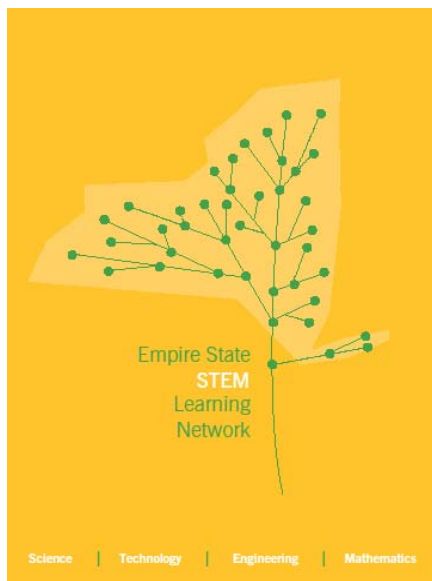


STEM Learning @ ESM



And other partners in the
Central New York STEM Hub



Office of the Senior Vice Chancellor for
Community Colleges and the Education Pipeline

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Learning Objectives

1. Share learning models in creating a world-class STEM district and school through observation and engagement with students, teachers, administrators and partners involved in STEM teaching and learning transformation across the PK-12 inclusive continuum in the Hub's lead district, East Syracuse Minoa (ESM)
2. Share perspectives about how the Central New York team engages stakeholders in their regional STEM hub and to move from high level mission/vision/goals to action plans for the year ahead

Suggested Discussion Points/Questions:

Curriculum

- How does the vision and mission of the East Syracuse Minoa Central School District pervade their schools?
- Similarly, how do the Elementary, Middle and High School approaches to STEM teaching and learning align and differ?
- To what extent is the curriculum in the Elementary, Middle and High School align to higher education? Careers?

Instruction and Assessment

- How is STEM education demonstrated in student learning and supported by interdisciplinary teams?
- How do students and faculty engage in STEM discourse, activities and learning?

Organization

- How does the ESM Strategic Plan guide systemic change?
- How do students define success? Teachers? Administrators?
- What are the essential resources that support STEM education at East Syracuse Minoa Central School District?

Professional Development

- What professional development opportunities are available to teachers?
- How does East Syracuse Minoa Central School District address the dual nature of STEM teaching: pedagogical professional development and workforce competency?
- How does East Syracuse Minoa Central School District recruit and train qualified STEM teachers?

Networks/Community Partnerships

- What kinds of partnerships for learning are integral for STEM development at ESM?
- How do the partnerships for learning support the district and the schools realizing their vision and mission?
- Why is the CNY STEM HUB important to the district and schools?
- What worked best in moving from talk about forming a regional hub to announcing the hub?
- What didn't work so well in forming the hub?

Experimental Models

- What can policy makers in New York do to support this kind of work?

East Syracuse Minoa Central School District

The Community

The 72-square-mile suburban district has a resident population of more than 22,000 and encompasses the Villages of East Syracuse and Minoa. As part of Central New York's four-season region, the district is minutes from the City of Syracuse's downtown amenities.

The area boasts of more than 44 universities and colleges offering professional and cultural opportunities, including Syracuse University, SUNY ESF, Le Moyne College and Onondaga Community College. Recreation opportunities abound with more than 50 state and county parks and 40 golf courses.

A strong, supportive business presence with Bristol Myers-Squibb, CORE Federal Credit Union, Siemens and others provides numerous career opportunities. Culturally, the nationally renowned Everson Museum of Art is among the museums and galleries, as is the Museum of Science and Technology. The Syracuse Opera serves the area musically, while Syracuse Stage leads the list of theatrical offerings.

The Carrier Dome, home to Syracuse University athletics, is the only domed stadium in the Northeast featuring the nationally renowned college basketball team – The Syracuse Orange! The sports scene also includes the Minor League Baseball Triple-A Syracuse Chiefs, Syracuse Silver Knights Soccer Team as well as the American Hockey League's Syracuse Crunch.

About ESM – www.esmschools.org

ESM supports the importance of early childhood education with a pre-kindergarten program serving ages 1-4 at Park Hill School and a full-day kindergarten program in each of its four elementary schools. Inquiry-based learning is an essential element in the delivery of the Common Core Curriculum.

Pine Grove Middle School is a collaborative learning community with a focus on transforming educational engagement and delivery as a model for 21st century learning. Pine Grove emulates preparing the *whole child* through the alignment of curriculum with the Common Core State Standards and the integration of STEM/STEAM principles in trans-disciplinary, project-based learning. Covey's *7 Habits of Highly Effective Teens* are an integral component of Pine Grove's youth development. Pine Grove Middle School was the recipient of the 2010 NYS ASCD Educating the Whole Child for the 21st Century Award and the 2011 ALA National School Library Program of the Year.

ESM is proud to be one of 11 schools in New York State designated as a comprehensive high school with a student-led credit union, courses for advanced placement and college credit and the integration of 21st century learning in preparedness for success with real-world application in learning and life. The East Syracuse Minoa Central School District is one of only 388 school districts in the nation honored by the College Board on its AP[®] Achievement List.

District Enrollment: The total enrollment for the Fall of 2011 is approximately 3,680 students.

Building Enrollment (approximate):

- Park Hill School: Pre-K program for ages 1 through 4, enrollment of 350
- East Syracuse Elementary School: Grades K-5, enrollment of 350
- Fremont Elementary School: Grades K-5, enrollment of 350
- Minoa Elementary School: Grades K-5, enrollment of 375
- Woodland Elementary School: Grades K-5, enrollment of 360
- Pine Grove Middle School: Grades 6-8, enrollment of 760
- Central High School: Grades 9-12, enrollment of 1,150



Vision

The East Syracuse Minoa Central School District will be an exemplary 21st Century learning community whose graduates are prepared to excel in a complex, interconnected, changing world.

Mission

The East Syracuse Minoa Central School District will prepare students for the 21st Century by engaging all learners in meaningful learning experiences that meet the highest educational and ethical standards in a caring, collaborative learning community supported through partnerships with parents and families, businesses, civic organizations, and higher education.

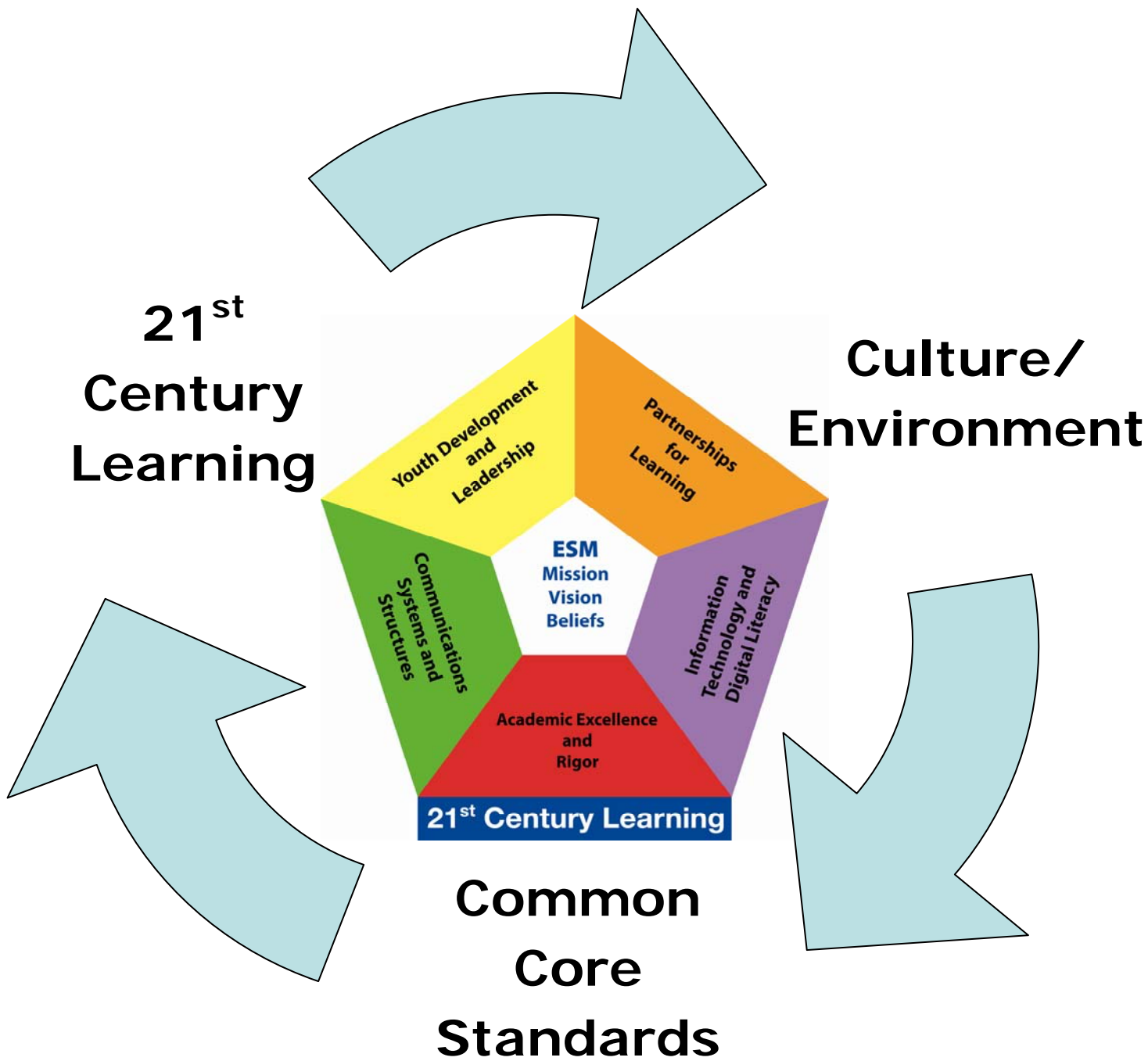
Belief Statements

We believe that:

- Each individual has dignity and worth
- The capacity to learn for each individual is boundless
- Curiosity and exploration stimulate innovation and learning
- High expectations and challenging curriculum lead to greater achievement
- Effort and perseverance are essential to achieve one's personal best
- Positive relationships are fundamental to success and growth
- Collaboration within and among school, families and community partners is essential to meet the needs of each student
- Acceptance and mutual respect encourages students to take the risks necessary for academic and personal growth
- Education prepares students to become productive and responsible citizens who contribute to their communities
- Students need to develop their strengths, confidence and resilience to meet the challenges they will face throughout life.

Goals

- Goal I: Increase student achievement through high expectations supported by a consistent, comprehensive focus on teaching and learning.
- Goal II: Build capacity within the system to support and nurture a continuum of learning through the implementation of research-based effective practices resulting in improved student achievement.
- Goal III: Strengthen parent engagement and community partnerships to support learning and achievement



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Central New York STEM Hub Overview

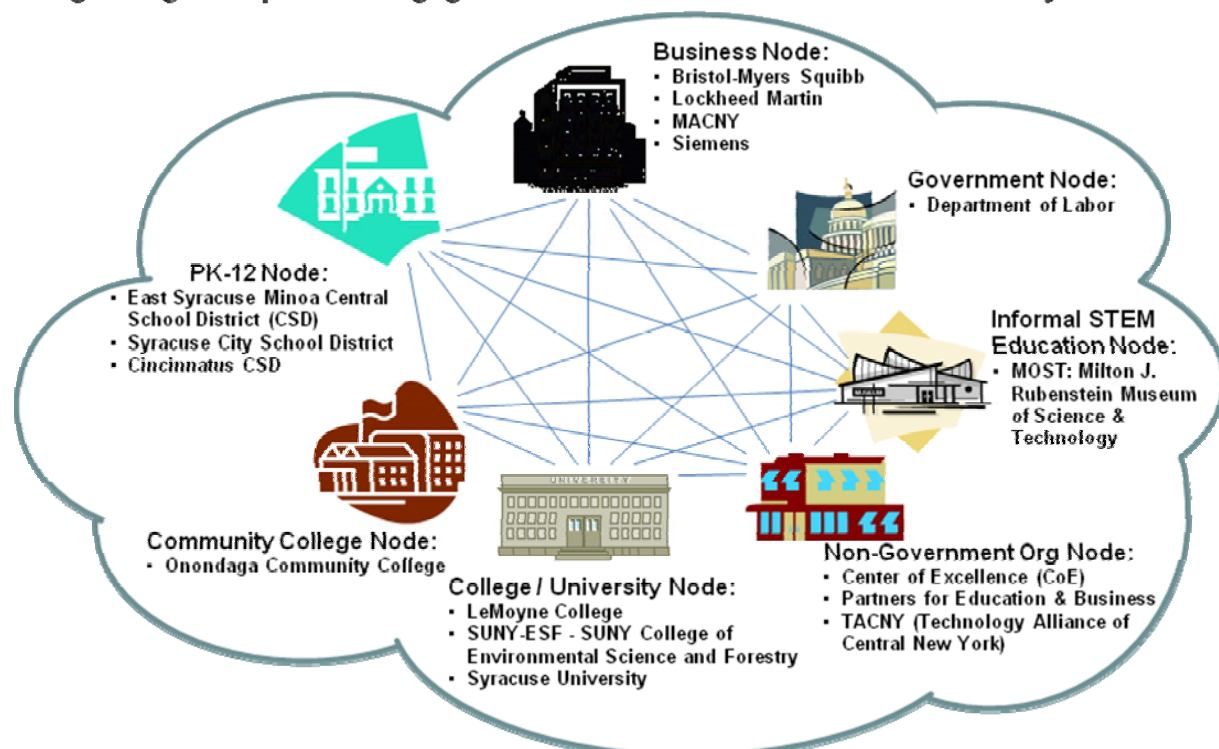
Vision: The CNY STEM Hub will design and incubate educational models of excellence empowering all PK-20 students to excel in a rapidly changing world.

Mission: The CNY STEM Hub will interconnect business, higher education, community organizations and PK-12 schools to design, develop and demonstrate innovative, sustainable and transferable STEM learning experiences.

Goals:

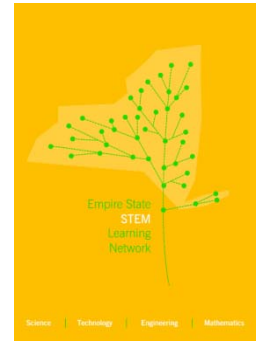
1. By 2014, the CNY STEM HUB will exemplify the attributes of a professional metropolitan learning community by creating and sharing knowledge and successful, innovative learning experiences that ignite and strengthen problem solving and critical thinking abilities in K-12 learners for success in our global society.
2. By 2014, the CNY STEM HUB will strengthen instructional practices in K-12 STEM HUB classrooms through professional development for teachers and administrators in inquiry and design learning models.
3. By 2014, the CNY STEM HUB schools will design and develop trans-disciplinary learning experiences through design and inquiry with real-world context/application.
4. By 2014, the CNY STEM HUB will design, develop and incubate STEM literacy educational models that prepare students for college and career through the integration of 21st Century knowledge and skills.
5. By 2014, the CNY STEM HUB will systematically document effects of new learning experiences on short term and long term student learning, student motivation, and college and career trajectories and performance, with the intent to regularly publish new findings in the education literature.

The growing list of partners engaged in the work of the CNY STEMHUB currently includes:



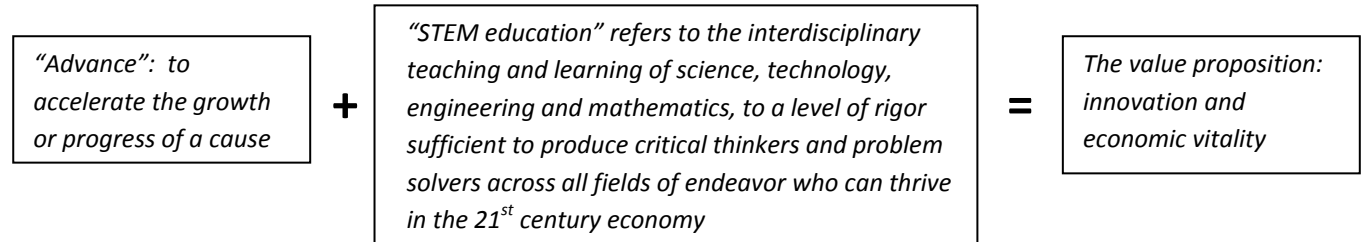
Empire State STEM Learning Network

Connect, Collaborate, Compete



Empire STEM is a statewide, community-led collaborative.

The Network mission is to advance STEM education to prepare *all* students – regardless of their career goals – for college and career success, to fuel innovation and economic vitality in the Empire State:



The Network’s **vision** provides a roadmap for communities to accelerate the way they learn and compete by leveraging assets, expertise and partnerships:

- Advocate for **POLICIES** that advance interdisciplinary, inquiry-based, contextual teaching and learning
- Contribute to **PORTFOLIOS** of effective and/or promising STEM practices and programs
- Establish **PLATFORMS** for innovative STEM teaching through proven or promising school models
- Develop public / private **PARTNERSHIPS** that engage diverse stakeholders over the long term

The Network’s **design principles** represent common beliefs held by stakeholders across the state:

1. **STEM FOR ALL**: All students must attain STEM literacy for the Empire State to thrive in the 21st century
2. **SYSTEMIC MODEL**: A systemic, interdisciplinary approach to STEM teaching and learning is required to prepare the “whole” student for success in work and life
3. **EVIDENCE-BASED APPROACH**: Effective STEM education must leverage existing assets and embrace new models that reflect real world context, interests and needs of students, teachers, and their communities
4. **OPEN COLLABORATIVE INNOVATION**: Innovative STEM education policies, processes and programs must be both scalable and sustainable
5. **COMMITTED STAKEHOLDERS**: Business, PK-20 education, students, parents, community organizations, foundations and government must engage steadfastly, openly, and with ingenuity across a broad spectrum of interests, expertise and capacities to achieve STEM excellence

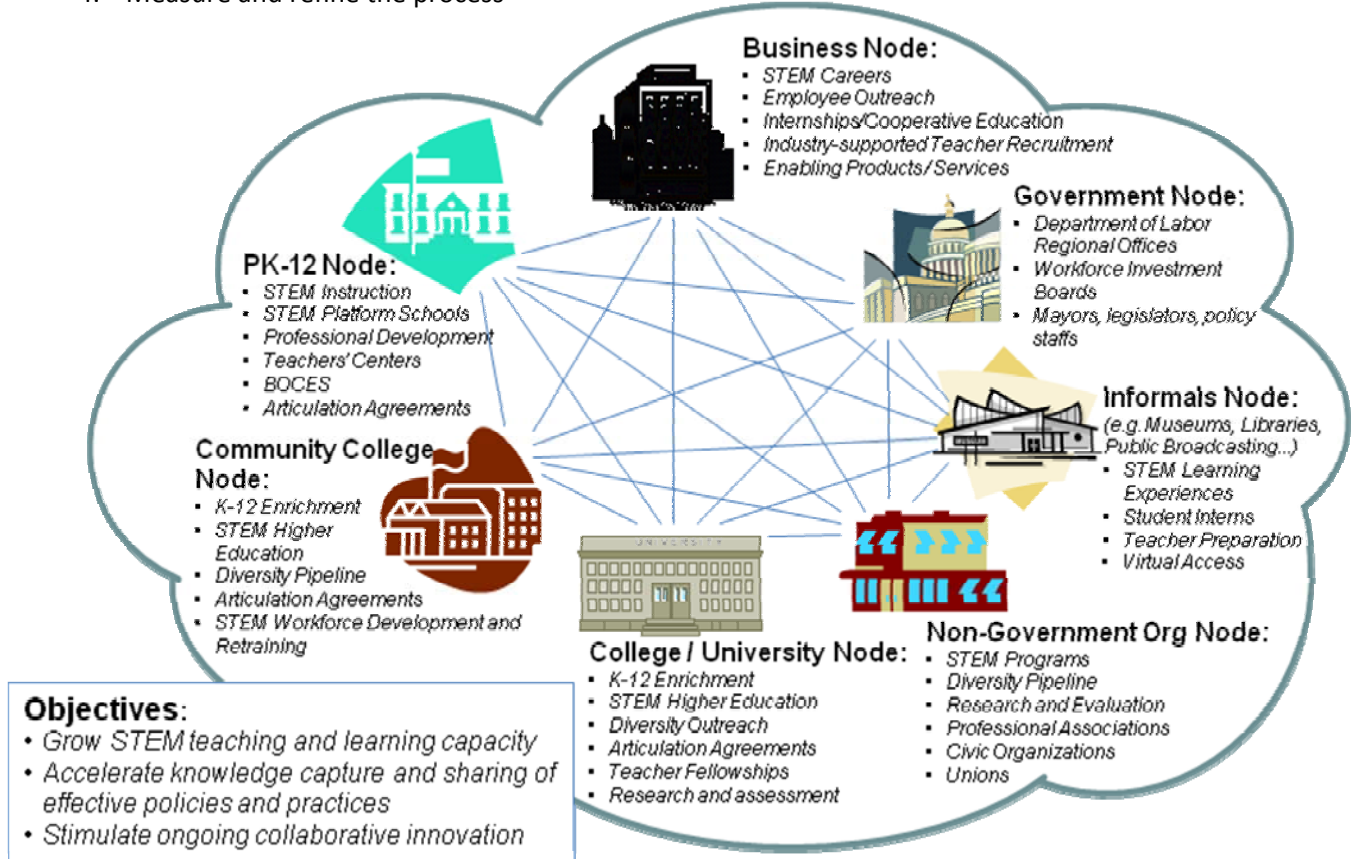
NETWORK FORMATION STATUS: Communities are mobilizing to form interconnected regional STEM hubs across the state with goals relevant to local needs, capacities and priorities that are aligned to the Network’s mission, vision and design principles. STEM hub initiatives are included in several of the November, 2011 Regional Economic Development Council strategic plans. Empire STEM’s statewide office is based in the State University of New York (SUNY) Office of the Senior Vice Chancellor for Community Colleges and the Education Pipeline in partnership with Battelle.

CHANGE THE EQUATION: CTEq members involved in the network at the statewide level include AT&T, Battelle, Bill & Melinda Gates Foundation, Cisco, Corning Incorporated, Ford, IBM, and Siemens. GE, Lockheed Martin Corp., Time Warner Cable and others support regional STEM initiatives.

WEB SITE: www.empirestem.org

Empire STEM Regional Hub Concept

0. Convene **Regional dialogue** to build awareness, interest and shared belief in the burning issue
 - a. Executed in 2009 in the largest 8 of the 10 economic regions in NYS; additional opportunity in remaining economic regions and sub-regions of the 8
 - b. Regional and statewide ethnographic reports are available at www.empirestem.org
1. Identify a regional Hub Steward to co-coordinate the startup of a regional hub of the Empire State STEM Learning Network
2. Develop **Regional STEM Learning Goals and enabling Statement of Work** that balances between prescription (design principles, stakeholder types and roles, goals framework) and flexibility (focusing on regional needs, leveraging regional capabilities)
 - a. Define initial Regional STEM Learning Goals
 - i. STEM goals and objectives specific to the region – short term, longer-term that clearly place schools/districts at the center of the design
 - ii. Regional needs versus existing capabilities (asset mapping)
 - b. Formalize action plans, measures of success and participants in the enabling public/private partnership through **Letters of Intent** to the regional Hub from:
 - i. Schools/districts serving as platforms at the center of the design
 - ii. Capacity builders (business, higher education, cultural institutions, community-based organizations, etc.)
 - c. Establish management system
 - i. Regional hub meetings, metrics and reporting, decision-making
 - ii. Connection to the statewide Network
3. Announce and Implement - Coordinate announcement timing for maximum impact
4. Measure and refine the process



TIES STEM Education Monograph

Attributes of STEM Education

By: Jan Morrison

The Student

The hallmark of being a youngster is play, “...the experience of play is grounded in the concept of possibility.” (Thorne, 1998) If the cognitive learning theorists are right, then play is the pre-cursor to problem solving. Questioning is central to play. Thus, children asking questions of the adult world is vital to their development. Children are handed verbal cues that keep them safe, “don’t touch the stove.” Yet, their world is full of stimulation that spurs them to questions, not just acceptance of commands. They “tinker” with notions as much as play dough and legos. “Why” is vital to their understanding. Slowly, over their early childhood they become more and more sophisticated problemsolvers, robust knowledge and understandings are socially constructed through talk, activity and interaction around meaningful problems and tools.” (Vygotsky, 1978) Their need to understand the world and address their whys creates pathways for them to begin to make sense of the world, “Humans are viewed as goal-directed agents who actively seek information.”(How People Learn, Pg. 10) Thus, as an entering elementary student, they have solved many problems for themselves using a design model.

A K-12 STEM educated youngster would then continue their education in consonance with this view of the world. They would be invited to continue to understand process and apply their understanding to novel situations. Knowledge, facts and vocabulary would support their drive to understand and make sense of things.

Suggested Attributes of the STEM educated student:

- Problem-solvers—able to frame problems as puzzles and then able to apply understanding and learning to these novel situations (argument and evidence)
- Innovators—“power to pursue independent and original investigation” (Gilman, 1898) using the design process
- Inventors—recognize the needs of the world and creatively design and implement solutions
- Self-reliant—able to set own agendas, develop and gain self-confidence and work within time specified time frames
- Logical thinkers—using the logic offered by calculus and found in 60% of all professions world-wide; able to make the kinds of connections to affect an understanding of natural phenomena
- Technologically literate—understand the nature of the technology, master the skills needed and apply it appropriately (Knowledge, Ways of Thinking and Acting, and Capabilities as specified by ITEA in Technically Speaking)
- Participants in the STEM lexicon that supports the bridge between STEM education in school and the workplace
- Able to relate their own culture and history to their education

The School

“For too long we have collapsed teaching in STEM to the presentation of information and cultivation of technique” and therefore student understanding has fallen short. (Rosenblatt, 2005). We have treated the material as sacred and paid little attention to the pedagogy that is key to quality instruction. Children learn through experience, talk and discourse. A student learns through shaping an argument and providing compelling evidence for it. On top of this narrowed view of STEM education, we have continued to perpetuate the great silos of biology, chemistry and physics, not as the natural phenomena present itself but as the Committee of Ten in the late 1800’s viewed STEM education. “The Committee of Ten reduced the American education system to the pursuit of “knowledge” and the exercise of the mind in the cause of judgment.” (Morrison, 2005) Therefore the challenge or charge for the STEM Academy is to, “construct a learning environment in which students have significant opportunities to take charge of their own learning; construct learning environments that are fundamentally oriented toward democratic ideals— independent of the age of the learning—rather than the preparation of “obedient” bodies (Foucault, 1975).” (WM Roth, 1998). Furthermore, as the National Science Education Standards relate, “The STEM Academy is

to, “construct a learning environment in which students have significant opportunities to take charge of their own learning; construct learning environments that are fundamentally oriented toward democratic ideals— independent of the age of the learning—rather than the preparation of “obedient” bodies (Foucault, 1975).” (WM Roth, 1998). Furthermore, as the National Science Education Standards relate, “There should be less emphasis on activities that demonstrate and verify science content” and more emphasis on those “that investigate and analyze science questions” (NRC, 113).

The synthesis of these ideas leads to acknowledging teaching of STEM in the first place but, with design leading the way. Teaching science and mathematics through design, “formally engages students in this basic human approach to meeting life’s challenges and in the process addresses several longstanding issues in science education... (and math education).” (Haury, 2002) The design process offers a means of problem solving that is time-tested in engineering, technology and the arts. It compels students to understand the issues, distill the problems and understand processes that lead to solutions, “The major education goal in design is that students can develop two important kinds of knowledge necessary for making increasingly intelligent choices and decisions: (a) deep familiarity within a specific domain (content knowledge); and (b) strategies for bringing structure to complex and ill-defined problem settings invention and engineering.” (W.M. Roth, 1998) There is widespread consensus that engaging students in design is vital in science and mathematics education (AAAS, Project 2061, 1993) with studies demonstrating that design can significantly advance academic, creative abilities and cognitive function. (Hetland, 2000; Seeley, 1994; Willet, 1992). The design process offers a sophisticated means of instruction for the school and classroom.

What about the curriculum and materials? Science, technology, engineering and math (STEM) is a metadiscipline, the “creation of a discipline based on the integration of other disciplinary knowledge into a new ‘whole’.” This interdisciplinary bridging among discrete disciplines is now treated as an entity, STEM. It offers a chance for students to make sense of the world rather than learn isolated bits and pieces of phenomena. Yet, STEM is really greater than interdisciplinary. It is actually trans-disciplinary in that it offers a “multi-faceted whole” with greater complexities and new spheres of understanding that ensure the integration of disciplines. (Kaufman, et al. 2003, Abts, 2006)

Suggested Attributes of the STEM School:

- STEM literacy as a priority for all students with all learning styles and backgrounds
- STEM literacy as culturally relevant to all students and teachers
- Design process driving the STEM instruction throughout the school
 - Designing is cognitive modeling in which a person gains insight into a problem, determines alternative pathways, and assesses the likelihood of success between solution sets
 - Designing is an intentional activity which can bring about change
 - Designing is intuitive and deductive, it is more than knowing how to use resources, or how to practice skill sets “through designing humans structure continuous experiences into a series of overlapping episodes... by focusing on designing and interpretive activity... construct meaning and knowledge.” (Roth, 1998, p.18; Abts MSP Pending 2006)
- Tinkering with notions and materials central in all school areas, curricular and co-curricular
- Curriculum materials in support of the instruction not to supplant it
- All curriculum materials STEM in nature (trans-disciplinary)
 - Emphasis on technology and engineering in science and mathematics courses
 - Use of NSF generated mathematics and science materials with design embedded
 - Broad range of STEM courses available to students throughout their high school career (ex.: animation with AAVID in the ninth grade, GIS throughout, etc.)
- Innovation and invention highly prized in all student engagement
- A culture of questioning, creativity and possibility pervading the school
- Rigor is defined using benchmarking of design process with student outcomes
- Testing of students formative and most often performance based
- Teachers having a “thorough understanding of the subject domain and the epistemology that guides the discipline (How People Learn, p. 188)

- All professional development for teachers yearlong would use classroom materials, integrate STEM across the curriculum and be constructivist in nature (Horizon Research NSF, 2006)
- Compliant in state testing and standards as the floor not the ceiling
- Administrative decisions data driven within the mission of the STEM Academy

The Classroom

Suggested attributes of the STEM classroom Grades 6-12:

- Active and student-centered
- Equipped to support spontaneous questioning as well as planned investigation
- Center for innovation and invention
- Classroom, laboratory and engineering lab are physically one
- Equipped with small hand tools, malleable materials and ventilation to specification
- Outfitted with computers (laptops) with STEM software: GIS, AAVID, CAD, etc.
- Supportive of teaching in multiple modalities
- Furniture is easily reconfigured
- Electricity is accessible from the ceiling and the floor
- Serves students with a variety of learning styles and disabilities

Lingering Issues...

Although we are replete with reports delineating the issues in workforce and school, there is very little that specifies STEM education (attributes of graduates, schools, and classrooms). Few hold a vision for this kind of secondary school reform. Few understand the bridge between workforce and school. Finally, very few understand the needed professional development for pre-service and in-service teachers who will be STEM teachers shortly. Many decision-makers further the misconceptions about this kind of work when they speak to this issue.

Major misconceptions about STEM education...

- Technology and engineering are to be layered as additional coursework
- Technology means additional computers for schools and students
- Technology means word processing
- Hands-on means active learning with protocols
- STEM omits laboratory work and the scientific method
- All STEM educated students will be forced to choose technical fields because they do not have a liberal arts foundation
- Mathematics education is apart from science education
- STEM addresses only workforce issues
- Technology education and engineering are disparate and troublesome
- Tech ed teachers cannot teach science or mathematics
- Engineers cannot teach science and math

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 - b. [NC STEM](#) Community Collaborative
 - c. Texas High School Project / [T-STEM](#)
 - d. [Washington STEM](#)
 - e. California STEM Learning Network ([CSLNet](#))
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