ESSEI
Empire State STEM Education Initiative Inaugural Dialogue
Breakout Sessions Summary

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Summary of Breakout Session Participation

Participation in the structured breakout session was organized into a set of six assigned sessions for conference participants. Sessions were conducted by a facilitator, and each session was assigned an observer from the cultural anthropology team. For purposes of this analysis, each group was randomly assigned a letter designation from A to F. Observers were tasked with documenting key issues discussed during breakout sessions. The analysis that follows presents a breakdown of issues by group and also provides a comparison of groups by age, sex and professional affiliation. The latter was based upon information that was available from the conference list of participants, and from the observer's record from each breakout session and included the following categories: business, education, government, higher education, nonprofit, STEM and other. Professional affiliation in some cases was either not known[1], or indicated as "other" on the RPI conference attendance list. Age was estimated by the observer and assigned as a range (e.g., 20-30, 40-50, 50-60, 60+).

Table 1: Breakout Session Participation by Profession Across all Groups, shows that a total of (59) individuals participated in breakout sessions on Day 1, and (45) on Day 2. Based upon the available information across all six groups for both days, the strongest representation was from the field of higher education (universities and colleges), followed by those affiliated with business and with STEM program development. On Day 1 and Day 2, government and nonprofit participation was at the same level, however on Day 2, both dropped in their level of participation. The least represented

TABLE 1: Breakout Session Participation by Profession across all Groups

GROUP	DAY 1	DAY 2
Higher Education	17	13
Business	9	8
STEM	9	5
Other/Unknown	8	6
Government	6	4
Nonprofit Organization	6	4
Education (k-12)	4	5
Total	59	45

[1] Based upon ethnographic observation where an individual's name and profession were only noted if given during the session as part of the introduction by the facilitator. In some cases names were not known, or only first names were given for those participants who joined a group late on the first day, or for those who only participated in D2 of the conference. These individuals were included in the "other" category.

On Day 1 was from the field of Education (k-12), and on Day 2 increased by one. Given the number of participants noted as "other" (D1=8, D2=6) it is likely that professional representation could shift slightly for each of the groups. However, as noted earlier in this report, conference participants commented on the absence of students, parents and k-12 educators in attendance at the conference, and during group discussion indicated the importance of future involvement of these groups, both as stakeholders and as partners in STEM development.

Table 2: Existing and Proposed Models for Transitioning to STEM Education, also shows a breakdown of professional participation by group for each day. Among the six groups, one group had participation by all professions for both days (Group B). Among all groups for both days, two had no education participant (Groups E and F); Group F had no business participant; Group D had no higher education participant, Group A had no nonprofit and no government participant, and Group C had no government participant. *Table 2* will be discussed further in the following sections of this report.

In considering age breakdown across breakout sessions, the overwhelming majority of participants both Day 1 and Day 2 was the 50-60 range (D1=58%, and D2=46%), and 40-50 range at 16% for Day 1, and 23% on Day 2. Together the 40-60 age range comprised 74% of all participants on Day 1, and 69% on Day 2. Breakdown of age by group showed four groups of the six on Day 1 had at least one participant in age range 20-30 (Groups A,B,D and E), and four groups had at least one participant in age range 30-40 (Groups A,C,D, and E). On Day 2, three groups had at least one participant in the 20-30 range and one in the 30-40 age range. The age factor was evident in one session on Day 2, where the question of the digital divide was discussed by a group ranging from 40-60, and the observer noted the discussants expressed confusion or lack of understanding on such things as "facebook," or terms like "social networking" (Group F).

Male and female breakdown across the groups broke out as follows (see *Table2):* For Day 1, two groups consisted of a nearly 50/50 ratio of males to females (Groups A and C). Two groups were mainly female (Groups B and F), and the remaining two groups were mainly male (Groups D and E). Day 2, only one group held near to the 50/50 ratio (Group F), three groups were mainly male, and two groups mainly female

Overview of Breakout Session Issues

Key issues presented in the first part of this report included four main areas of discussion across the six groups:

- Engage stakeholders across a broad spectrum of interests, expertise and capacities to contribute to the transition to STEM
- Education must be cradle to grave to go beyond k-20
- 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

Across all groups, ideas for specific action or models for action developed through group discussion and were related to a range of issues including such things as: models for project based learning (PBL) and teaching through open source content (OSC); teacher training and professional development; and suggestions for identifying effective ways to implement systematic changes to meet statewide goals, including ways to engage a broader set of community stakeholders. These appear in *Table 2: Existing and Proposed Models for Transitioning to STEM Education.* Beyond the specific models noted, ideas also included ways in which to harness existing resources in order to maximize the potential for initiating STEM statewide in an efficient manner (e.g., conduct a survey of educational resources consistent with STEM education, or direct the existing requirement for 175 hours of professional development for k-12 teachers to focus on STEM content areas). References to existing programs as models for change, as well as suggestions for developing or creating new models for action, indicate that discussants not only endorse the idea that change is necessary, but also recognize that the actions required may need to follow either known, as well as innovative or as yet unknown approaches.

In the review that follows, these issues will be further explored within the context of individual group discussions to more fully inform the potential range of specific actions for initiating change that can support implementation of STEM education in New York State.

Stakeholder Participation

A priority for stakeholder involvement focused discussion on students, parents and families. Students are viewed as essential partners in creating a new learning environment and approaches to instruction that are discussed throughout this report. Parents and families were noted for several important new roles and functions (Groups B and F). The view that STEM must ultimately become a societal priority (Group A), and that parents and others in the community also need access to technology in order to increase understanding of STEM (Groups B and D) is a theme that recurs among the groups in different ways.

Parents are viewed as essential partners in curriculum development to work with educators and students in partnerships that lead to greater involvement from parents, both in school and in the home (e.g., launch a "do math with your kid" campaign," Group B). Parents must also be directly engaged in ways that will give them access to the process and opportunities to see the changes that are occurring, as well as the results in student achievement (Group C). As stakeholders, participation in the transition to STEM education will also ensure that parents shift their expectations based on their own experience of traditional education (grades, testing, age level advancement, Group D) as STEM education shifts toward new strategies for learning that embraces PBL, OSC and other technology based approaches to formal education.

Broader community involvement also includes parents and others who can help to structure school network relations that reach out to businesses and other potential partners from within the social network of the community. These ideas include the need to identify role models for students (Group E), and specifically the need for "community role models" to demonstrate to students the value of STEM education for career success to show "you can do it" (Group F). Identifying local corporate executives and others with the ability to create targeted action similar to "adopt-a-school" programs was also cited as an important possibility, with the caveat that these must be structured as partnerships to meet future community needs, and not seen as a form of "charity" (Group C).

The importance of creating national level support emerged among discussants in various ways that included targeting partners in media and "Hollywood," to create cultural heroes through film and television (Groups B and C). The idea of making science exciting in ways that could encourage a surge of interest such as that in forensic science driven by the recent slate of popular television programs was suggested as a way to increase interest in math. Creating national role models for girls was also cited as an important need (Group F).

Engaging the business community was suggested to bring them into the process as stakeholders in a collaborative process to build a viable economic future for the community. Business involvement in STEM education can assure that the goals of STEM reflect business and community needs, and that business sees effective change and student achievement that will lead to development of a viable workforce (Group C). Ideas about the role of business and industry ranged from the importance of using marketing strategies adopted from business models, to partnering in the use of technology for social network development within the community to include a broad range of participants, including parents as a starting point to help grow the school network (Group B).

The use of marketing strategies linked with new technologies to facilitate network building can also be developed through the formation of "business alliances" to link business resources directly to the classroom, to teachers and students through project based learning (Groups A and B). Business partnerships can also support distance learning and continuing education opportunities for adults, and provide mentoring opportunities for students through technology (Group E).

Collaboration across many groups (Group D, E and F) was identified as a necessary step in order to assure labor and teacher union interests are recognized and addressed; higher education is engaged both in training teachers for STEM; links between k-12 and higher education are focused on meeting diversity goals; and also that adult education needs across the board are fully considered. One key observation (Group B) concerned the idea that the schools themselves will have to shift toward forming partnerships in which all partners have the opportunity to contribute to the process to do "what each can do best," noting that this would be a very different type of partnering relationship and a departure from past practice in education.

In the next section, issues related to the concept of broadening STEM education to meet the needs of a 21st century society are explored further to understand the broader set of stakeholders and potential partnerships identified by discussants across all groups.

STEM Education for a 21st Century Society

The concept of STEM as the foundation for meeting societal needs for a 21st century workforce was viewed by some to include not only students in the k-20 educational system, but also working adults and others in need of retraining in the current era (Group E). Discussant's perspectives spanned a broad range of needs including the view that students and adults alike must be prepared to not only become "smart" producers of technology and knowledge, but must also become smart consumers of information if we are to fully prepare for the "coming economic portfolio of the state" (Groups A and C). This requires a new kind of literacy that can occur if we educate society broadly to understand and participate in STEM education (Group D and F).

Among discussants, there were distinct views on whether to engage students in pre-k to 6 programs, or whether middle school was more appropriate (Groups D and F). However, the concept that a culture of lifelong learning is essential to engendering innovation, and to overcoming the current era of a "throw away culture" (Group E) was linked with ideas for building a 21st century workforce. Changing the current paradigm and approach to learning math and science, to shift toward the understanding that life is about science (Group B), and that "STEM is everywhere," also requires that access to STEM education is broad in order to meet societal needs (Group C). The importance of building a new paradigm for workforce development to meet global challenges for economic viability was also noted in acknowledging that U.S. college graduates are no longer as competitive with graduates from other countries such as China and India (Group A).

The idea of building a "STEM literate society" requires that we engage students and adults in developing new perceptions about technology and the importance of access to information (Group D). Engaging the public directly will help to shift the notion that math and science are "exclusive," and that access to higher education and STEM careers is a viable option across diverse groups, including women and minorities (Group F).

Building a STEM literate society also requires that the learning experience is not exclusive to the classroom. As STEM programs are initiated and access to learning is opened up via multiple points of access beyond the classroom (Group E), access to new technologies will also support "learner driven" processes that will reframe education, both in and out of the classroom. Citing the shift to "open source content" by some educational institutions (see *Table 2*) to create a self-learning approach through technology (Group C) emulates the business model, where workers are expected to function through problem-solving and project based pursuit of knowledge and expertise (Group B).

Linking the real world and societal needs through access to technology, and cultural values that prize innovation and achievement are important goals that can occur through STEM education. Changing the framework of education to support a STEM approach to learning is discussed further in the following section.

Changing the Paradigm: What will the STEM School House Look Like?

Consensus on the need for change to shift away from the policies and regulations of the "no child left behind" paradigm, and ineffectiveness of "teaching to the test," were identified as barriers to change that must be addressed at both the national and state level. However, discussants did identify a broad set of priority actions that include key areas of change at the local scale that are reviewed in this section. They include: teacher training and professional development; curriculum and instruction approaches; learning in nontraditional environments; engendering cultural values rooted in scientific principles for exploration and discovery; and linking standards of performance and measures of success with desired outcomes consistent with STEM.

The list of models for action presented in *Table 2* suggests that a few institutions in both k-12 and higher education in New York State have already initiated innovative changes that can begin to meet the challenges for improving education statewide. Among the existing models cited are those institutions that have shifted away from textbooks to utilize an "open source content" approach, and those that have organized curriculum around problem based learning modes that require multidisciplinary content. Other models noted are those that provide a science-based approach to learning in nontraditional settings (e.g., museums, state parks) where students seek answers to questions that drive learning through "hands-on" problem solving in a teacherless environment.

All six groups agreed that the key to fundamental change in education is to restructure the way in which teachers are trained and prepared for the classroom. Currently, the system leaves much to be desired as the trend has been for the best teachers to avoid under-performing schools, making access to quality education a roll of the dice for many students (Group B). The question of how to achieve equity in distribution of quality teaching was raised as another issue that could be addressed through STEM professional development (Groups D and F). However, requiring "retraining" for experienced teachers is also seen as a hurdle to overcome in noting that teachers can be reluctant to adopt new methods if they are satisfied with their established practices (Groups C and D).

Shifting the role of the teacher from "knowledge giver" to "learning facilitator" (MIT philosophy, Groups A and D) also calls for changes in the culture of education to support a collaborative process engaging teachers, students and others, both in and out of the classroom, in partnerships that support a "student-driven" mode of learning (Groups B and E). Additionally, it was noted that teachers must be trained for "open source content" instruction and this also requires that teachers master the use of technology as a primary learning tool. Suggestions that teachers be exposed to other environments (e.g., business) and to gain real world experience in problem based learning through "externships" (Group A and F) are also viewed as potentially valuable in shifting the culture of teaching in ways that will ensure that students develop real world skills and proficiencies (Group A).

A shift from the current mode of "siloed" learning toward a multidisciplinary approach (Group C), and specifically the importance of improving the way in which math and science are taught, are also viewed as essential to improving the quality of education (Groups A and E). The idea that curriculum should be designed around "habits of mind" was proposed (Group B), or that curriculum could be restructured around interdisciplinary projects was also posed as a potential approach to a new curriculum (Group D). Agreement that teachers should not and cannot accomplish these changes without the support and collaboration of others was a view shared among several groups (Groups A, C, and E). Additionally, involving students in collaborative processes with teachers to design curriculum, as well as working with higher education are also seen as desirable approaches to STEM curriculum development (Group C)

The relationship to science and technology in today's classroom is often at odds with the real world, noted by some discussants who described a lack of scientific spirit for exploration (science should be exciting and fun, Group B) and standard practices that employ technology at its lowest function (Groups B and F). Fundamental to this view is the idea that under the current paradigm students are discouraged from exploring and risk-taking in seeking answers to questions and innovative solutions to problems. The experience is one that engenders students with the notion that failure is to be avoided, and that there is no value to be gained in learning through trial and error and understanding "what works and what doesn't work" (Group A). Additionally, classroom use of technology and approaches to math and science have created a cultural context in which many students consider math to be "boring" (Groups C and E), and also do not make the connection to meaningful exploration of the real world and real issues through technology (Groups B, C, and D). These issues raise questions about the current system and important changes that must be made if we are to cultivate innovative strengths in students, versus continuing practices that support the status quo (Group E).

Last, the question of developing new assessment standards presents a set of challenges that will also require a new context in which to reconsider outdated measures of proficiency that include such things as credits to meet graduation requirements, and age-based grade advancement (Groups A, B, C, D and E). A shift to "paperless testing," and sorting out issues of web access versus "cheating" (Group B), also require changes in the cultural context of demonstrating proficiency with new technologies. Remarks were also made concerning the importance of calibrating new standards to equate with expectations in the workplace (Groups C and E). Standards should also focus on assessing desired skills that include communication, writing, problem solving and critical thinking (Groups A and C).

In the final section of this report that follows, issues addressed by discussants concern the sustainability of educational systems, and meeting the long-term needs for developing a highly functional and competitive 21st century workforce through STEM education.

Sustaining STEM Education for Long-Term Success

Many of the breakout session discussants identified the lack of government action to initiate systematic statewide changes, as well as lack of leadership of elected officials and policy makers in reforming education in the state of New York. While there is consensus that government should play a role, it is also clear from the views expressed across the six discussion groups that local scale change will require community-based initiatives and the formation of new partnering relationships. These actions will need to be supported by public-private funding to effectively implement long-term changes in education. From the perspective of some of the discussants, this requires an entrepreneurial approach to developing STEM networks that will harness the existing resources of the community and its learning institutions. These actions at the local level are key to providing the platform for national and state level reform that may also be cultivated through the shift to STEM education in the near future.

The way in which the problems in education are defined will in part determine the solutions that are sought and implemented, and the results that follow. In this view, the urgency of the current situation in New York State should be considered a "crisis in education," and in this manner trigger the full resources of the public as well as the private sectors (Groups B and C). The discussants expressed belief that elected officials and others such as the Regents support reform of the educational system, however, little has been done to shift necessary resources and funding to initiate action (Groups A, C and E). Business, in taking cues from lack of action by universities and government, also lacks the sense of a "shared crisis" and is reluctant to move at the institutional level (Group C). Furthermore, STEM presents a long-term investment that is more like "a seed for the future," and is not likely to be viewed as a short-term "fix" that many feel is needed now (Group E).

One area of reform that can initiate cross cutting action to support local scale change is to reframe funding formulas for education from both the state and federal levels. The accompanying message directed at decision makers in support of this action should clarify the link between STEM education and STEM jobs (Group F). Increasing funding to schools that place more graduates in STEM jobs, or linking funding to desired outcomes such as raising graduation rates for high-risk students in underperforming school districts (Group D) are examples of funding targeted to desired outcomes. Another approach could allow for creation of "innovation zones" where new policies and funding practices that include innovate public/private collaborations could be explored without being constrained by current regulations (Group F).

The need to reconsider incentives is apparent in that the current system of incentives often leads to the wrong outcomes: current practice awards dollars for numbers of students enrolled, versus student performance, or quality of teaching (Group C). Creating different opportunities to drive change through outcomes based assessment includes issuing Challenge Grants to community colleges that meet desired outcomes such as actual numbers of students entering STEM careers (Group D), development of internships that lead to college credit, or shifting to OSC and away from textbooks. Syracuse University was cited as an example where all students within the city limits are offered incentives that lead to entrance to higher education (Group C).

Increasing involvement of the private sector to engage in entrepreneurial explorations can result in better connections with business and industry. Partnering with business can lead to new relations based on market strategies that link services and resources with the classroom that can be mutually beneficial (Group E). These include marketing of technology and services that meet the scale of current business practices as noted in the comment that business no longer sells "door-to-door" (Group D). State leadership can also play a role in building high profile network partners within the state. Notably, McGraw-Hill was cited as an example where Regents could be encouraged to pursue new interests from the corporate community (Group C). Targeting a smaller scale, utilizing an "engage and reward" strategy would encourage relations with small businesses that are then given tax incentives for STEM involvement (Group A).

Partnering with business to develop other types of marketing strategies to grow and strengthen community networks is also a key action that could promote STEM in targeted ways that could increase broad based STEM program development (Group E). Development of "business alliances" to benefit from expert, "how to" strategies (Group B) can help to develop marketing campaigns such as one aimed at parents to define what STEM is and what STEM does (Group A), or targeting students through technology with the message that STEM is "cool" (Group E). Another direction would be to target marketing to areas of lower performing schools (Group B). In this way, partnering with business to apply marketing principles to motivate change, students and others in the community are engaged in the process as consumers of information (Group C).

Use of technology to drive change raises the question of access to technology and the issue of the "digital divide," which includes several dimensions. Access to technology can be considered from the aspect of generational and cultural differences, as well as differences in access among rural areas, or low SES urban areas that effectively form barriers to access, versus suburban areas where libraries are better equipped and other points of access are available (Groups A and F). Lack of access to technology also appears to be a factor for U.S. college graduates, while graduates from other countries apparently are not as affected as demonstrated by the quality of "job ready" college graduates emerging from places like China and India (Group A). The fact that classrooms are 15-25 years out of synch with the real world in the application of technology underlies the urgency of shifting away from high cost text books toward OSC (Group D). Other issues of equity that link to the digital divide also stem from goals to increase inclusiveness of access to technology and to higher education for underrepresented groups including women and minorities (Groups B, D and E).

Seeking guidance as well as learning from other experiences in the transition to STEM education is potentially beneficial and a number of programs were cited by discussants over the course of the two-day conference (see *Table 2*). Additionally, discussants noted that future conferences will benefit from involvement of key stakeholders, including students, parents and k-12 educators, whose perspectives will bring additional knowledge and expertise to the process of developing STEM education in New York State.

Conclusion

Conference participants were asked to consider important challenges facing New York State in preparing students for a 21st century world. Utilizing existing resources to initiate the development of STEM education includes the potential to build viable partnerships and alliances in the form of networks that can maximize an efficient transition to a new educational paradigm. Conference participants provided many ideas including those noted in *Table 2*, citing existing programs and opportunities for partnering to launch STEM education in New York State. Developing an entrepreneurial approach to long-term sustainability can also help to nurture and expand public-private networks that can function and change in the context of local economies, and can lead to creating sustainable programs in the long run.

Table 2: Existing and Proposed Models for Transitioning to STEM Education

KEY:	B=Business; E=Education; G=Government; HE=Higher Education; NP=Nonprofit; Oth=Other, S=STEM

Group A	**D1: 12 participants: 6F/6M; HE=4, Oth=4, B=2, S=1, Ed=1, NP=0, G=0**
	D2: 7 participants: 2F/5M; HE=2, B=2, Oth=2, E=1, G=0, NP=0, S=0
	High Tech High
	Tech Valley High
	Partner with public libraries to conduct summer reading programs that incorporate math and science
	Explore the medical model (shift from single generalist working alone to teams of experts working jointly)
	Explore the business model (motivated by competition)
	Metro High School
	MIT (open access to lectures and other course materials online, and more value placed on MIT learning experience
	Project Zero, Harvard University, "Learning for Understanding," (problem based learning builds a wide range of skills)
	Use the "Bush" model for teacher evaluation to assess training needs
	Conduct statewide inventory to identify existing STEM related resources
	Require STEM focus for existing required professional development (175 hrs)

Group B	**D1: 9 participants: 7F/2M; HE=4, B=1, E=1, G=1, NP=1, S=1, Oth=0**
	D2: 11 participants: 9F/2M; HE=5, E=2, B=1, G=1, NP=1, S=1, Oth=0
	Develop an investment fund similar to the "GI Bill" to attract investers in STEM
	Tech Valley High "mini-internship" program in partnership with small business
	Teacher Transition Program (no other details provided)

Group C	**D1: 9 participants: 4F/5M; HE=4, B=2, E=1, NP=1 S=1, G=0, Oth=0**
	D2: 6 participants: 4F/2M; HE=3, B=1, E=1, S=1, G=0, NP=0, Oth=0
	Bard College (Open Source Content; Teacher Training, terminal certificate in content area and placement program)
	Develop a Ph.D. program for STEM teachers, link graduates to university w/joint (part-time) faculty positions
	Develop teacher professional development through charter schools (greater ability to work around regulations)
	Ohio STEM schools (more local control over designing change, built into legislation, e.g., control over scheduling, development of off-site projects, summer programs for credit
	Require calculus in high school (would require system to offer related courses that would increase difficulty of coursework)

Group D	D1: 11 participants: 2F/9M; B=3, G=2, Oth=2, S=2, E=1, NP=1, HE=0
	D2: 8 participants: 2F/6M; B=3, E=1, G=1, NP=1, S=1, Oth=1, HE=0
	Identify "models of intervention" that are effective in creating systematic changes to solve problems in education
	Identify the existing components of the school district that are consistent with STEM education and could function to support the transition (don't reinvent the wheel)
	Change the funding formula so "at-risk" schools receive funding for increased rate of graduation; job placement in STEM careers

Group E	D1: 10 participants: 2F/8M; HE=3, G=2, NP=2, B=1, S=1, Oth=1, E=0
	D2: 8 participants: 1F/7M; G=2, Oth=2, B=1, HE=1, NP=1, S=1, E=0
	Explore the military model success in engaging school drop outs
	Bard College (Continuing Education for prison population; new learning facility has resulted in attracting students, increased enrollment)
	Develop a 2-4 year STEM scholarship
	See E models for change - pd internships
	Cornell University apprenticeship program
	Nike model (marketing to influence interest before a product is "rolled out")
	Create a k-20 "demonstration" program in one system as a model for change
	Create a network of schools, organizations, business employers, and higher education with broad authority to implement and assess policy and pracrtices that demonstrate effectiveness of "hands on learning," transforming the entire community to the STEM operational model
	Create five "platform" schools statewide that can impact a region by a specific point in time

Group F	D1: 8 participants: 5F/3M; S=3, HE=2, G=1, NP=1, Oth=1, B=0, E=0
	D2: 5 participants: 3F/2M; HE=2, S=1, NP=1, Oth=1, B=0, E=0, G=0
	Create "innovation zones" to permit flexibility in exploring changes in policies and regulations; explore public/private funding options
	Develop extended learning networks to link schools with learning environments in the community
	Adirondack Park (provides students an opportunity for science-based learning experience)
	SUNY Teaching College should partner and provide model for teacher training
	Modify New York State "Teach for America" to support STEM education goals
	Develop a lottery enrollment system to increase diversity and access to education