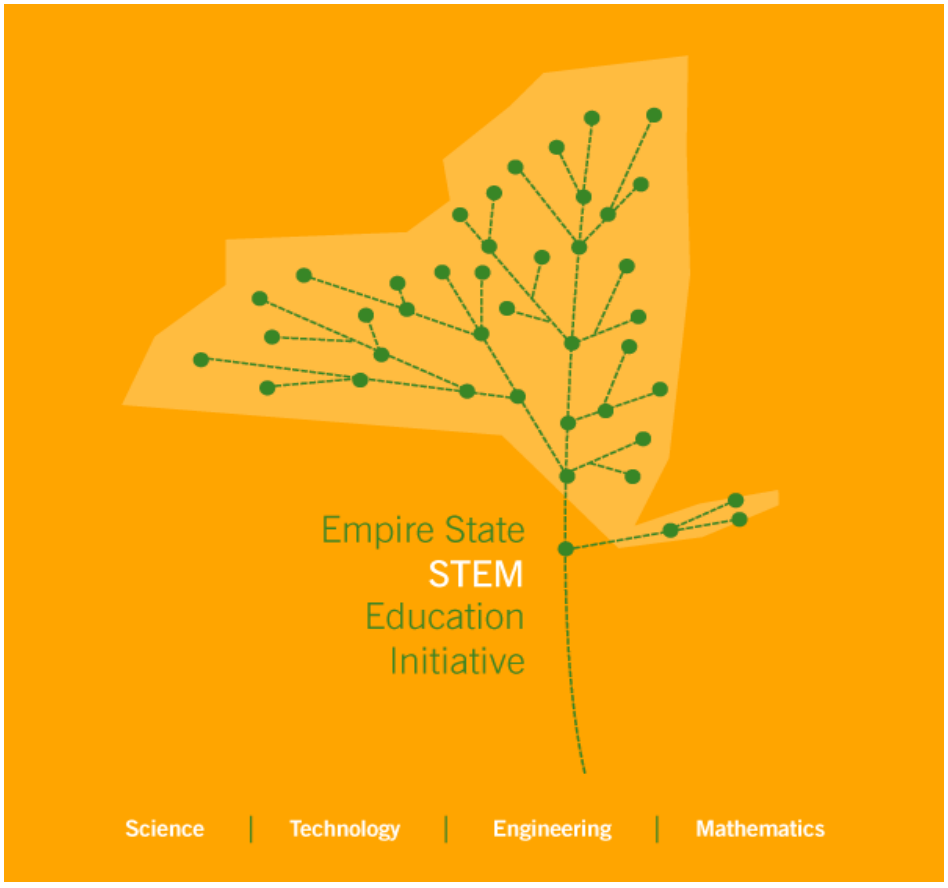
Empire State STEM Education Initiative

Progressive Dialogue – Rochester Region

November 4, 2009

Update for Dialogue Participants



Prepared by: Margaret Ashida, Rensselaer Polytechnic Institute
Monica Hunter, PAST Foundation

Rochester Progressive Dialogue Update

The Empire State STEM Education Initiative, led by Rensselaer Polytechnic Institute and supported by grants from the Bill & Melinda Gates Foundation and the AT&T Foundation, has initiated a "progressive dialogue" to identify ways to advance PK-20 education in science, technology, engineering, and mathematics (STEM) across New York State, and thereby prepare the next generation of New York's graduates to innovate and compete in the global economy. The progressive dialogue is engaging leaders from the public and private sectors in the design of a strategic public policy roadmap for increasing the number of students – from all backgrounds – aspiring to and prepared for STEM disciplines. Advice and participation in this work is being provided by leaders in industry, philanthropy, community-based organizations, and New York's State Education Department (SED) and Deputy Secretary of Education.

The Progressive Dialogue was launched on the Rensselaer campus in June, 2009 in a convening of over 100 stakeholder leaders. The Dialogue continued in a series of 8 regional summits held in October-December, 2009 in the "Big Five" cities (Buffalo, Rochester, Syracuse, Yonkers, and New York City) along with the Capital region, Long Island, and the Southern Tier. In total, over 500 stakeholders participated from sectors including 40 companies, state and local government, public and private K-12 and higher education, corporate and family foundations, museums, public television, PTAs and school boards, professional associations in the STEM disciplines, and non-government organizations.

Dialogue participants recognized the need to act now, boldly to enhance and expand STEM education opportunities for students and teachers. They identified constraints and barriers to transition before developing recommendations for action at both the state and local level. In broad terms, the Dialogue generated the following findings:

Constraints

- State and federal regulatory boundaries are rigid and constrain local scale educational reform.
- The STEM education concept is not commonly understood, and the values and benefits associated with STEM education are not well known in education, business and industry nor by the general public.
- The current system of incentives does not motivate key outcomes (ex., education funding tied to enrollment, not to student performance or teaching quality).
- There are shortages of STEM-qualified teachers and a lack of professional development in STEM (both pre-service and in-service), needed at the elementary, middle and high school levels. There is no STEM-specific certification at the state level.
- Current assessments do not measure mastery in project- and problem-based learning, and assessment innovation is limited by the Adequate Yearly Progress indicator.
- Time segments used in education – school year, school day, and class period – constrain classroom innovations that would be conducive to STEM learning. For example, the class period constrains project-based learning opportunities; seat-time requirements do the same.

- Use of technology in the classroom is 15-25 years out of sync with the real world, bound by traditional reliance on textbooks and other outdated classroom resources, and by lack of capital investment.
- The K-20 system is not structured to support STEM; many university faculty and administrators are not prepared for or willing to undertake joint program development with K-12 educators.
- Union contracts have established rules and practices that must be addressed to achieve certain STEM reforms.

Challenges to Transition

- Stakeholders must be engaged across a broad spectrum of interests, expertise and capacities to contribute to the transition to STEM literacy
- Education must be cradle to grave to go beyond K-20
- Effective education must break with current practices that deliver siloed instruction in order to link with real world interests and needs that are meaningful to students who must achieve multiple literacies
- Education must become more entrepreneurial if it is to achieve long-term sustainability

Recommendations (preliminary):

- **Regents / SED policies and programs**: Address STEM teacher needs across dimensions of human capital management (attract, recruit, develop, retain top talent; performance-based culture; alternative certification pathways); engage students in STEM (student-centered design, project-based learning, internships, apprenticeships); integrate STEM into the curriculum and assessments (project-based, experiential, multidisciplinary learning and assessment at all levels); integrate / expand the use of technology throughout the learning environment (open source models for access to content and expertise, "virtual worlds", distance learning, mobile labs); pursue new models for schools (e.g., regional STEM schools, career academies)
- **State Government Administrative Structures**: Integrate education and economic development activities to eliminate silos / acknowledge links between all disciplines
- **Community Initiatives**: Develop partnerships involving business, schools, and higher education to ensure education outcomes resonate with local economy and community needs; access available resources to reshape schools, address teaching deficiencies; create alternative / creative STEM learning experiences for students; engage state policymakers and regulators to remove regulatory / legal barriers to change; engage parents in STEM education
- **Cross-sector:** Build community connections / capacity to address STEM needs through the creation of a statewide STEM Network to coordinate state and local STEM activities across Government, K-12 education, higher education, business, philanthropic and business disciplines

Prioritization of recommendations and briefings are underway to share findings and engage stakeholders in commitments required to move from dialogue to action.

The progressive dialogue in Rochester was held on November 4, 2009 at the Memorial Art Gallery and was co-hosted by the University of Rochester and the New York State Board of Regents. Over 50 stakeholders came together, representing diverse communities across the Rochester and Finger Lakes region. Context was provided by President Joel Seligman, University of Rochester; Vice Chancellor Milton Cofield and Regent Wade Norwood, New York State Board of Regents; and New York State Senator Joseph Robach. The dialogue was planned and led by Dr. Judi Fonzi, Director, Warner Center for Professional Development and Education Reform (University of Rochester). A brief overview of the Ohio STEM Learning Network was shared by Mr. Buzz Bartlett, Teaching Institute for Excellence in STEM education (TIES). Participants developed recommendations in small groups and share their top ideas in plenary session. They also interactively assessed each group's recommendation and four summary statements with the support of e-Instruction hand-held devices.

Ethnographic observation of the small group and plenary sessions was led by the PAST Foundation with support of local graduate students. Their detailed notes have been transcribed and are being synthesized by PAST anthropologists. As a participant in this effort you will receive an ethnographic bullet point report for the Rochester dialogue and a final ethnographic report for the full Progressive Dialogue that is being prepared by the PAST Foundation.

In the meantime, this update is being distributed to participants in the Rochester region meeting to provide a record of the ideas shared in plenary by the small groups:

- Summary statements and ("clicker") response data for each breakout group with unedited transcription of the groups' flip charts (pp 5-12)
- Bullet Point Report – Summary of Break Out Sessions (pp 13-24)
- Participant assessment of four summary statements (p 25)

Group 7 – Presented:

Appoint a STEM advocate in every school to balance process to content

- Through NYSED; Report to Principal, not to union
- Coordinate teacher prep, process, communication
- Create critical thinkers! Think outside the educational process!

Group 7 Interactive Assessment	1	2	3	4		N/A
Low Priority	10%	27%	25%	22%	High Priority	16%
Requires NYS Policy Change	41%	12%	10%	16%	Implementable Locally	22%
Low Effect on Educ'l Reform	20%	29%	20%	18%	High Effect on Educ'l Reform	14%
Requires Identifying New Resources	25%	12%	18%	18%	Could Redirect Existing Resources	27%

Group 7 – Flipchart Notes:

Summary ideas and group's "votes":

1. There is no "ownership" for students in a part of their education
2. Every school needs a STEM advocate to balance process to content (5 votes)
3. How do we attract top technical students to pursue teaching as a career choice (2 votes)
4. Need STEM pre-K to get them excited
5. "High Tech High" in San Diego → NYSED needs to get administrators to see these places first hand. Bring the teachers too! (5 votes and 2 stars)
6. Professional societies need to endorse national changes to avoide "average" based results
7. Need to incorporate in tech. to how education is delivered (sic)
8. Think beyond the educational "system" – look at 3 p.m. – 7 p.m. timeframe where lacking constructive activities. Focus Community-Based Organizations on programming after the school day (5 votes and 1 star)
9. In communities with higher ed – use undergraduate population
10. Need to find ways to re-train existing teachers in new sciences to get them passionate about their fields of interest (5 votes and 1 star)
11. RCSD (Rochester Central School District) teachers are inundated with opportunities and grants to make good on (sic)
12. Get away from "paper & pencil"

13. Use modern science as a context for teaching fundamental science (2 votes)

Implementation notes on the "Advocate per school" idea:

- Hire involved teachers / not only source
- Doing creative things outside the classroom environment
- Coordinated by SC (STEM Coordinator)
    - How many students from STEM are in post-secondary education?
- Working in conjunction w/PH
- Undergrads to be involved with the you – students becoming interested in STEM fields!
- 175 P.D.
- Respect each school culture
- How can we build/implement the needs for our population
- Overseer over the advocates – could divide by zone

STEM advocate Roles:

- Informal education groups / universities / industries
- Direct STEM after-school programming
- Communication w/students → advertising
- Identifying educators to work in the program
- Identifying funding sources
- Assist agencies in filling their program slots
- Connect students to counselors for 1-on-1's with students
- Identify businesses who can provide scholarships for STEM education

Group 5 – Presented:

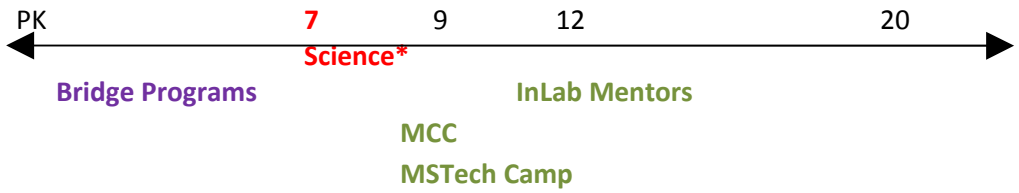
Promote a local and regional mandate to bring together universities, business, and other existing organizations to identify potential STEM students and provide experiences for them (example: FIRST program)

Group 5 Interactive Assessment	1	2	3	4		N/A
Low Priority	10%	18%	29%	35%	High Priority	8%
Requires NYS Policy Change	25%	12%	12%	45%	Implementable Locally	6%
Low Effect on Educ'l Reform	12%	35%	29%	16%	High Effect on Educ'l Reform	8%
Requires Identifying New Resources	10%	18%	25%	35%	Could Redirect Existing Resources	12%

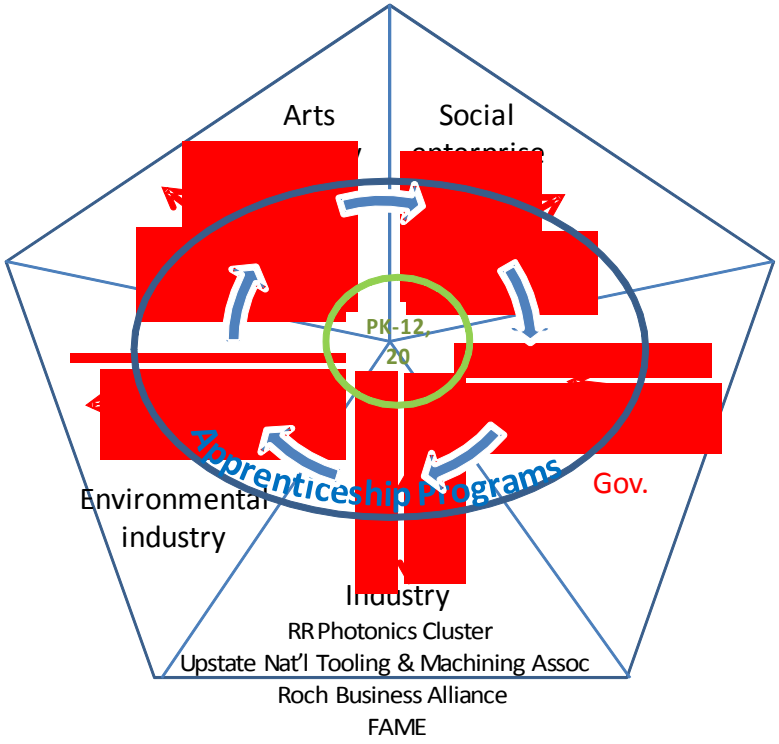
Group 5 – Flipchart Notes

<u>Apprenticeships</u>

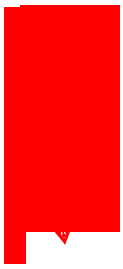
- Project based
- Credit bearing (doable)+



Education: Life long, Humanities, STEM, 21st century



Expeditionary Learning



- **PK-20 teachers**
- **Apprenticeship mentors**
- **Industry leaders**
- **Alternative certification folks**
- **Industry practitioners**

- Kids need to <u>see</u> what they can do in a <u>short</u> period of time (built a robot in 6 weeks)
- Being involved in a STEM application exposes students to novel roles in STEM (the business end of development)
- Kids know what high school courses "set them up" for what potential careers; how to build credentials for a career
- Get parents involved early – so they champion STEM thinking & doings
- Do we need a national goal to drive interest?

  - (to address? Is it worth it? Putting man on moon was driven by industry)
- Little media exposure of STEM initiatives happening around the world
- Practitioners share pathways to their careers
- Passionate to "suck" students in!
- Does industry need to lead this goal?
  - National mandate
  - Local mandate – we have a lot of "ingredients" that could be linked and act as a "pilot" for others
- Ohio started STEM platform schools that focus on local STEM issues / resources

Paid Apprenticeship Programs – result in a skilled / talented workforce, allow for non-traditional pathway to a profession, could be work first, theory when the interest has been sparked

Co-op Models – need to educate educators and industry

- Can we really afford to have educational initiatives tied to the economy?
- How can we embrace cultural values?
- Where are / who are our role models?
- PreK-20 all need practical / applied opportunities connected to what students are already doing
  - FIRST robotics program
  - Summer learning Camps (project-based)
- Is the "Carnegie Unit" a problem?
- Regional or BOCES STEM schools
- Exposure "breadth" or "depth"?
- "We cannot allow AIG to fail!" How does education get this level of urgency and resources?

Group 2 – Presented:

Develop systemic problem-based learning approach (Pre-K-20) with relevant/effective assessment of students' abilities to DO vs. recite. Blink project: remove all standardized testing for one semester.

Group 2 Interactive Assessment	1	2	3	4		N/A
Low Priority	10%	10%	18%	49%	High Priority	14%
Requires NYS Policy Change	59%	10%	6%	10%	Implementable Locally	16%
Low Effect on Educ'l Reform	8%	0%	25%	53%	High Effect on Educ'l Reform	14%
Requires Identifying New Resources	14%	20%	25%	24%	Could Redirect Existing Resources	18%

Group 2 – Flipchart Notes

Doing math, science, technology, engineering, and English		
V A L U E S	- PreK to 20	
	- Focus on critical skills of the future	
	- Learn how to solve problems	
	- Interdisciplinary	
	- Real world examples	
	- New assessment congruent with acquired skills	

How?

- Sabbaticals – cross-fertilization?
- STEM / science as a community?

Needs	Stakeholders
Facilities (?) Buy-in Support for program Eliminate exams Devise assessment	Administration $ Change professional development / educate teachers Assessment rubric

Changes Needed

Ohio model: philosophy

- Pilot project
- Volunteer public schools
- Support from?
- Plan: → Education
  → Consortium

Blink project: no exams in STEM for ½ semester

- Is it OK/
- What instead?
- Prove it's better?
- How do we know?

- Sample alt. L.O.s
- Sample assessment
- Support for teachers, before & during (professional development)

Group 1 - Presented

Expand STEM experiences for teachers as part of their professional development.

Group 1 Interactive Assessment	1	2	3	4		N/A
Low Priority	12%	20%	24%	31%	High Priority	14%
Requires NYS Policy Change	25%	14%	14%	29%	Implementable Locally	18%
Low Effect on Educ'l Reform	10%	24%	27%	24%	High Effect on Educ'l Reform	16%
Requires Identifying New Resources	45%	8%	12%	20%	Could Redirect Existing Resources	16%

Group 1 – No Flipchart Notes

Group 4 – Presented:

Implement more elementary teacher certification in STEM; focus on completion of STEM, including STEM standards / MST standards / STEP.

Group 4 Interactive Assessment	1	2	3	4		N/A
Low Priority	12%	8%	16%	57%	High Priority	8%
Requires NYS Policy Change	59%	12%	6%	8%	Implementable Locally	16%
Low Effect on Educ'l Reform	2%	12%	24%	41%	High Effect on Educ'l Reform	22%
Requires Identifying New Resources	14%	22%	25%	25%	Could Redirect Existing Resources	14%

Teacher training

- Change certification and preparation of elementary school teachers – STE(M)
- Measure intelligence differently

Need to address:

- How to attract elementary certification candidates to STEM – enhanced program
- How to increase the number of required S.H. from NYS (minimum) → national standard

- How to increase challenging / intensity / validity of the STEM courses
  - Content & content pedagogy with "lab" experience PBL
  - Prescriptive from the state level
  - Misconceptions

- Q: How do you increase hours & rigor & fit it into the 120 S.H. limit?

A: Consolidate & intensify?

- Elementary teachers need to understand the middle school curriculum to know where their students are "going" & why they are covering it
- Require an integrated MST/STEM unit plan for graduation
- Require a number of hours in student teaching; engage in delivering STEM unit

Group 3 – Presented:

Revolutionize the current educational system philosophy to one supporting a system that retains the best teachers and removes the worst.

Group 3 Interactive Assessment	1	2	3	4		N/A
Low Priority	8%	4%	24%	49%	High Priority	16%
Requires NYS Policy Change	67%	6%	0%	10%	Implementable Locally	18%
Low Effect on Educ'l Reform	6%	10%	14%	53%	High Effect on Educ'l Reform	18%
Requires Identifying New Resources	24%	18%	24%	20%	Could Redirect Existing Resources	16%

Group 3 – Flipchart Notes

- Disconnect between high school and college
- AP – courses in college – don't blend often enough

Group 6 – Presented:

Informal learning context: create opportunities to illustrate to students what could happen with STEM

- Professional development for teachers
- Greater collaboration among universities, industry, community-based organizations

Group 6 Interactive Assessment	1	2	3	4		N/A
Low Priority	6%	20%	24%	41%	High Priority	10%
Requires NYS Policy Change	8%	0%	14%	63%	Implementable Locally	16%
Low Effect on Educ'l Reform	18%	20%	29%	16%	High Effect on Educ'l Reform	18%
Requires Identifying New Resources	31%	24%	8%	24%	Could Redirect Existing Resources	14%

Group 6 – Flipchart Notes

Problems:

- Curriculum → take tests
- Lack of support for 21st century skills
- Lack of depth
- Tech standards out of date
- Lack of p.d. (teachers)
- Assessments
- Time
- Artificial disciplinary boundaries marketing of science
- Strong leadership
- Awareness of "the game"
    - Nature of science
    - Career "illustrations"
- Developing scientific literacy
- Mentorship – time
- Like-minded peers
- PD / induction support – no system in place
- Supporting transitions for kids

Radical ideas:

→ Work around schools by investing in "informal" or non-schools

→ C.T. support (PD)

→ Teacher feedback – independent from district

→ Teacher induction (collaborations with industry)

Outcomes: - what do we mean by "advance"?

→ Engage students to learn math/science in authentic ways

→ Better preparation for workforce

- More advanced STEM expectations
- "21st century skills"

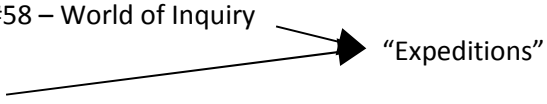
→ Focus on depth – core concepts of discipline

→ Bridge the gap – equitable access

Exemplars: sources of hope / insight

School #58 – World of Inquiry

GCCS



Teacher Induction / PD:

→ Meaningful feedback by stakeholders (parents; kids; ...)
→ Meaningful evaluation by a professional / 3rd party

Cross site collaborations

→ System of PD program – w/kids embedded in practice
→ Professional learning communities
    - Mentors (internal & 3rd party)

Structure of PD

→ Look / learn from exemplars
→ Action research: syst evaluation of practices informed by analysisof student work

Capitalizing on "informal contexts"
(Strategy to break from being stalled by constraints of school)
→ Could become exemplars / test beds
→ Could be sites for PD
→ Could consist of collaboration between pre-service / in-service / industry
→ Access for everyone ($$)
→ Involving varied stakeholders in thoughtful ways throughout schooling (K-16)
→ Pot of money
- Industry volunteers (company gets credit)
- PD $ - BOCES center
- Pre-service teachers as field experience
- Proposals – can be multi-year

→ Organizing group?
→ Recruitment?
  - College applicant quality
  - Career / awareness

→ Framework grounded in need
  - RFPs; targeted objectives; involving industry

→ P.D. – teacher centers
→ Scaling up?

Resources
- Small business connections – Rotary for example
- City/county
- Department of Labor / Department of Energy
  - areas where we need growth
  - qualify them for this post-secondary work
- State grants? (new program)

Stakeholders
→ City/community
→ Small business (tax incentive)
→ University → schools of education (field experiences)
→ Schools (PD)
→ Informal education institutions

Organized as systematic / systemic P.D.
→ Objective-driven

Bullet Point Report

(DRAFT 1-19-10)

The following summary of issues and suggested actions for implementing STEM education in New York State have been compiled from the ethnographic observations of the STEM Progressive Dialogue conducted on November 4, 2009.

This preliminary report is intended to provide a brief overview of key themes developed during a total of 14 breakout sessions conducted by seven groups. Breakout groups consisted of participants representing higher education, K-12 education, business, government, nonprofit organizations and STEM proponents from the Bill and Melinda Gates Foundation, the TIES organization, and the PAST Foundation. The information presented in this report is based on nine categories that have emerged from the ten Progressive Dialogues held since June 2009. They include:

1) Federal and State Policy, Regulations and Standards
2) Regional Issues and Local School Districts
3) School Infrastructure
4) Teachers: Training and Professional Development
5) Student Needs and Potential Engagement in STEM Education
6) Partnering: Learning Community Stakeholders
7) Curriculum and Instruction
8) Assessment (Measurement)
9) Models/Strategies for Action (STEM implementation)

This preliminary report is intended to provide a brief overview of key themes developed by breakout group participants in Rochester, and contributes to issues raised and suggested actions across all regional dialogues held in the state during October, November, and December 2009. This report is being circulated to all Rochester region participants for review and comment.

Breakout groups were asked to identify radical ideas to advance STEM education reform both statewide and within their own region and school districts. In the nine sections that follow, statements that were selected by a breakout group as an important idea are identified in **boldface**. Statements that are <u>underlined</u> were selected by a breakout group as a priority action to advance STEM education in the region.

Federal and State Policy, Regulations and Standards

- Work with the federal agencies to define and link in with the national referendum on STEM education and STEM career urgency; parents and students need to see the urgency and need for workforce development expressed at the national level as well as the state level; the federal government should take the lead in the position that we “cannot let education fail” similar to their role in banking crisis, their role has to be bigger
- STEM requires changes to occur at the state level including legislative action to support STEM education implementation

- State policy on teacher to student ratio should be reduced below 1 to 25 for all schools
- Provide state funding during initial phases of STEM program development understanding that long term funding will be required at the regional level (local tax base, business and industry investment)
- Utilize existing state and federal funds more effectively, stop throwing money at failing programs, and instead shift dollars to meet needs including hiring more teachers, paying higher salaries, providing programs that address family needs, and creating paid summer internships
- Federal and state investment in education has to increase similar to other countries like China where they have increased their support of education; it is not just about the dollars spent, other countries spend less per capita and are producing better results
- The state needs to partner with business and industry to benefit from their expertise and ability to lead in implementing change, e.g., 911 technology problems shows that government doesn't understand what needs to change
- Create statewide programs that offer tax incentives or grants to businesses that establish internships or apprenticeships for students before graduation; a monster.com study shows that Rochester has the fewest internships available to college students than other similar cities
- Address liability issues that constrain students and teachers from entering the workplace
- Create mandates that require teacher training to include business/industry apprenticeships, internships or other forms of involvement to gain experience outside the classroom
- Create mechanisms for career professionals to enter the teaching profession including mechanisms such as tax credits for businesses that "lend" industry professionals to fill the shortage of STEM teachers
- Sustainability of programs will require clearly defined objectives and outcomes, including desired skill set for graduates, and firm commitment for K-20 engagement in systematic change that will build a 21st century workforce
- Regents' standards for high school graduates should relate to career readiness and competitiveness in a global market; work with business and industry to develop curriculum and standards that meet state needs
- Regents should consider the differences between the pressure to meet deadlines to cover topics, versus approaching instruction as a way to provide deep essentials to enjoy and understand topics
- This is at least a 30-year effort of work between state and local level to implement change in the public schools
- There are cultural conflicts over being tech oriented versus sports oriented; we need stronger national leadership from business and industry to grow support for technology development

Regional Issues and Local School Districts

- **Focus on developing regional mandates that bring industry and education together to develop STEM programs; identify a strong leader that can make the right things happen and get the essential people committed**
- Create partnerships among different decision makers including principals and administrators to work with teachers and members of the business community; engage school board members as key decision makers
- Draw upon existing resources and incorporate competition across regions for STEM implementation funding

- **Create a program in which individual schools can compete for STEM funds as a way to demonstrate willingness/commitment to change; clearly define criteria for selection so that schools understand what the goals are**
- **Create a STEM advocate/coordinator for every school who reports to the Principal, with key responsibilities including: 1) coordinating required 175 hrs of professional development (PD) for all teachers; 2) network building linking the school with universities, business and the informal learning community; 3) meet with other STEM advocates and coordinate regionally; 4) identify community resources that match up with school needs; 5) coordinate afterschool programs; 6) work with school guidance counselors; 7/ coordinate student internships to ensure meaningful experience (not just standing at the copier); 8) coordinate STEM workshops as needed;** consider the Hillside scholarship education liaison as a model for STEM School Coordinators
- Utilize local authority in setting rules and regulations at the district level in ways that allow change to occur without having to wait for state support
- Use tax dollars more efficiently at the district level to achieve STEM goals
- Approach STEM program funding from community base in order to allow schools to focus on local priorities and needs; find ways to: 1) gain strong state support, and 2) create systematic regional connections to learn from each other
- Each school district should develop their own technology plan and leadership in seeking funding, training and professional development, implementation and program vision
- Administrators should work to create the STEM environment and take an active role in the effort to implement the program; administrators should work with teachers regarding decisions that affect what's happening in the classroom including integration of science, math, language arts
- Hire more school counselors
- Initiate program development at the earliest levels beginning with kindergarten; starting with high school is not the solution
- Start project based learning through informal education programs in order to move ahead without delays; eventually successful programs can merge into school programs
- Principals have an important role to play in leading and supporting teachers in STEM program implementation
- Build on existing successful programs, like Tech Valley High, to foster changes in administrative and teaching practices
- Administrators should be evaluated
- Improve outreach to parents to extend communication beyond bad news, e.g., "your child needs to do better," to include positive progress that will encourage parents to connect with the school
- Extend high school credit for community service to include work with STEM related businesses and organizations

School Infrastructure

- Today's classroom does not reflect the real world; invest in teacher training and interactive technology to support STEM instruction
- Urban school facilities need to be updated to support STEM instruction
- Develop a plan that starts with changes at the level of the school building as part of establishing model STEM schools; gain support for the plan among community stakeholders, including the university and the State Department of Education

Teachers: Training and Professional Development (PD)

- **Invest in high quality teacher training; increase teacher pay; expose teachers to STEM careers; encourage teachers to act as role models for their students**
- **Require teachers to use technology in the classroom, including smart boards, and integrate tech use into the curriculum**
- **Mandate science and math certified teachers to utilize project based learning**
- **Require a masters degree in math, biology, etc., for certification to assure content expertise**
- Utilize private/philanthropic funding sources to initiate STEM PD in the short term, and seek funds from the state and federal government to sustain PD programs including the Department of Labor, U.S. Department of Education, and NSF program grants.
- Utilize the existing mandate for 175 hours of PD to engage teachers in work outside the classroom, e.g., a teacher who spent one year working at Kodak returned to the classroom as a different person, providing great counseling to the student as a result of that business experience; allow K-12 teachers six months' immersion in industry, and pay teachers a stipend
- Design STEM PD to include the point of view of the student, not just the teacher's; real PD occurs when students and teachers work together; change in curriculum occurs when teachers are in the classroom
- Design PD to create a vision of STEM, to give teachers an idea of what to work toward in the future similar to the way business works, where the team leader makes sure everyone has a vision for the future of the company
- Design PD to consider cultural differences in teaching styles that include two-way student teacher learning where the student is encouraged to point our errors by the teacher, versus the more traditional approach; teachers who lack confidence are sometimes uncomfortable when students ask questions, but this is not real learning; the best teachers learn from their students, but this is not part of their training; giving up control means teachers have to face not knowing everything and overcome their fear of not having all the answers
- Must have buy-in of veteran teachers who have teaching practice and are comfortable in the classroom; the role of the teacher is ubiquitous to the transition to STEM; design PD for experienced teachers; add coaching and content development to PD programs; strive for seamless teaching; design PD to consider the teacher's comfort level with science instruction
- It is very hard for new teachers who are inspired and passionate about teaching to enter the classroom as agents of change with union rules constraining their actions, and considering that they are mentored by veteran teachers who encourage new teachers to follow the rules and not "rock the boat," e.g., don't work past 3pm; mentoring of new teachers by veteran teachers means that we perpetuate the culture that we know
- In NYS, teachers have opportunities to attend seminars and conferences to learn about emerging pedagogical practices, but few attend
- Focus on elementary school teacher training that requires 6 units of math and science and develop a good model that includes problem solving; mandate required lab experience; **increase the NYS standards from 6 units in math to meet national requirements of 9-12 units for a math degree; require an integrated Master/STEM unit plan with required hours for student teachers**
- Provide scholarships for student teachers to get STEM certified; create research internships for teachers and student teachers (graduate students); graduate research assistants should be trained in teaching and how to communicate with students; provide a stipend/grant to fund teacher training for research assistants

- Increase teacher salaries; **Double the salary of science certified teachers**
- Eliminate tenure and start "grading" teachers, they are dying for meaningful feedback, e.g., observation and written feedback is rarely done; design differential pay structure based on grading scale; not everyone is motivated by salary alone, create ways to recognize excellence in teaching that elevates quality teaching practices
- Teachers can benefit from collaborating with career professionals; create opportunities for teachers to partner with career professionals for up to six months to co-design projects, identify common interests and build relationships
- Create summer programs for teachers to work with career professionals, then follow with a fall program where students become involved in hands on learning
- Provide teachers with a framework to develop collaborative relations with other teachers, transforming the concept of teaching practices; develop skill set to promote team dynamics and project based instruction; utilize strong teachers as lead to collaborate with weak teachers, and new teachers; utilize the BOCES PD model
- There is a disconnect between elementary and middle school curriculum; give elementary school teachers clearer understanding of middle school curriculum to help them prepare students for later grades and material to be covered
- Teachers enthusiasm for STEM would increase with increased support and leadership of principals
- Create programs that "cross-fertilize" faculty from higher education and from K-12 through planned sabbaticals that allow teachers to trade places for a period of time
- PD for higher education faculty is essential to improve the quality of teaching
- PD should include ongoing technical training to current practices, and not allow teachers in the classroom to fall behind
- PD design for teachers who leave the classroom for the business world should address a systematic plan for replacing them in the classroom, how to assess necessary expertise, new certifications, appropriate level of classroom management, and how to reenter the classroom and teaching profession
- Provide teachers the opportunity to leave the classroom and gain experience in other fields to better understand the "entrepreneurial" community, and get beyond traditional approaches to teaching and learning
- Develop a summer exchange program for teachers and career professionals linked to tax incentives for participating businesses, and provide sabbatical leave to support teachers
- Career professionals that shift into teaching are entering urban classrooms and are struggling with classroom management; create a framework that partners the experienced teacher with the content expert so they both gain from their combined strengths; develop online courses for career professionals to eliminate the problem of classroom management for novice teachers
- Parents should be more involved with K-12 education including providing meaningful feedback on teacher performance, most parents know what their child needs from the teacher; can be impartial by involving parents in different school districts from their home district

Student Needs and Potential Engagement in STEM Education

- Identify student interests in technology at an early stage and target program development and career pathways to build on those interests
- **STEM is a long term path for students, if they get off the path, make sure there are other doors to get back in; students can be inspired by one good teacher, or influenced by one bad**

teacher and discouraged for life, the solution is better teacher training and PD, and stronger support from parents

- STEM outcomes for students include more students enrolled in postsecondary programs, more students doing real science, and more students enrolled in math courses
- Give students opportunities to engage in being scientists and exploring and learning, not through more schooling but through different types of learning experiences, do school differently; portray science so young children see it as something they want to do; students should see science as messy and tentative and understand that it is a range of things
- Give students a framework for learning that is problem oriented, and linked to real needs in industry and business; students should feel ownership of their learning experience that makes the difference between 'have to stay in school' and 'want to stay in school'; teachers should explore ways to encourage student enthusiasm for learning
- Students and teachers need to have sufficient knowledge base to be STEM capable in order to be responsible citizens
- Encourage students to find their passion for learning and take the classroom into the real world so they can see the connection between learning and real world challenges; teachers must give students control and make students responsible for their own learning
- Competition between students for the right answer does not help a student to learn, it may actually cause them to feel "dumb" and discourage them from trying; teachers and students should learn to respect failure, recognizing the value of understanding and explaining why something is wrong as well as why something is right
- Student projects should mimic the way companies operate, with students taking on roles and responsibilities, developing real life skills, and selling a product
- Recruitment for students to STEM careers should focus on career awareness, industry awareness
- Students are not informed on STEM careers and do not see jobs to pursue; expose all students to STEM career professionals, not just the advanced students, so they know what's out there; **expose students to different careers, and provide support for students to go beyond initial exposure to develop self-confidence in pursuing a career and connection to RIT;** connect younger students with college students so they can see what is possible and a path to a career and ongoing education
- Target Latino and African American students, they don't know what STEM careers look like and what direction to pursue; these students are facing a 50% unemployment rate
- There are scholarships and grants targeted to inner city students who can qualify for college entrance, but many can't meet admittance requirements
- Suburban students are told by their parents that they will be successful, urban students do not hear this from their parents; some students do not have family support for their education, teachers have to fill the gap to motivate and counsel students to achieve and attain career goals; create cultural expectations about STEM for students including providing financial support/incentives and assistance with application processes
- Students who are judged to be "dumb" at an early age, and expected to not do well by their teachers, are then pegged in the system and will likely not have doors open to them as they move toward graduation; poor performing students are discouraged from trying
- Change the perception of apprenticeships as alternative paths to career development, to that of a "front burner" option along with traditional education
- Students do not see the urgency and importance of pursuing STEM careers, and do not have a sense of purpose that is bigger than their personal goals, and do not value their opportunity to meet national and state goals for economic growth

- Students dream about having more, not about failing, those that make it through are those who want to make it, find ways for students who don't know how to make it through but could with more support
- Affluent students have opportunities in the summer and after school to expand their learning experiences, other students have to work
- Tech camps for middle school students are important because this is when the "I" develops further
- U.S. female students are trailing European females who are equal to boys in STEM proficiency
- Student's interests are sucked up by the wrong things, e.g., celebrity gossip, and are not exposed enough to critical issues facing the nation

Partnering: Learning Community Stakeholders

- **STEM is not just about teachers, its about the family and parents being involved too; the community has a role to play in the education of its youth**
- Initiate a stakeholder-based STEM program development process across diverse interests in the community; focus on program development for younger students and get them engaged out in the community where everyone can see achievements and attract parents and students to new programs
- Augment the national referendum with a local regional mandate where it is easier to get stakeholders together, to reach agreement; "connect the dots" and take advantage of the existing resources
- Change the way collaborative projects are packaged to include access to tech labs, transportation, e.g., bus tokens, in order to develop research-based projects that expose students to their world; work collaboratively with universities and businesses to ground student projects in areas that are essential to business, and that also provide a student centered context; set up partnerships as 3-year commitments with year-end quality checks
- Engage with business to develop clear idea of benefits of change that they would be willing to invest in, and shift away from philanthropic sources of support for education
- Work with small businesses to gain their input on strategies for success and build on their expertise in thinking through problems and diverse challenges; small business has a real interest in improving the quality of future employees and can give input to structuring program goals
- Build partnerships between teachers, principals, administrators and business; create business relations that help to define common interests, and bring career professionals into a process to co-design interesting projects; bring teachers and students together with career professionals to co-design interesting projects and internships
- Work with business to develop efficient approaches to linking business expertise and resources with students in a way that works for everyone; business needs to do more than complain about low rate of students going into STEM fields, they need to engage with students and programs directly and do more at all levels, we need to educate industry on how to engage more effectively
- Partner with business to develop paid summer internships and target students who haven't made it through academics and are drop outs or ready to drop out; develop a program collaboratively with business where students investigate real problems, they report back to business, and participate in an authentic process allowing students to contribute to developing curriculum, standards and leadership
- Identify energy and environmental companies to engage in STEM program development

- The model for engaging business in education has been around since the 1950s and isn't working; in Germany, VW gives Ph.D.s
- Utilize social networking media to develop professional discussion groups that can contribute to ideas and potential project development
- Identify funding needs and levels, as well as human resources needed; seek out those who need to be involved; initiate the process with state funds to get it launched
- Partner with the city as a potential funder of STEM programs that target out-of-school youth including pregnant and parenting young adults as a direct means of getting specific target populations into programs that will benefit the community through tax dollars at work
- Rochester has opportunities to develop middle school tech camps, and could provide a way to rally the community around STEM
- Work with the university to redesign teacher training and pre-service training; the link between schools, schools of education and business is the student teacher because they need incentives, rewards, and grant funding to support tuition for STEM training
- The expectation of university involvement through volunteerism is not sustainable; identify funding sources to support involvement of junior professors and graduate students who are readily available for STEM program participation
- Create opportunities for career professionals and college students to co-teach STEM courses; higher education should reach out to work with high school students
- Parents need to understand that essential career skills for success in jobs not yet invented (next 5-10 years) requires that students develop fundamental skills including critical thinking, problem solving, creativity and innovation; it is especially important to work with parents at the elementary school level to help shift their views and understanding of the value of STEM education for their children
- Work with parents to build an understanding of the learning process including the value of students succeeding or falling on their own, parents provide too much cushion; some parents are constrained by generational and cultural differences that inhibits their ability to support and encourage their child to succeed in school; parents are critical to the educational process, they have to assume responsibilities, encourage their child and stand with them, they must be engaged
- Educate parents about technology so that they consider it "cool," and influence their child's view of technology
- If parents cannot engage in supportive ways with their child, then there needs to be other mechanisms to provide guidance and encouragement for kids "in the pipeline"; the leaky pipeline is about kids that do not have support at home
- Use social networking tools to fix the leaky pipeline; use Facebook or Second Life to introduce people to STEM

Curriculum and Instruction

- **Implement problem based learning for K-20**
- **Develop business input on curriculum and standards in order to serve the long term needs of business as well as society, and that also reflects important global challenges and real world issues that should be integrated into the curriculum**; **disseminate effective curriculum to other schools**
- Use the opportunity to work with business to integrate access to resources outside the classroom; improve coordination across different programs to stay informed and learn from others

- Change curriculum to provide project based, hands on experiences in ways that encourage students to discover something new and to nurture a passion for science that will drive their STEM studies
- Problem based learning is too complex and shouldn't be the target, instead focus on STEM to engage students in meaningful ways in investigatory, interdisciplinary learning
- Develop mandates that integrate tech use in problem based learning in ways that will benefit students
- The Local Advisory Council prefers the term, STE^2M, to include engineering and English language skills essential to problem solving
- Students need to learn basic research methods starting in early grades, and continue to apply research tools in learning through to college; embed STEM instruction within existing programs
- Change the culture of math instruction so that student expectations are not about being shown what to do, and instead there is a different approach that engages students in an alternative kind of learning experience; engage parents in shifting expectations about math instruction
- Shift the culture of the classroom from paper and pencil to hands on learning
- Develop online instruction for K-12
- Create a student peer to peer teaching/learning model to increase student performance (used in a chemistry class by one teacher with a 15-20% increase in outcomes); allow students to investigate a problem in a social context where students are on their own to pursue solutions with their friends
- Form student clusters structured by interests designed by the teacher who know students best then promote learning
- Align high school and college science curriculum; incorporate hands on learning in the science curriculum across high school and college
- College level science instruction occurs in real settings working like real scientists in labs, with hierarchies (professor, post-doctoral researchers, doctoral students and lab techs) working together following ideas, not following a syllabus; build this approach from both ends beginning with Pre-K through college
- Students are not prepared for the transition from high school to college, from one on one and small groups to large classes with teaching assistants who are likely under stress, makes it hard for students to do well
- Students are not well prepared for college level science and math, they must start higher level math by 6th grade; after that point, their next opportunity is through extra curricular options, but this requires that the student seek it out
- Identify careers that don't require a college degree and develop/offer courses to support skill development, e.g., cad-based instruction offered in high school drafting courses that prepares a student to become a cad designer, or aviation mechanics training for careers as certified mechanical inspectors, both make good salaries
- CAD instruction 30 years old, out of date
- Change the structure of the school day to expand beyond a 45-minute segment; extend the school day to provide students with different learning experiences, not more of the same
- Change classroom experience for young children who lose interest in learning by the 3rd grade; create STEM curriculum for Pre-K level; expose pre-k students to science through play and then start science learning in later grades; start students early in networked learning (Pre-K), to experience learning from their peers and others, and breakdown barriers at an early stage of development
- K-5 is largely project based and interdisciplinary; shift to focus on developing all around basic skills like reading and writing

- The pipeline is too weak to start early

Assessment (Measurement)

- **Eliminate the standardized state exams and promote real assessment, make the concept work**
- Waive the exams for one year and design new methods to determine value as a teacher, value as a learner
- Set a one semester time period in which to develop STEM teaching and assessment methods; include STEM, as well as communication and writing performance
- District dollars spent on conducting exams do not benefit the student or the district, e.g., the 5th grade math exam results are returned to the school half way through 6th grade
- Student's do not benefit from academic assessments at age 15, that is too late to provide them with the opportunity to change course
- Standardized tests prevent teachers from teaching anything new, and constrain individualized learning
- Changing teaching methods can improve retention which could be measured by assessing applied projects through a practicum
- Develop sample alternative objectives and new testing approach that moves away from teaching to the test
- Develop an exam based upon (35) integrative questions in which there are no definite answers to experiments for students to assess by the end of the term; allow students to utilize internet sources and discuss questions with each other; the process is not competitive but instead engages students in collaborative research and study throughout the term, not just at the end of the term
- Go beyond current approach to measure only what a student has learned in a specific period of time, to assess the student's cumulative knowledge base (retained knowledge over time)
- Develop a biocultural assessment to get beyond traditional approach based on one single curriculum (lack of attention to diversity)
- There are no state exams to assess problem solving skills, its not about testing a student's factual knowledge
- Race to the Top grants will require that innovation is assessed, but we don't have methods to do that
- Track students throughout their academic career

Models/Strategies for Action

- Fund those schools and teachers who are willing to implement problem based learning; start an independent school to initiate the transition through a six-week pilot program; evaluation could require a control group to compare outcomes (control groups are controversial)
- Develop a competitive project proposal system to gauge best projects region wide; students should play a role in developing proposals; East High School offers seven opportunities each year to submit project proposals for the following year; the East High Go Green Club has been successful in this competition, and engaged students in developing environmental projects
- Identify potential program components that can be mapped out and launched, then work backwards to build a comprehensive approach; utilizing existing resources will give students the opportunity to experience different ways to learn, e.g., the Wegman 4th grade program
- Work around the school system by developing after school and summer programs where there are no rules, allowing changes to be more easily implemented to show what kids can do without burden of formal process of change; give teachers summer programs to develop programs

without restrictions; create a framework in which students and teachers work together to design summer programs

- STEM related programs could be offered before or after school, or weekends, similar to the Science STARS program (Students Tackling Authentic and Relevant Science) offered by the Warner School of Education, where graduate students meet with 7th and 8th grade female students on Saturdays; the Science STARS Program allows students to pursue projects in the field of optics to find problem based questions, whether case analysis or research
- Create a STEM institute similar to the Oswego program where scientists, mathematicians, engineers and educators can share and learn from each other to be able to make changes in elementary, middle, high school and college level classrooms
- Approach marketing of STEM to students beyond the narrow traditional approach of the academic pathway to include other existing options that are not being embraced; must expand marketing to students who are not innately attracted to STEM, so that more students realize the benefit of pursuing a career; overcome reluctance of the student to choose the social life of a tech student versus the social life of an athlete
- BOCES training facilities allow student access for ages 16-18; work with BOCES to identify other situations that students can access for STEM training (liability issues)
- BOCES provides a model of earning credits for alternative learning experiences; consider the New Vision Program for high school seniors as well as the Franklin High School Program linked to the Rochester General Hospital for examples of ways students can earn credit in alternative programs
- Consider the program at Aviation High School in New York City, where students can achieve certification as mechanical inspectors
- The Youth Apprenticeship Program of Rochester requires students to complete capstone projects that link school with community
- Consider the Hillside scholarship education liaison as a model for STEM School District Coordinators; Hillside has grown in partnerships, causing the program to be spread thin; the program has effectively provided workplace mentors who work with students and with the school advocate/liaison
- School 58, the World of Inquiry K-6 School in Rochester produces scores in the 90s in math through expeditionary learning, where 90% of students are poverty level (determined by free and reduced lunch program participants); elementary school students "defend" their performance with presentation of portfolios; program practices are being expanded to K-12
- The School Without Walls, established in Rochester in 1971 (7th -12th grades) requires students to complete Senior Projects that are like Ph.D. dissertations; initially students selected courses to be taught and no grades were given, now assessments are required
- University of Rochester has a pilot project for seniors to train peer leaders in junior courses (weekly meetings)
- Consider St. John Fisher program for students to expose them to careers, hands on learning and opportunities for employment, e.g., pharmacy technician
- Wegman's has students rotate through six-week programs in different departments
- In 1995 a college workshop program for chemistry teachers to learn to work together was initiated with good results, later it was expanded to the biology department by request where it has also been effective; take this program to the lower grades and show what can be achieved
- Consider a program for 7th and 8th grade students who were about to drop out and were instead placed in a class with no curriculum where students developed a project based on their interest in illness and began a research project using the internet to study blood-borne diseases demonstrating "learn by doing"

- MCC program tech camps effectively marketed to students through linking the camp with student interests, e.g., bicycles, offering them a fun, applied, embedded learning experience
- Consider RIT program that connects college age female students with 5th grade girls
- Capitalize on resources in Rochester, including the Rochester Regional Photonics Cluster, the National Teaching and Machining Association, Rochester Business Alliance, and FAME (need more information on this acronym); seek methods to link these resources with student opportunities to earn credits
- Consider the state Center of Excellence for STEM science camp opportunities in partnership with SIMI Semiconductors
- Consider the Xerox adult mentoring program as a model for outreach to students about how to pursue STEM careers; demonstrate potential careers through product outcomes, e.g., robots to show student potential exciting technology they can pursue
- NSF funds three schools to support inquiry based learning in math and science, providing mentors and opportunities for teachers to collaborate in Yonkers, Buffalo, and New York City; principals are strong supporters of the program and this has had a big effect on the program's success; teachers also experience summer sessions that include travel to work with mentors in intensive project development processes
- Various federal and state programs including the USDOE and the Institute for Education Sciences as well as USDOE Innovation Grants, NYS DOE, Department of Labor, and Council of the Arts, could be targeted for support, but this could take as long as five years to incubate; the Department of Energy is looking for programs to replicate in order to develop the needed workforce for federal jobs (cannot hire foreign nationals)
- Identify charter schools that are succeeding to learn about what works from their programs; develop links between public schools and charter schools to influence change in the public schools
- The City of Rochester has double the museum facilities of many communities in the U.S., which could be utilized to support informal learning program development
- Utilize ethnographic methods to gain a better understanding of the process for implementing STEM; consider the drawbacks of qualitative data analysis

Participant survey to launch breakout groups

Four statements were assessed.

1. Economic development and vitality can only be realized through STEM education by broadening collaborative partnerships inclusive of stakeholders in education, business and industry, and the community.

Statement 1	1	2	3	4		N/A
Strongly Disagree	5%	5%	38%	48%	Strongly Agree	4%
Low Priority	4%	7%	39%	46%	High Priority	4%
Requires NYS Policy Change	20%	32%	23%	21%	Implementable Locally	4%
Low Effect on Educ'l Reform	4%	14%	36%	41%	High Effect on Educ'l Reform	5%
Requires Identifying New Resources	7%	29%	38%	21%	Could Redirect Existing Resources	5%

2. Comprehensive STEM education approaches to teaching and learning in all content areas provide opportunities preparing all learners for citizenship, higher education, and careers required of a more scientifically and technologically demanding and complex global community.

Statement 2	1	2	3	4		N/A
Strongly Disagree	4%	14%	30%	41%	Strongly Agree	11%
Low Priority	2%	7%	34%	45%	High Priority	12%
Requires NYS Policy Change	38%	41%	11%	7%	Implementable Locally	4%
Low Effect on Educ'l Reform	2%	7%	34%	54%	High Effect on Educ'l Reform	4%
Requires Identifying New Resources	9%	29%	36%	18%	Could Redirect Existing Resources	9%

3. A network of PreK-20 data systems that collect, analyze, and synthesize data using multiple measures is necessary to implement systemic change in STEM education.

Statement 3	1	2	3	4		N/A
Strongly Disagree	9%	18%	34%	32%	Strongly Agree	7%
Low Priority	11%	27%	41%	16%	High Priority	5%
Requires NYS Policy Change	43%	21%	21%	7%	Implementable Locally	7%
Low Effect on Educ'l Reform	5%	18%	36%	30%	High Effect on Educ'l Reform	11%
Requires Identifying New Resources	20%	30%	30%	12%	Could Redirect Existing Resources	7%

4. Amendments to existing legislation, regulation, and policy are necessary to provide multiple and varied opportunities for students to engage in STEM education.

Statement 4	1	2	3	4		N/A
Strongly Disagree	7%	18%	30%	38%	Strongly Agree	7%
Low Priority	5%	21%	30%	34%	High Priority	9%
Requires NYS Policy Change	62%	20%	5%	4%	Implementable Locally	9%
Low Effect on Educ'l Reform	2%	7%	39%	45%	High Effect on Educ'l Reform	7%
Requires Identifying New Resources	14%	21%	34%	20%	Could Redirect Existing Resources	11%