts teachers in their laboratory during the summer and has designated an employee to act as liaison to the network, including participating in the network’s executive committee. The liaison, who had known the director during his recent tenure at the firm, articulates two principal rationales for the company’s commitment to the network:

1. Community outreach: the organization is committed to being a “good member of the community” and supporting science and science education.
2. Workforce development: the company has a particular eye toward establishing relationships with local colleges and universities so as to improve the quality of science course offerings in higher education.

With respect to workforce development, the organization recognizes an imperative to develop a rich pool of local talent given the costs associated with hiring outside of the state and/or the country. The network liaison was recently asked to sit on the Foundation Board for FSU. The Board is in the process of soliciting community support in its efforts to lobby the state for additional funds to revamp their science education program. The liaison commented on these efforts as follows:

Perkin-Elmer wants to be a part of that.... If you have a rich pool of talent right in the local area, that really makes you feel a lot more comfortable about looking at the future, in terms of the types of quality people that we will have in our workforce.

Following the LIFT² model, Perkin-Elmer has developed a well-crafted program to provide local high school teachers with an experience of working in a professional laboratory. Typically, a teacher spends five weeks during the summer participating in hands-on projects and then prepares a presentation for the scientists at Perkin-Elmer,

¹¹ See the Discussion section (below) for a more thorough examination of these ideas.

detailing what they learned and how they plan to apply what they learned in the classroom. Over the past two years, the program was expanded to include a student component: the teacher returned to the laboratory with approximately 15 students for a 1-day laboratory experience, allowing the students to work “at the bench.”

The organization has taken steps to ensure that the program is successful from the perspectives of both Perkin-Elmer and the teachers. Specifically, the selection process for participating teachers focuses on teachers’ experience, skill sets and attitudes. In the spring, teacher candidates are interviewed to determine whether they possess minimal familiarity with the laboratory setting (some prior laboratory experience is required) and whether they demonstrate enthusiasm and motivation to learn. This process helps to ensure that time in the laboratory will be used efficiently, that “They are well prepared before they even walk in the door.”

The liaison describes the program as highly successful, especially with regard to awakening students’ awareness of and interest in STEM careers:

It’s a fascinating opportunity, because in effect we are living in silos. The kids are sitting in class and staring at blackboards or whiteboards or whatever they are now and reading books, we’re in here in the industry developing products and talking to customers ... but isn’t it great that the two groups can actually meet. The best thing is that the kids can actually see all this theoretical science coming to life and understanding that there are people that *make a living out of this* and they have a good time. It is *fun* to do science and this can be your livelihood.... We say, “Here is the stuff you learned in school and now we are going to put it into real life.” ... You can take it from the classroom and say, “OK, you remember this—what you learned in this biology class? Well, here is what we do, and here are these products that we make, and here is how they work for our customers. And when our customers use them, they can develop medicine and so forth to potentially cure diseases and things of that nature. I think it keeps [students] really engaged.

Reflecting on his overall experience with the Pipeline networks, the liaison describes his own deepened awareness of the potential to motivate students and, accordingly, focuses on the need to increase industry’s participation in STEM education efforts:

So I met a lot of good people along the way and really understand that everybody is really committed to bettering the science-related opportunities for our young people, for our students, and getting them more excited about the opportunities in the industry that they could have.... It has really opened my eyes quite a bit, and I have to say over the last few years, seeing what the opportunities are, it wouldn’t it be great if ... we could get more state attention and funding for these types of initiatives? I think the focus needs to be really strong on getting more industrial participation.

Big Picture

The strength of the MetroWest network lies in the passion and commitment of its key members, who for years have been developing working relationships and a shared vision, coupled with a carefully implemented administrative structure designed to educate and inform. After an uncertain start, the network has expanded and thrived, consistently bringing to the table representatives of multiple constituencies who acknowledge their interdependence. The MetroWest regional network encapsulates the “collaborative approach” described in the original RFP perhaps more than the other networks. Truly a “democratic organization,” it is driven by the collective energies of the membership at large, who have crafted a well-reasoned plan and made decisions along the way to ensure its execution. Positioned to negotiate ongoing challenges to sustainability, the network looks to build on its experiences to date, including collaborations with neighboring networks and other partners, in order to

advance the persuasive argument that the region’s education, industry and economic development partners will “achieve more by working together than working alone.”

D. The Northeast Regional Network

UMass Lowell is the lead agency for the Northeast regional network, which is comprised of 44 cities and towns. From the outset, key players adopted a systematic approach to understanding the state of STEM initiatives in the region so that the Pipeline network could complement ongoing efforts effectively, thereby avoiding duplication and addressing real needs. A group of people involved in STEM areas gathered data from across the region, brainstormed options and concurred that their approach to seeking network funding would not revolve around the identification of specific projects, but rather that it would be grounded in a philosophy of empowering teachers. The two-fold goal was to create opportunities for teachers to learn about the STEM education programs in their districts and to reinforce their skills and knowledge in STEM areas so that they could make informed contributions to their districts' STEM planning processes.

Structure and Major Activities

The group that originally undertook a review of STEM opportunities in the region determined that a Fellows program approach would effectively address the intent to build teachers' capacity. Eight school districts participated in a proposal-writing process during 2004 and 2005; they proposed a program whereby teachers would work in teams to analyze their districts' STEM offerings, capabilities and needs and then develop a capstone plan for the district. The project developed a template for the capstone plans, and a district liaison was assigned to work with each team to formulate their capstone plan. Additionally, the proposal called for individual professional development to be provided to each Fellow, one that would be tailored to the Fellow's particular teaching portfolio.

In the words of the Project Manager, the overall goal of the capstone plan was as follows:

...to look at the resources that you have, look at the programs that you had in your district, and really think creatively about what might be good for students as far as trying to interest them in studying STEM subjects for STEM careers, as opposed to just saying, "Oh you know we don't have any money to this kind of thing." [Instead, it was] really to try to think of things that might be implemented or that they themselves could implement in their classrooms, to try to make a difference in the STEM preparation and interest of their students.

The first round of funding (2005-2007) for the STEM Fellows project funded 40 teachers (middle and high school STEM teachers) from the 8 districts that had been involved in the planning process. The project funded team time to work on capstone plans, 40 hours of individual professional development and four full-day workshops facilitated by STEM experts that were focused on STEM content, careers and cutting-edge technologies. The program culminated with a full-day presentation by the Fellows, showcasing their individual professional development and capstone plans.

A second round of funding (2007-2009) supported 15 of the original cohort of Fellows, now called STEM Leaders, and a new cohort of 35 Fellows from an additional 7 districts. With this new grant, the networks' advisory committee decided to limit recruitment to teams of middle school teachers rather than high school teachers. Mirroring the initial grant, the new district teams participated in individual professional development (30 hours), formulated capstone plans for their district, and participated in four full-day workshops. The 15 STEM Leaders worked with the new Fellows teams to provide guidance on their capstone plans, participated in individual professional development on a space-available basis and took part in teacher leadership training.

Both sets of participants provided uniformly positive feedback on the program. Participants appreciated not only the customized professional development but also the opportunity to interact with representatives from the school district and to learn about the extent and depth of STEM instruction across the district. For example, teachers had the opportunity to work with teachers from other grades and also to sit with administrators and look at factors such as Advanced Placement offerings, enrollment in AP courses, STEM course enrollment by gender and patterns of SAT scores. Teachers described these experiences as “eye-opening,” allowing them to understand the expectations and required preparation for their students across the spectrum. Leaders identified the skills and knowledge they acquired through the teacher leadership training component as valuable tools for carrying out the network project and for advancing a STEM agenda across the district. Many participants—both Fellows and Leaders—remarked that the opportunities provided under the grant were the “best professional development” of their careers. One of the most popular activities was an online course developed by UMass Lowell, “Engineering for Teachers,” which was offered to the second cohort of participants. The University arranged for participants to earn college credits for the course, which created, in the words of the project manager, a “win-win” situation. The content was described by teachers as very challenging, and teachers are reported to have worked extremely hard. They reported being equipped to apply much of the learning to their classrooms, and some districts now offer engineering components in their middle school curricula as a result of this course and other initiatives like it.

In contrast to other regions, there was not an already existing structure for the Northeast constituencies to build on when beginning their Pipeline work. A part-time project manager position was created, and three UMass Lowell faculty members contributed time and attention to developing the network: the dean of the Graduate School of Education; the Howard Foley Professor of Workforce Development; and the director of the Office of School Partnerships, who served as co-director of the Northeast Network. An advisory board was established that met three to four times a year during the grant periods; the board and interested districts continue to meet even in the absence of funding.¹² The board is comprised of diverse constituencies, including higher education (community colleges demonstrate notably high levels of involvement), all the K-12 districts that had Fellows and Leaders participating in the project, the Workforce Investment Board, and a variety of industry representatives, including Raytheon as the most active partner.

Additionally, as suggested above, interest in STEM issues in the region is high and accordingly, some districts that were not part of the original project continue to send representatives to meetings in order to keep apprised of developments in the STEM fields. Other groups on the UMass Lowell campus, such as the Engineering, Nanotechnology and Science Departments also continue to attend meetings and/or be visible in the STEM community, indicating further the degree of STEM-related activity and interest in the Northeast region. Attendance at regular quarterly meetings generally numbers approximately 20 to 25 people. Meeting venues rotate from one meeting to the next, so that ownership and leadership are shared among all the network members. The manager explained this philosophy as follows: “We don’t want to have ownership of the whole project. We felt like this was something that was supposed to be collaborative and we made it that way as much as we could.”

Challenges

Looking back over the past few years, the manager identified a few lessons learned to guide similar initiatives in the future. As noted above, the organizers of the Northeast Pipeline network did not inherit a structure or a legacy of partners who had shared experiences and deep working relationships with one another. Rather, the manager said, “We started from nothing.... so we sort of built it from the ground up.” While this context offered great potential for STEM programming efforts, the time commitments needed to build a network “from the ground up” and support its growth were substantial. The project was not staffed by a full-time position, however, and in

¹² Some alternative funding has been secured to support projects that evolved from the initial Pipeline activities; the intent is not only to support the continued activity but also to nurture the interest in STEM offerings that some districts demonstrate.

retrospect, a full-time role would have been beneficial. (The manager works with a number of related initiatives and so is immersed in the region and various partners' efforts to address STEM education, but the manager's level of effort for the Pipeline is only part-time.) The considerable set of demands, including not only the day-to-day organizing and management responsibilities but also tasks such as materials development, website maintenance and even direct support to the district teams, would easily comprise a full-time position.

To a lesser extent, the program's shift in emphasis from high school (the first round of funding) to middle school (the second round of funding) reflects a response to certain challenges; in particular, professional development options needed to be carefully tailored to align with high school teachers' proficiency in the content areas. Additionally, the shift reflected a belief that the project would be more likely to impact student interest in STEM by focusing on the middle school population, assuming that high school students would be more likely to have already made decisions about their academic and professional futures.

Private Sector Involvement

The Northeast regional network has benefited from involvement from some industries in the region. Industries have provided expertise and services for teachers and their district counterparts by, for example, participating in advisory board meetings. Industry representatives have also served as speakers for STEM Fellows' and Leaders' events, presenting on topics such as their group's involvement in STEM education and/or current applications of cutting-edge technologies. The motivation for private sector involvement in the Pipeline is two-fold: a desire to be seen as a "good neighbor" and a need to contribute to the development of a highly skilled and STEM-literate local workforce.

Big Picture

Participants' favorable response to the project is largely attributable to the sense of empowerment that the project supported. High-quality, customized professional development was integrated into a team structure and collaborative decision-making process, whereby a district liaison was charged with bringing ideas to the administration. Reflecting on the powerful messages that this approach communicated to teachers, the project manager commented:

Teachers were empowered to do something without it being dictated by their administration or their principals. I think that was really powerful and fulfilling.... It was distributed leadership—each of the constituencies had representations, especially the school folks.... You can have teams of teachers ... but if there is no administrator or responsible party, someone who is going to say "this is important" and bring it to the powers that be, what's the point?

Many Pipeline participants proposed new initiatives and later developed those plans with administrators, which culminated in new programs such as math or science coaching or strategies to enhance communication and planning between middle and high school teachers. Interest in STEM in the region is still notable; new districts have expressed interest in participating in Fellows or Leaders programs, and they continue to attend meetings to keep apprised of STEM developments in the region. The project manager anticipates that future initiatives could reasonably target the upper elementary grades as well as middle school, citing the need to build students' mathematics skills so that they are prepared for science and advanced mathematics courses later on and to address a perceived pattern of declining science instructional time as a result of increased mathematics and literacy instruction at the elementary levels.

Built “from the ground up,” the Northeast regional network demonstrates an approach to capacity-building that is likely replicable in other contexts. Independent of specific projects or programs, the approach hinges on clear goal-setting and careful facilitation of processes and experiences that foster a district-wide perspective on STEM education.

IV. Discussion

This section provides a synthesis of the reflections offered in the preceding pages, as well as discussion of issues that study participants raised but that extend beyond the parameters of a particular region.

A. Supporting Factors: Lessons Learned

Various factors are widely credited as supports to the networks' success. These factors include characteristics of the grant itself as well as the configuration of the roles played by key partners. Overall, the regional approach to identifying and addressing problems is seen as an effective strategy for mobilizing resources, building relationships and fostering sustainability.

The networks achieved credibility and legitimacy because the goal of educational innovation was linked with the promise of economic development.

Launched and recapitalized under Massachusetts 2003 and 2006 Economic Stimulus legislation and administered by the Massachusetts Board of Higher Education, the Pipeline fund catalyzed partnerships between multiple constituencies in the form of regional networks. Challenges that in the past have plagued broad-based educational initiatives were mitigated by the structural conditions of the grant:

- a) Housing the initiative in the Board of Higher Education helped to minimize the effects of a historical cultural disjunction between the private sector and the K-12 arena. That is, in contrast to prior efforts that had linked education and economic development through the K-12 system, the Pipeline networks were led by colleges and universities rather than school districts. Casting the Board of Higher Education as the principal interlocutor between the education sector and the private sector contributed to a growing public awareness of the linkages between the two sectors. Industry was more inclined to participate in a broad-based conversation that was led by individuals with recognized expertise in STEM content areas than with leaders from the K-12 arena, and higher education representatives brought to the table an organizational structure and set of resources that accommodated the processes of developing vision and goals on a regional scale.
- b) Mandating the participation of business and industry representatives communicated the vision that workforce development would be effectively achieved through a collaborative effort that harnessed the business community's inherent interest in the "products" of their local educational systems.

Over time networks developed a shared set of assumptions and common language that defused longstanding debates over the goals of education (e.g. to produce citizens or workers or consumers) and instead forged common ground. While networks largely cite recruiting and sustaining industry participation as an ongoing challenge, the Pipeline network grants helped to "tip the balance" so that business and education increasingly recognize their shared interests in an agenda that centers on a technologically-literate, highly-skilled citizenry-workforce.

The regional approach to educational innovation and economic development fostered collaborative relationships, which members cite as significant benefits of the Pipeline networks and a key to the sustainability of efforts.

The grant was structured so that multiple stakeholders would identify and address the needs of their particular region. This approach is largely perceived to have been effective, not only because it acknowledges that “one size does not fit all” but also because it fostered dialogue about STEM goals.

Most networks did not execute a comprehensive needs assessment *per se*, but they all launched exploratory conversations that have been sustained over time, *even without funding* in some cases, to stay abreast of evolving needs and develop responses. Those networks that shared some history were somewhat better positioned to craft these conversations and maintain a focus on needs rather than programs, but all networks have developed a habit of taking the pulse of their region’s strengths and needs.

The relationships formed under the aegis of the networks have in many cases contributed to a climate in which principal stakeholders in STEM arenas have developed high levels of comfort and familiarity with one another. In many instances they have a track record of pooling their resources—staffing, intellectual and financial resources—to create products and services that surpass the potential of each member organization acting alone.

The network members’ cumulative experience has led to the establishment of norms of collaboration rather than competition, such that members share information easily and work toward a shared goal instead of carving out individual “territories.”

The existence of a longstanding group of professional collaborators is also beneficial to the extent that

- a) more experienced colleagues are readily available to mentor younger and more junior colleagues through routine interactions;
- b) individuals who relocate to a new area are received by a professional community that welcomes them, in contrast to other communities that may be perceived to be exclusive or “hard to break into;” and
- c) because partners do not work in isolation, they have ready access to funders or donors who are positioned to help transform their dreams into reality.

Ideas are generated through sustained dialogue among partners, which helps ensure that visionaries and managers share a common understanding of the needs and potential solutions.

Some employees within a system (local school district or college or university) will tend to prefer not to relocate when possible. Some of these individuals will change positions within their organization but still remain central to STEM work. The regional network structure serves as a mechanism both to a) keep these individuals connected and focused on a common goal and b) preserve the historical knowledge that resides in their individual and collective experiences and that would be lost if a move to a different position removed them from ongoing professional dialogue and exchanges.

- **The roles played by the Department of Higher Education and the external evaluator reinforced the networks and supported the advancement of STEM agendas. An integrated model that maximized the strengths of the Department and the evaluator fostered cross-fertilization among the regions and contributed to statewide capacity-building.**

The networks were strengthened by the coordinating role played by the Department of Higher Education, including site visits from DHE representatives and statewide meetings that brought leaders of all networks together. Statewide meetings convened by the Department kept the regions abreast of policy developments and thereby prepared the networks to play important roles in emerging STEM agendas. Additionally, the meetings were structured so that networks examined challenges and emerging solutions, learning from one another's experiences and adopting and adapting approaches and practices that they would otherwise not have considered.

The external evaluator collaborated closely with the Department, participating in statewide meetings and maintaining ongoing communication with the networks. The evaluator's role was crafted such that data analyses and summaries of the networks' standardized reports helped to foster a statewide perspective on STEM issues and strengthened network leaders' and members' awareness of and responsiveness to the needs, and strengths, of their own contexts. Viewed as a partner in the work, the evaluator supported and informed the continued evolution of the initiative and provided the tools needed for statewide dialogue and continued capacity-building.

This model granted validity and legitimacy to the networks' undertakings. Network members derived continued inspiration from indications that their efforts were not isolated and limited to one segment of the Commonwealth, but rather were part of a broader movement to advance STEM agendas on a larger scale.

B. Promising Practices

Formal organizational structures and processes differ somewhat between networks; largely, the networks are described as relationships, collaborations, or connections between people and institutions. Typically, informants report some difficulty in identifying exactly what the network is and is not, but overall they describe a commitment to share resources in the pursuit of a common goal, which network members believe they are more likely to attain by collaborating than by working independently. Promising practices are grouped below under descriptive sub-headings.

Passion and effective management are key to recruiting and sustaining participation.

Networks demonstrate a strong combination of visionary leadership and effective, thoughtful management practices. Overall, the networks are highly participatory and reflect democratic principles and practices. Network directors and others sought broad-based participation from a cross-section of constituencies and created a framework or rationale to guide decision making. Internal decision-making procedures varied across networks, ranging from individual authority to voting to consensus, but all networks considered whether potential options aligned with their framework.

Networks recruited and worked to retain a broad cross-section of representatives from various sectors to play leadership roles in the network (e.g., by sitting on steering committees and advisory boards). Some informants expressly recruited people who are *passionate* about STEM and STEM education, reasoning not only that their ideas would be valuable drivers in programming decisions but also that in the face of limited resources and competing demands, these passionate individuals would be most likely to offer their time and attention.

Some network directors adopted a proactive stance toward managing the membership. In some cases, directors monitored meeting attendance and asked those with sporadic attendance records if they wanted to continue to attend or to designate an alternate.

Most directors focused on employing effective meeting facilitation strategies. They were acutely aware of a need to respect members' time commitments, and used strategies designed to maximize the utility of meetings, such as clear agendas, which were distributed in advance; strict adherence to timeframes; and incorporation of advisory board input into agendas. Also, some networks rotate their meeting venues, so that members are exposed to one another's work and share a sense of ownership about the initiative, rather than routinely conducting the meetings at the lead agency's offices.

Directors describe a need for good administrative practices within the network, including making sure that administrative systems between different organizations are reconciled so that day to day tasks are carried out efficiently (e.g., getting invoices paid without undue delay). A full-time director position is a valuable component of most networks' operating structure. The value of the full-time commitment is two-fold: to articulate the message that the work of the network is a high priority and to ensure that due diligence is granted to the necessary aspects of network maintenance (e.g., communication, website updates). One study participant described the necessity of a full-time position as follows:

A full-time position is needed. It says that this is serious. We have complicated, difficult work to do and it's going to take a lot of energy to address problems or issues that we've been trying to address over a period of time, but not very successfully.... If the position is not full-time, in great likelihood the network is not going to be taken very seriously by serious partners. They just won't believe that you can accomplish very much and it's just an initial signal that this is more like a peripheral effort than something that people feel is mission-critical.

Effective school-business partnerships require time, personnel and careful planning.

Network members described a process of continually exploring the inherent connections between the private sector and K-16 education. Some industry representatives expressed a sense of urgency about the need to "grow their own" local workforce, while others expressed a commitment to "being a good neighbor." The study identifies a few factors that contribute to successful collaborations between education and industry:

- A point person: Networks thrive when business partners assign a liaison—an individual whose regular job responsibilities include attending to the work of the partnership, being readily available and developing a cumulative understanding of the region over time.
- A "do your homework" attitude: Industries respond best to inquiries from individuals who are familiar with their organization and its priorities, and who have articulated a clear role for them to fill. In some instances networks identify a key employee or employee group of interest within an organization before approaching the CEO with an inquiry.
- An effort to plan and carefully structure the experiences of school and business representatives together. In cases where internships or other collaborative efforts are undertaken, industry representatives appreciate efforts to minimize disruption and maximize anticipated benefits (e.g., some organizations have developed selection criteria and other protocols to identify appropriate candidates for their internship experiences).

C. Challenges and Potential Solutions

Challenges experienced by the networks encompass a range of areas. For the purposes of this report, discussion of challenges and networks' approaches to them is organized by four topic areas: participation of the business community; tension between planning and spontaneity; sustainability of efforts beyond funding; and assessing impact and moving toward scale-up.

Securing the participation of business and industry in the networks has been and remains an ongoing challenge: revised approaches to planning and evaluation are suggested.

While the networks demonstrate a range of success in recruiting and sustaining businesses, most acknowledge that an unsteady economic landscape inhibits rather than enhances the likelihood of collaboration. Revenues are down, capital outlays have diminished and in-kind contributions of time and labor are in many cases hard to make. In addition to the practices noted above, networks continue to explore approaches to fostering mutually beneficial partnerships with their neighbors in the private sector. Some study participants believe that STEM efforts to date have not communicated the “sense of urgency” that business leaders typically bring to problems. Therefore, these leaders are in many cases left to conclude that involvement in STEM efforts as they are currently organized would not be a productive use of their time. These study participants call for a systematic approach to planning and evaluating STEM initiatives across the state. They perceive a need for a common agenda that articulates shared goals, establishes procedures to measure progress toward goals and demonstrates results. In particular, some participants call for a statewide plan that is developed in partnership with the business community and that includes a coherent approach to evaluation. Some participants call for a plan that invites and coordinates roles for multiple constituencies, including the Department of Higher Education, the Department of Elementary and Secondary Education, the regional employment boards, and workforce development boards. Some participants call for an expanded role for the Department of Economic Development in identifying the state's priorities, given its natural affinity with business. One participant commented:

We are going to need ... the Department of Economic Development to be more directly involved [in identifying priorities for the state] because they are the ones that are talking to the business community on a daily basis, and if we really want to engage the business community we need someone—some intermediary that they know, that they talk to—who can be at the table shaping goals and discussions.

Some study participants cite the business community's inherent interest in results; these participants perceive a need to distinguish STEM programs that are more likely to be effective from programs that are less likely to be effective. One participant commented:

I think one of the things that is going to be essential for really engaging the business community effectively going forward is being able to demonstrate results, and for the state to be able to demonstrate that if there are ten good approaches to teaching professional development, and if, after three or four years, everybody is not producing the same results, then—given scarce resources—there's now a basis for saying that we are going to have to cut the funding to programs A, B, and C that are getting fairly minimal results and instead shift resources to programs that are really getting substantial results. Those are the kinds of decisions that they have to make weekly, monthly, year in and year out [in the private sector]. What gets resources? Where is the evidence taking us?

Some participants observed that, from the business perspective, evidence of very limited impact is not convincing. For some business leaders, programs that effect change in a single classroom, a single school or even multiple

schools in a district are not large enough to warrant the time and labor commitment requested. Rather, some study participants emphasize the need for a systematic approach to comparing programs that assesses their impact and makes decisions about which programs to expand. One participant commented:

Business is used to seeing results. Businesses will be interested in data that suggests how to scale up, how to move from individual projects to a broader scale.... [W]e ought to be able to come up with five common formats for evaluating programs... We can come up with a common format for evaluating after-school STEM programs. We can come up with a common format for evaluating programs that are reaching out to women and unrepresented minorities. We can come up with one for teacher professional development, etc. That will provide us some really crucial information for comparing programs and seeing what is actually working and then helping to guide decisions about the things that need to be scaled and regionalized. In the same way I think it can say, given these goals and these strategies, we're now going to bring in some national foundations and local foundations and say, "Here is the commitment we will make to you to see that these programs, which we have vetted, are the kinds of programs that we think, with your support, can go to scale and really make an impact and therefore become national models. So I think that would be very appealing to the business community and to local and national foundations.

Additionally, some participants have found that the business community does not necessarily possess the capability to project future workforce needs; these participants suggest a role for the state in helping to make these projections.

These challenges notwithstanding, participants reported overall that the business and education sectors now share more common ground than ever before, having begun to craft reciprocal goals and strategies in support of a shared vision.

Planning vs. spontaneity: Planning grants facilitate sustained interaction among network members and their continued capacity to generate ideas

Some network members described a tension inherent in the networks' utilization of an advisory board structure. That is, in some cases, advisory board members were brought on after a network's original proposal had been submitted. In other cases, the board's interest may have shifted over time to address challenges or opportunities that did not figure in the proposal. The tension that some members described revolves around a healthy respect for accountability (planning and measuring progress against a plan) as well as a desire to nurture the spontaneous generation of ideas within the advisory board and the larger network membership. More broadly, some members describe the tension as a natural disjunction between top-down and bottom-up approaches to program design.

Study participants suggest that planning grants (to help ensure that meetings are held regularly, thereby facilitating routine sharing of ideas among all constituencies) and/or other funding mechanisms that support emergent designs accommodate the constraints and possibilities of a given network's situation.

Sustainability is one element of an ongoing conversation.

Networks have adopted varying approaches to ensuring that their efforts continue beyond the life of the grant. Largely, they report that considerations of long-term sustainability have become integrated into their routine, ongoing conversations. Against this backdrop, a few key strategies are employed:

- Network members keep themselves apprised of upcoming opportunities and reflect on them as part of their regularly scheduled meetings. They assess in advance whether options such as

various funding streams, solicitations, or potential projects align with the direction the group is pursuing.

- Some networks invite their local evaluator to participate in routine meetings to help the group assess what works and what does not and to incorporate that perspective into decision-making.
- In the face of declining resources, one network appealed to members, many of whom made financial contributions.

How to prioritize: calls for a statewide agenda (“Everything isn’t local”) and scale-up

Given the broad range of needs within each region, some participants describe the potential to be engaged in multiple activities without demonstrated evidence of effectiveness.

One set of proposed solutions is to capture the needs of the end-users (e.g., colleges who train students and businesses who will hire their graduates) and communicate those needs at the regional and statewide levels. Some participants believe that efforts such as the STEM Pipeline Indicators framework¹³ will help to convey a sense of urgency about particular needs within a region.

Some networks describe an explicit attempt to maximize the impact of their individual programs. In these instances the statewide network forum has helped educators and business representatives move from a segmented to a more comprehensive approach; that is, they situate their individual efforts within a broader conceptual framework and set of goals, such as making high school students aware of STEM opportunities in their local areas.

As noted above, some network members suggest the need for a coherent statewide plan or agenda to ensure that networks not only address local needs but also that their effective practices be replicated on a broader scale. “Everything isn’t local,” said one network member.

Additionally, some network members point to a need for increased opportunity to share practices, thereby increasing networks’ capacity to identify and address STEM needs in their regions and also aligning efforts statewide.

D. Implications

What does the experience of Pipeline networks suggest for policy-makers, legislators, STEM experts, educators, business representatives or others who may wish to replicate similar models? Which factors would enhance the likelihood that the lessons articulated in this study could be generalized to other settings and/or translated into practice?

¹³<http://dl.dropbox.com/u/3561120/MASSIP%202009%20Full%20Report%2012-16-09.pdf>

“Amplify the message”: Increase public awareness of the needs and opportunities in all STEM areas

The most robust theme to emerge from this study is the call to increase public awareness of the needs and opportunities that present themselves in a variety of STEM areas. The phrase “amplify the message” was used by a number of speakers to describe a need to increase the visibility of the work that has been undertaken thus far by the regional networks and also to communicate the message that STEM issues are a high priority in each region and across the state. Other phrases typically used include the need to create a “regular drumbeat” and the need to cast STEM issues as “mission-critical.” A variety of strategies to “amplify the message” were suggested by participants, including:

- Change the nomenclature from “STEM” to a more recognized word or phrase.
- Accord recognition to local leaders in the field (e.g., create various STEM awards and give them periodically to local leaders who have somehow made a difference in STEM fields in the region).
- Use tools such as op-ed pieces in local newspapers.
- Create regional scorecards that demonstrate areas of need and are tied to an annual report that proposes recommendations.
- Use frameworks such as the STEM Indicators that help to create a systemic or comprehensive understanding of the needs.
- Increase media coverage of successful collaborations with the private sector.
- Develop public service announcements that describe the exciting career opportunities available in each region and the steps to necessary preparation.
- Assign senior-level government leaders (e.g., secretariat) to STEM planning tasks, including the crafting of a coherent statewide STEM plan.
- Promote and support science instruction in the elementary grades, understanding that mathematics and literacy tend to be prioritized in elementary classrooms and the time allocated to science instruction may be reduced proportionally.
- Encourage participation in professional associations and presentations at large-scale conferences, to “get the word out” about STEM activity in Massachusetts.
- Develop “planning grants” funding mechanisms to allow for spontaneity, continued meetings of network members and an increasing track record of success.
- Shape an expanded role for the Department of Higher Education to include capacity-building for regional STEM leaders so that they are equipped to carry the agenda forward. Invite consultants with relevant expertise to help expand regional leaders’ skills sets and knowledge base so that they are positioned to a) identify the needs in their region and pursue appropriate responses to challenges, and b) develop sustainability plans that will ensure long-term survival and impact of their efforts.

Build on the legacy of regional networks’ shared history: Articulate a statewide agenda, craft roles for multiple constituencies, and establish a systematic approach to evaluating impact and scaling up successes.

A secondary theme to emerge from the study is the very strong legacy of network members’ history of planning and collaboration. The regional networks exist now as collaborations between stakeholders who share common goals and interests. After years of collaboration, members of the regional networks now enjoy trusting and mutually beneficial relationships; their organizational practices are sound and efficient and reflective of democratic principles. The study reveals calls for a coherent, coordinated statewide plan that articulates broad goals and espouses systematic approaches to measuring progress toward those goals. The regional networks are poised to be vital partners in the next phases of STEM development in the Commonwealth. The study suggests

that one of the key legacies of the Pipeline grant is that it nurtured sustained conversation about STEM issues within and, to a lesser extent, across, the regions. As discussed in the preceding pages, sustainability has largely become a taken-for-granted component of the ongoing dialogues within regions. The 2006 Call for Proposals anticipated that "...by bringing together key regional stakeholders, the Networks provide a vehicle to address and communicate topics of regional concern such as industry training, grant opportunities and events." Having fulfilled this promise, the regional Pipeline networks are now positioned to be key vehicles for the next phases of continued STEM conversation.

Appendix A: Networks' Membership Lists

Appendix A

Berkshire PreK-16 Regional Network Advisory Board

Monica Joslin
Dean of Academic Affairs

Lisa Provencher
Berkshire STEM Coordinator

James E. Montepare
Superintendent, North Adams Public
Schools

Ellen Barber
Education Department, MCLA

Adrienne Wootters
Physics Department, MCLA

Charles Kaminski
Dean of Business, Science & Technology,
BCC

Julie M. Hannum
Director, Berkshire Tech Prep Consortium

Barbara Malkas
Deputy Superintendent Pittsfield Public
Schools

Michael Supranowicz
President/CEO, Berkshire Chamber of
Commerce

Chris Malumphy
General Dynamics - AIS

Heather Shogry
Youth Director, Berkshire County Regional
Employment Board

Curtis Asch
Berkshire Arts and Technology Charter
Public School

Pam Malumphy
Massachusetts Office of Business
Development

Jane Burke
Flying Cloud Institute

Paul O'Brien
Southern Berkshire School District

CENTRAL MA STEM PIPELINE NETWORK PARTNERS (10/7/10)

The following is the listing of the Advisory Board members representing:

	Partner Name	Title
Abbott Laboratories	Ms. Kathleen Mitchell	Director, Biologics Manufacturing
Anna Maria College	Ms. Joanne McDonnell	Education Department Faculty
AstraZeneca	TBD	
Blackstone Valley Chamber of Commerce		
Education Foundation	Ms. Susan Gately	Director
Central MA Regional Employment Board	Ms. Lisa Derby Oden	Director STEMPower
Coghlin Electrical Contractors, Inc.	Mr. Edwin B. Coghlin, Jr.	Treasurer/Chairman
Colleges of Worcester Consortium	Ms. Pam Boisvert	Vice President
Cummings School of Veterinary Medicine, Tufts University	Dr. Deborah Kochevar	Dean
Cummings School of Veterinary Medicine, Tufts University	Ms. Linette Scibelli	
EcoTarium	Mr. Steve Pitcher	CEO
EMC	Ms. Victoria Grisanti	Manager of Community Involvement
Hanover Insurance Group	David Trigo	Manager
Intel Corporation	Mr. Robert W. Richardson	East Coast Education Manager
Massachusetts State Legislature	Rep. Karyn Polito	Representative
Quinsigamond Community College	Ms. Carol King	Director, Mass TEC
Spirit of Knowledge Charter School	Dr. Julia Sigalovsky	Executive Director
Worcester State College	Dr. Douglas Dawson	Chair, Education Department
Worcester Polytechnic Institute	Dr. Martha Cyr	Director, K-12 Outreach
Worcester Public Schools	Ms. Kathy Berube	Science Liaison
University of Massachusetts Medical School	Ms. Sandra Mayrand	Director, Central MA STEM Pipeline Network
University of Massachusetts Medical School	Ms. Karin Spahl	Science Coordinator

University of Massachusetts Medical School

Mr. James Leary

Vice Chancellor for Government and
Community Relations

**The following is the listing of the
Coordinating Council members
representing:**

Blackstone Valley Education Foundation
(representing 8 south county districts)
Quinsigamond Community College

Ms.. Susan Gately
Ms. Kathy Rentsch

Director
Dean, Business and Technology
Director, Regional Science Resource
Center

Regional Science Resource Center, UMMS
Central Massachusetts Curriculum Coordinators'
Network (65 districts)
Leominster Public Schools
Fitchburg Public Schools
Intel
Lunenburg Public Schools
Shrewsbury Public Schools
Worcester Polytechnic Institute
Worcester Public Schools
Worcester Public Schools
Worcester Public Schools

Ms. Sandra. Mayrand
Ms. Wendy Cleaves
Ms. Laureen Cipolla
Ms. Eileen Spinney
Mr. Robert Richardson
Ms. Karen Martin
Ms. Pam Pointus
Dr. Martha Cyr
Ms. Kathy Berube
Mr. Daniel Case
Ms. Louise Clarke

Facilitator
Interim Director of Curriculum
Director of Curriculum
East Coast Education Manager
Director of Curriculum Development
Middle School Science Coordinator
Director, K-12 Outreach
K-12 Science Liaison
K-12 Mathematics Liaison
Grants Coordinator

Other Key Stakeholders as Partners

Higher Education

Colleges of the Worcester Consortium
Fitchburg State College
Fitchburg State College
Mount Wachusett Community College
Mount Wachusett Community College
Worcester State College

Mr. Mark Bilotta
Dr. Chris Cratsley
Karen Frank Mays
Mr. Joseph Stiso
Ms. Pati Gregson
Dr. Elaine Tateronis

CEO
Graduate Program Chair in Biology
Director, Grant Development
Director, Grant Development
Vice President, Access and Transition
Education Chair

Worcester State College

Dr. Ray Lewis

Assistant Professor

Network/Programs

Worcester Regional Science and Engineering Fair
Board (12 districts)
Central MA Curriculum Coordinators Network
AP Networks

Ms. Nancy Degon
Wendy Cleaves
Karin Spahl

Chair
Coordinator
Coordinator

Non-Profit Organizations

Bi-County Collaborative
Broad Meadow Brook Conservation Center and
Wildlife Sanctuary
Catch the Science Bug
Massachusetts State Science and Engineering
Fair, Inc.
MassMEP
Pride Productions, Inc.
Massachusetts Academy of Mathematics and
Science, WPI

Mary Jo Jones
Ms. Deb Cary
Ms. Kim Bent
Cora Beth Abel
Ms. Katie Mahoney
Mr. Ernie Floyd
Ms. Jacklyn Bonneau

Professional Development Consultant
Executive Director
President
Executive Director
Associate Director
President
Teacher

Participating School Districts

Acton-Boxborough Public Schools
Ashburnham-Westminster Regional School District
Ashland Public Schools
Bay Path Regional High School
Blackstone-Millville Regional School District
Clinton Public Schools
Douglas Public Schools
Fitchburg Public Schools
Leominster Public Schools

Ms. Susan Horn
Ms. Jana Harrison
Dr. Kay Wood
Ms. Sylvia Murphey
Ms. Pauline Allaire
Mr. Terry Ingano
Ms. Beverly Bachelder
Ms. Eileen Spinney
Ms. Laureen Cipolla

Assistant Superintendent
Grant Coordinator
Assistant Superintendent
Science Teacher
Curriculum Coordinator
Superintendent
Principal
Technology Coordinator
Interim Director of Curriculum

Lunenburg Public Schools	Ms. Karen Martin	Director of Curriculum Development
Mendon – Upton Regional School District	Ms. Melissa P. Earls	Assistant Superintendent
Nashoba Regional School District	TBD	Curriculum Director
Northbridge Public Schools	Ms. Gail Arsenault	Curriculum Director
Shrewsbury Public Schools	Ms. Pam Pointus	Science Coordinator
Spencer – East Brookfield Regional School District	Mr. Matthew Bolduc	Curriculum Coordinator
The Learning Center, Framingham	Ms. Amanda Clements	Teacher
Westborough Public Schools	Ms. Lisa Greenwald	Middle school teacher
Winchendon Public Schools	Ms. Valerie Miller	Director, Instruction Services
Worcester Public Schools	Mr. Kathy Berube	K-12 Science Liaison
Worcester Public Schools	Dr. Melinda Boone	Superintendent
Worcester Public Schools	Mr. Daniel Case	K-12 Mathematics Liaison
Worcester Public Schools	Ms. Louise Clarke	Grants Coordinator
Worcester Public Schools	Mr. Dennis Ferrante	Director, Adult Education
Diocese of Worcester, Catholic Schools Office	Dr. Delma Josephson	Superintendent

10/7/10

MetroWest Network

Organization	Representative
ACCEPT Collaborative	Susan Rees
Acton-Boxborough Regional Schools	Susan Horn
AMSA Charter School	
Ashland PS	Ann Dargaon, Cathy Stickney
AstraZeneca	John Hennesey, Gail Cohen
Concord-Carlisle Regional Schools	Diane Kablik
Dean College	Melissa Read, Paula Rooney, Amy Matten
Dover-Sherborn Schools	Deb Reinemann
Framingham PS	Christine Tyrie, Beverly Hugo
Framingham State College	Tim Flanagan, Linda Vaden-Goad, Pat Ruane
Genzyme	Jeff Kablik
Holliston PS	Patricia Rourke
Hopedale PS	Coleen Collette, Ann LaBrode
Hopkinton PS	Mary Colombo, Robert Berlo
Keefe Tech HS	Jim Lynch, Shannon Snow
Marlboro PS	Bill Rigney, Sandra Delaney
Marlborough Chamber of Commerce	Susanne Leeber
Mass Assoc of Vocational Administrators	Peter Dewar
Mass Bay Community College	Linda Grisham, Carole Joseph
Mass General Hospital	Steve Niemi, Angela Howard
MASSBIOED Foundation	Suzanne Grillo, Lance Hartford
McAuliffe Challenger Learning Center	Mary Liscombe, Nanci Goguen
Metro S/W Regional Employment Bd	Jim Stanton
MetroWest 495 Corridor Partnership	Paul Matthews
MetroWest Chamber of Commerce	
Milford Area Chamber of Commerce	Barry Feingold
Milford PS	Kathy Shea
Millis Public Schools	Nancy Gustafson
	Donna Bulger, LeeAnn Barkhouse, Colleen Cathcart
US Army Natick Soldier RD&E Center (NSRDEC)	
US Army Research Institute of Environmental Medicine (ARIEM)	
Natick PS	Karen Leduc
Needham PS	Dan Gutekanst, Terry Duggan
Norfolk Agr. HS	Mike McFarland, Suzzane Green
Norwood Public Schools	Alex Wyeth
NSTAR	Mary McCarthy
Olin College of Engineering	Rick Miller, Joanne Kossuth
PerkinElmer	Jeff Killian, Dan Marshak, Paul Scott
Raytheon Corp.	John Letendre
Regis College	Walt Horner, Tom Pistorino
Sen. Spilka's Office	Sarah Blodgett
Tetra Tech Rizzo	Rick Moore
The DOME Foundation	Larisa Schelkin
The Learning Curve Consortium	Romeo Marquis, John Piso
Towerwall, Inc	Michelle Drolet
Tufts Veterinary School	Linette Scibelli
Independent Consultant	Pat Hamblett

Spirit Charter School
Independent Consultant
Hefferin Jones
Independent Consultant
CAPE Consulting

Julia Sigalovsky
Bill Wolfson
Connie Anick
Ronit Carter
Charlie Martin

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Appendix B: Networks' Highlights

Appendix B

Berkshire

Network Highlights

Maintained and updated a listserv that is capable of tracking the number of views, and links clicked through - giving us insight into who is interested in the STEM Pipeline (700+ STEM educators are on the listserv)

Connected with local school districts to set up in-service professional development workshops with 9 schools covering four school districts for fall 2009 and spring 2010

Steering committee meetings: June 16, 2010 and September 15, 2010.

Engaged local students, family and community members in STEM related activities. The Starlab was used by the Berkshire Museum (February vacation) and the Boston Children's Museum (July) and an approximately 3,000 people visited the Starlab.

Central Network

Network Highlights

The most important work of the Network has been to develop so that it and the goals of its partner organizations are aligned and working in concert. Year to year and month to month the impact of the Network broadens. Its most important long-term accomplishment to date is developing strong linkages to other like-minded educational stakeholders. Business especially has developed closer ties with K-12 institutions due to the Network. This could not have happened without the staff and structure of the Network. The Network is really the glue that allows central MA to leverage its own resources to improve STEM education and outreach. The Advisory Board is the engine that drives it all.

The following are examples of the Network's collaborative ability:

- Joint membership on partner's federal grants Leadership Teams, i.e. MasSTEC at Quinsigamond Community College and STEMPower, a project funded by the Department of Labor to the Central MA Regional Employment Board.
- Development and implementation of Innovation Month in Worcester Public Schools with all volunteer and in-kind resources from the Network partners.
Innovation Month focuses on STEM careers and how they relate to learning in the middle school classroom. Volunteer STEM professionals bring interactive STEM activities into every 7th grade classroom (1500 students), which connect the world of STEM to the work of a middle school student. (Partner in-kind support is \$68,598 including 418 STEM professional volunteer hours) The Network produces a calendar that highlights all the out of school time Worcester STEM activities that are coordinated to occur in March. The Third Annual Innovation Month will occur in 2011.
- Production of STEM Career Awareness TV show
Through Network discussions, the Colleges of the Worcester Consortium (COWC), Central MA STEM Network and Quinsigamond Community College (QCC) identified the common need to reach a large audience with their STEM Career Awareness messages. To do it alone would be cost prohibitive but by working together and sharing the cost, developing two hours of programming with segments about college preparedness, admission and retention (COWC), what middle school students can do to prepare for a STEM career (STEM Network), and the reality of today's manufacturing jobs (QCC) was possible. Parts of the production were shown at the 2009 STEM Summit, the complete TV show aired in November, 2009 on Charter Cable and small segments were uploaded to YouTube and TeacherTube with over 2500 hits to date.
- Initiation of STEM Expo
In conjunction with the Massachusetts State Middle School Science and Engineering Fair at the Worcester Technical High School, the Network organizes local business, higher education and non-profit STEM organizations to showcase their work to budding scientists and engineers in the middle school grades, their parents, teachers

and community members attending the state middle school science fair. The participants are all volunteers. 2011 will be the Third Annual STEM Expo.

MetroWest STEM Network (MSEN)

IV. Network Highlights

Engagement of the MetroWest STEM Education Network membership continues to be strong, growing to forty three member organizations since the last report. MSEN Advisory Board meetings held on April 3, and July 10, 2009, were well attended as the membership actively considered the impact of funding constraints. In addition, Executive Committee meetings were held on March 26, April 30, June 23, and July 30, 2009. Complete agenda minutes, membership listings, and attendance are contained in Appendix II.

In addition to STEM Pipeline funded programs that will be reported on individually, MSEN also received DHE funding to sponsor a MassInsight Pre-AP training seminar and develop math modules to better prepare elementary teachers under the MPET grant. Pre-AP training in middle school science was conducted at Framingham High School on June 9, June 23, and August 20-21, 2009. Twenty teachers from Framingham, Hopkinton, and Ashland completed the training and will introduce the lesson supplements into their classrooms this fall.

The MPET project was a joint venture between Framingham State College and Mass Bay Community College math departments. Faculty from both institutions participated in a focus group of elementary school teachers on May 19, 2009. Teachers from Framingham, Natick, and Holliston shared the challenges of preparation for teaching math concepts to elementary students. Faculty members incorporated the output into their course module design and will pilot the modules during the fall semester.

Other non-STEM Pipeline funded projects undertaken during this reporting period include:

1. DOD STEM education programs - Natick Army Labs has engaged MSEN to pilot DOD STEM curricula enhancement materials in five MetroWest school districts. Teachers from Natick, Framingham, Dover-Sherborn, Needham, and Hopedale are participating on three design teams (K5, middle school, and high school) to review and select materials that will be jointly introduced with Natick Labs scientists and engineers. Approximately \$25K funding will be available from the Army.
2. NDEP/FIRST robotics team – MSEN coordinated with Natick Labs to secure \$8K to fund Natick High School and middle school robotics teams for the coming academic year.
3. STEM Masters program – MSEN and Framingham State College has sponsor collaboration with the Metro S/W Regional Employment Board, Mass BioEd Foundation, and Massachusetts Science Fair Curious Minds Initiative to investigate the feasibility of establishing a STEM Masters degree program for elementary and secondary school teachers. Based on the results of a focus group of school administrator and teachers planned for October, a degree program will be structured for implementation during the 2010/11 academic year.
4. NSTAR Program – As a regulated public utility, NSTAR is charged with conducting energy conservation education programs in schools within its service area. MSEN has proposed development of a program targeting middle schools in MetroWest pending funding approval by NSTAR management.

Northeast Network

Network Highlights

The Northeast Network continues to hold Advisory Board meetings in 2009 and 2010. It was determined that continuation of the network structure is the number one priority during these tough economic times. This was reiterated by the DHE in various memos during the spring and summer. In 2010, the Network produced a new website containing information from the variety of constituents involved in the project. The new website address is <http://nestemnet.org>

The Northeast Network Advisory Board was also invited to the full day STEM Fellows and Leaders event held on June 11, 2009 as described in Section A of this report. There was fair representation of board members, including district administrators, during the day.

In March 2009 and March 2010, representatives of the Northeast Network presented at the annual ASCD (Association of Supervision and Curriculum Development) conference. Our presentation "STEM Teachers Take the Lead" described the two year process of STEM Fellows and Leaders that can be replicated by other schools and districts. The more recent presentation teamed up 4 regional network leaders to discuss "Building Sustainable STEM Education Partnerships"

A National Science Foundation proposal submitted by UMass Lowell Office of School Partnerships and the School of Engineering was funded in April 2009 for a 5 year GK-12 project with Lawrence and Lowell High Schools; two of the Networks partners. The project will provide funds for STEM graduate students to work with math and physics teachers during the academic year to enrich the programs at the high schools and to provide opportunities for future scientists to communicate their research to lay audiences. The pilot for this project, funding from the Motorola Corporation, was also funded again in 2009. Other STEM grant initiatives continue to be on the forefront of planning for the future of the Northeast network.