

## ISSUE BRIEF

### **Advancing STEM Learning across the Educational Pipeline: Statewide Efforts in Ohio**

*This issue brief is one in a series supported by the Bill & Melinda Gates Foundation that addresses current educational issues informed by relevant research and also based on information gained through an AYPF field trip. AYPF convened a group of policy leaders from states engaged in work to advance STEM education for a field trip to Columbus and Dayton, Ohio in March, 2009 to learn from Ohio's success advancing STEM education across the state. This brief is focused on the topics covered during the field trip to Ohio.*

#### **Framing the Issue**

Education in science, technology, engineering, and math - collectively known as the "STEM" disciplines - is key to our nation's ability to prepare our youth with the skills and knowledge to succeed in jobs in the 21<sup>st</sup> century. The U.S. economy is increasingly linked to the global economy, and competition from international competitors such as China, India, and Japan threatens to permanently unseat the U.S. as the leader in innovation. This new economy has at its center a range of jobs based on skills grounded in the STEM disciplines. A commitment to better educating American youth in the STEM disciplines has the potential to position the U.S. for continued economic competitiveness.

In recent years, awareness of the need to strengthen the nation's STEM disciplines has emerged in many sectors of society. On the part of the Federal government, the push for STEM improvements has been articulated as a strategy to improve innovation and competitiveness. Research and development (R&D) in science and related disciplines were made a priority with the passage of the America Competes Act (ACA) in Fiscal Year 2007. The ACA committed \$5.9 billion in FY 2007, and more than \$136 billion over the following 10 years, "to increase investments in R&D, strengthen education, and encourage entrepreneurship and innovation."<sup>i</sup> On the state level, a commitment to improving STEM education in schools is often an outgrowth of the need to provide qualified workers for specific state-based or regional industries. State leadership is increasingly investing in initiatives that help "grow their own talent" to supply qualified workers to local industries. Businesses and philanthropies, too, have provided integral support of STEM learning throughout the educational pipeline, from early education through postsecondary education. The public also is aware of the need for STEM, and recognizes that the modern workforce requires every worker to have some skills in technology in order to be able to do the jobs of today and the future.

#### **STEM Education as an Issue of Educational Equity and Workforce Readiness**

Improving the quality of STEM education for *all* American youth may also be thought of as an issue of educational equity. Better preparation in the STEM subjects has the potential to enhance future job opportunities for less advantaged students. A range of non-governmental organizations has mobilized to advance the nation's capacity to prepare our youth for work in STEM careers as a means of narrowing gaps in several domains of life. A recent report from the Commission on Mathematics and Science Education convened by the Carnegie Corporation of New York Institute for Advanced Study, for example, urges improvements in the teaching of math and science in the U.S. as central to preserving democracy and social mobility for our nation's young people. The Commission proposes coordinated action to establish common standards for math and science, paired with high quality assessments;

improvements in math and science teaching through better training and recruitment; and a redesign of schools and systems to “deliver excellent, equitable math and science learning.”<sup>ii</sup> A new report by McKinsey & Company highlights the significant negative correlation between educational achievement gaps and national GDP.<sup>iii</sup> The data in this report emphasize the need for the nation to close achievement gaps and raise achievement for all students.

In addition to an emphasis on improving standards, assessments, and student achievement in the STEM subjects, improving STEM education has at its core the need to teach the *skills* that are integral to students’ success in a range of jobs and disciplines. The set of competencies commonly referred to as “21<sup>st</sup> Century Skills” prepare youth with critical thinking and problem solving skills that are essential to applying STEM content knowledge to real-world challenges. STEM education today has significant overlap with the styles of learning and development of skills that are emphasized in Career and Technical Education (CTE). Many of the issues around improving STEM education can also inform enhancing CTE, as the two areas are interconnected and in many instances aim to develop the same competencies in students.

The awareness that STEM education is critical to preparing our nation’s youth for the jobs of the future is increasingly spreading at the state level. There is much to learn from the work of state policymakers and other stakeholders who have implemented education-focused initiatives with the aim of ensuring a strong pipeline of individuals prepared to take on the tasks of a changing economy based on a rapidly evolving set of STEM-related skills and knowledge.

### **A Closer Look: AYPF Field Trip to Columbus and Dayton, Ohio**

The State of Ohio has emerged as a leader in the articulation and advancement of a statewide agenda and strategy for improving STEM education, with the goal of fostering individuals prepared to work in 21<sup>st</sup> century jobs. The March, 2009 AYPF field trip to Ohio convened teams of policy leaders working on STEM education initiatives in five different states. Participating states were Arizona, Connecticut, Georgia, Maryland, and Massachusetts. Each state team had a range of participants, representing secondary education, higher education, philanthropy, and business. The field trip was part of a larger AYPF initiative, also funded by the Bill & Melinda Gates Foundation, to provide learning opportunities for policymakers on a number of topics related to secondary school reform. Trip participants met with a variety of stakeholders, including state officials and business leaders, involved in Ohio’s STEM reform efforts. The agenda provided opportunities to learn about the leadership, partnerships, funding, implementation, teacher preparation, and curriculum development integral to STEM-focused school reform.<sup>iv</sup> The group also had the opportunity to visit two high schools that are new models for STEM education.

The following sections of the brief detail the elements of Ohio’s STEM strategy addressed on the AYPF Field Trip, including building a statewide STEM agenda; creating the capacity to advance a STEM agenda; the role of communication and visibility in advancing STEM education; a regional approach to STEM education; approaches and challenges to STEM education at the school level; and the lessons to be learned from Ohio’s work. The brief concludes with state policy recommendations for advancing STEM education.

## Topics and Presenters for the AYPF Field Trip

**Keynote Address:** Rich Rosen, Corporate VP, Education and Philanthropy Partnerships, Battelle  
**An Overview of STEM Education Initiatives in Ohio:** Eric Fingerhut, Chancellor, Ohio Board of Regents; Jon Husted, Ohio State Senator; John Stanford, Education Policy Advisor to Governor Strickland; and Marilyn Troyer, Ohio Associate Superintendent of Public Instruction

### **Perspectives from the Business Community:**

David Andrews, Professor of Human Development and Family Science, Ohio State University; Shaun Yoder, Executive Director, Ohio Business Alliance for Higher Education and the Economy; Ricardo Negron, Program Manager, Air Force Research Laboratory; and Stephen Krak, Senior Research Scientist, Ohio STEM Learning Network, Battelle

**Regional STEM Collaboration in Dayton:** Susan Bodary, Executive Director, EDvention; Jim Leftwich, President and CEO, Dayton Development Coalition; Tom Lasley, Dean of Education, University of Dayton; and Margy Stevens, Executive Director, Dayton Regional STEM Center

**Site Visits:** Miami Valley Career Technology Center, Dayton (Superintendent: John Boggess); and Metro High School, Columbus (Principal: Marcy Raymond)



'Perspectives from the Business Community' panel discussion

## Building a Statewide STEM Agenda

Leaders in Ohio have recognized the need to “grow our own talent” and create a pool of individuals prepared to work in the jobs of the 21<sup>st</sup> Century workforce. The State of Ohio has made great strides towards ensuring a strong pipeline of individuals prepared to work in STEM occupations through its commitment to a strong P-16 approach to STEM education. Ohio is exemplary in its advancement of a statewide STEM agenda that was propelled by the commitment of business and legislative leaders, the Governor, and a diverse set of key stakeholders in education and philanthropy. The

advancement of the STEM agenda, which includes a network of STEM-focused schools across the state, grew out of multiple years of work to build awareness and urgency among stakeholders and political will among bipartisan policy leaders.

In 2005, the Ohio Business Alliance for Higher Education and the Economy (BAHEE), a non-profit affiliate of the Ohio Business Roundtable (BRT), adopted the goal of doubling the number of baccalaureate degrees awarded in STEM by 2015, with a particular emphasis on increasing the number of minority and low income graduates. Additional industry involvement at this time on the part of Ohio-based Battelle, the world's largest non-profit independent research and development organization, was integral to designing a state STEM plan with local support for a network of schools. Concurrently, the BAHEE, in conjunction with the BRT, assembled a “STEM Learning Tour” that included stops at Metro High School (Columbus), McKinley Technical High School (Washington, D.C.), and Denver School of Science and Technology for key members of the legislature. In turn, legislators began to educate and inform their colleagues about STEM-focused schools in other states that were supported by public funding. In 2007, after several iterations, the Ohio General Assembly passed, by a near-unanimous margin, the state's FY

2008-2009 biennial budget which contained support for STEM Schools (grades 6-12) and a set of K-8 STEM Programs of Excellence, along with other STEM initiatives that span the entire P-16 education continuum.

As part of Ohio's larger education reform plan, the STEM initiative aims to transform the public education system to one in which students gain project-based, real world experiences in every classroom. According to John Stanford, Education Policy Advisor to Governor Strickland, Ohio is committed to continuing to build on a strong foundation and to working on P-16 coordination of STEM initiatives.

### **Creating the Capacity to Advance a STEM Agenda**

Specifically, the state's 2008-2009 budget authorized more than \$200 million in funding for STEM education initiatives. The budget formalized the following priorities:

- \$6 million to develop a set of connected regional STEM-based schools for students in grades 6 through 12.
- \$7 million for creating STEM Programs of Excellence serving students in grades K through 8.
- \$42 million for building student and teacher capacity in STEM through supplemental programs, professional development, and state education aid.
- \$50 million to increase the number of STEM researchers and scientists at the postsecondary level.
- \$100 million for postsecondary scholarships to attract undergraduates into the STEM majors.

The legislation charged the Ohio Partnership for Continued Learning (the state's P-16 Council) STEM Subcommittee with selecting new STEM schools (a group of five "initial" schools were awarded grants in 2008 and an additional three received grants in 2009) and a set of STEM Programs of Excellence. The regional STEM schools awarded are currently at varying levels of development, and will be located in Cleveland, Akron, Columbus, Dayton, Cincinnati, Reynoldsburg, Sandusky, and Hamilton. These eight STEM schools share common design principles derived from Metro High School, a celebrated pre-existing STEM high school in Columbus. Metro High School, opened in 2006 with funding from Battelle, serves as a partner and advisor for the newly opened Linden McKinley STEM Academy in Columbus, emphasizing Ohio's core vision for STEM education as "small schools with big footprints."

The STEM Subcommittee of the Ohio Partnership for Continued Learning, now known as the "STEM Committee," is a collaboration among the Governor's office, Department of Education, Board of Regents, and Department of Development to coordinate and advance Ohio's P-16 STEM agenda across the educational pipeline. Other states have similarly built STEM capacity across the educational pipeline by coordinating STEM education efforts, beginning with early education. In Maryland, for example, the Governor leads a P-20 task force in STEM Education, while in Ohio and Minnesota, STEM standards have been integrated into early education.

Ohio's most recent biennial budget for FY 2010-2011, adopted on July 13 2009 by the General Assembly and signed into law on July 17, 2009 by the Governor, makes a \$10 million investment in STEM Initiatives by leveraging STEM Schools and K-8 STEM Programs of Excellence to support innovative STEM teacher professional development, including on-site laboratories, job-embedded professional development, and mentoring and coaching.

## **The Role of Communication and Visibility in Advancing STEM Education**

The 2008-2009 budget directed the STEM Subcommittee to select an Ohio-based nonprofit intermediary “to support the strategic and operational coordination of public and private STEM education initiatives.” The privately supported, non-profit initiative, the Ohio STEM Learning Network (OSLN), was launched on January 30, 2008, with the core objective of magnifying the impact that the platform STEM school is having in each region. Battelle was chosen to manage the Network. In addition to increasing the visibility of STEM across the state, OLSN also works to enhance the teaching and learning capacity in STEM, accelerate the state’s STEM initiatives, and promote and connect “innovative, scalable, and sustainable STEM initiatives.” OLSN is working to connect the state’s system of STEM schools and Programs of Excellence and to leverage the work taking place in regions across the state, along with a \$12 million grant from the Bill & Melinda Gates Foundation and an initial \$2.8 million investment from Battelle.

State leaders in Ohio recognize that students and parents, too, need to be aware of the need for and relevance of a STEM skill set to success in the future. As articulated by John Boggess, Superintendent of Miami Valley Career Technology Center, “Not everyone understands how CTE is a viable pathway into college and careers.” This comment underscores that there is still more education of the public to be done, including helping younger students acquire an interest in and understanding of STEM subjects and the utility of CTE. Ohio is working to increase early student awareness of STEM and improve practices in the teaching of these subjects, and has recently established 26 K-8 “Programs of Excellence” across the state that offer “rigorous and diverse curriculum based in scientific inquiry and technological design.”<sup>v</sup> The goal of these programs is to expose students to advanced scientific concepts inside and outside of the classroom while emphasizing personalized learning and teamwork skills.

## **A Regional Approach to STEM Education**

In addition to funding the opening of the eight regional STEM schools, Ohio received a \$500,000 grant from the National Governors Association that enabled the construction of a regional STEM Center. Dayton, a metropolitan area with an economy based on innovation and entrepreneurship, was selected as the site for this regional center. This first regional center in Dayton plays a critical role in enhancing the capacity of schools to provide high quality instruction in the STEM subjects. The Dayton Regional STEM Center focuses on teacher professional development, curriculum design, and overall STEM support for the Dayton region. Ohio’s initial proposal called for additional regional STEM centers to be created across the state, modeled on the Dayton center. A second STEM Center is currently under development in Cincinnati—the Fusion STEM Center.

Assets in each region of Ohio are being utilized to support the STEM schools and STEM education throughout the state. Just as Metro High School is operated in ongoing collaboration with Battelle, the Dayton Regional STEM School has been created in partnership with both Wright State University and the Air Force Research Lab (AFRL), one of the biggest STEM employers in Ohio. Wright State took a leadership role in crafting the region’s proposal for the school, and the AFRL has “educational partnership agreements” that enable the provision of experts and resources, review of lessons, and donation and lending of equipment to the STEM school. The AFRL is also providing mentors and volunteers to support the teaching of STEM subjects throughout the region, in non-STEM schools.



## New Approaches and Challenges: STEM Education at the School Level

The AYPF Field Trip included site visits to the Miami Valley Career Technology Center (MVCTC) in Dayton, and Metro High School in Columbus. MVCTC serves nearly 3,000 students from 27 area high schools across 5 counties and offers over 50 career and technical programs for high school juniors and seniors, as well as lifelong learning opportunities for adult students. At MVCTC, the goal is to integrate STEM skills into all CTE courses. Students are taught to use “inquiry-based learning” as a method for learning through real-world scenarios. John Boggess, Superintendent of MVCTC, underscored that the school has worked hard to ensure that problem-based learning is rich with content and rigor, and students at MVCTC said they were more engaged in their learning because it is “hands-on,” and they understand how it connects to having a career in the future.



Students in a biotechnology class at MVCTC

Metro High School is a small early college high school with a special emphasis on math, science, and technology that is open to students in 16 public school districts across Franklin County. Metro was opened with support from Battelle and the KnowledgeWorks Foundation, and students have access to STEM resources at Battelle and The Ohio State University, where they have the option of earning college credit while attending high school. The curriculum at Metro has a college readiness focus and encourages “learning outside the school walls” and helping students develop the capacity to succeed at college work. Students in 11<sup>th</sup> and 12<sup>th</sup> grades participate in hands-on, self-

directed learning outside the classroom with teachers and mentors from the community, through research projects, group projects with other students, and community internships. Educators at Metro High described STEM learning as content- *and* context-based learning, and stressed that project-based learning occurs via a context that enables students to *apply* science and math knowledge to solve real world problems. Metro High is piloting a project-based learning curriculum developed by the PAST Foundation that maps to the state standards. The aim is to then publish this curriculum and make it available for other similar learning environments free of charge.

Teachers and administrators at MVCTC and Metro High identified several challenges around pedagogy, accountability, and professional development. Among the challenges of a classroom that uses inquiry-based and project-based learning is the need for teachers to oversee different topics and approaches to learning for the students in the classroom. Since this type of education often enables students to propose their own projects, teachers may be asked to contribute various types of support and knowledge to each student, rather than just providing information through lecture format. At both schools, smaller class sizes and opportunities for students to work in small groups helped to address this challenge. Additionally, questions around accountability and how to measure performance become more complicated when courses are taught on interdisciplinary topics, and often through less traditional methods. Professional development is often self-directed for instructors in CTE and STEM subjects. One instructor told us of his need to subscribe to industry publications in order to stay current, and that these publications were purchased with his own money. Another instructor who formerly worked in a lab told our group that working as a teacher is harder, as she needs to take classes in the summer to stay

up to date with how science is applied in the industry world. At Metro High, teachers are empowered to obtain professional development outside of the school and then asked to share this learning with other teachers.

## Lessons learned from Ohio

### *Creating a Statewide Plan for STEM Education*

Progress in STEM education in Ohio has been very deliberate and strategic and has been guided by a clear agenda articulated by the Governor's Office and aligned with the needs identified by the business community. Structural mechanisms to support this work, such as the Ohio STEM Learning Network, have been critical to enhanced visibility and scaling up of STEM initiatives. All stakeholders have a common understanding that STEM is important for *all* and can be transformative for education and future success.

### *Casting a Wide Net to Utilize Available Resources*

As the mission of the Ohio STEM Learning Network recognizes, assets and resources are spread across communities in the state and can be leveraged to improve education. STEM schools in Ohio utilize the resources of local businesses and universities, and broaden traditional teacher pipelines by integrating industry professionals into students' learning. In Ohio, business support across the state has come through a variety of approaches. For example, the Cleveland STEM school, known as MC<sup>2</sup>STEM High School, is physically located on the corporate campus of General Electric Lighting and Industrial and the Great Lakes Science Center, both local partners involved since day one. As with the Air Force Regional Lab in Dayton, businesses and other industry leaders have the capacity to lend and donate equipment that can be used in STEM classrooms. STEM education at all levels relies on industry-trained professionals and apprenticeship opportunities to engage students in how skills relate to real-world work.



Steve Krak of Battelle and Len Fine of Science Foundation Arizona

### *Ensuring Cross-System Collaboration*

Institutions of higher education are also integral to nurturing the STEM pipeline. The involvement of higher education and the cross-system collaboration in Ohio is multifaceted. Included in Ohio's strategic plan for higher education are the goals of graduating more students, keeping graduates in Ohio, and attracting others into Ohio's colleges and universities from out of state. According to Eric Fingerhut, Chancellor of the Ohio Board of Regents, 80% of college graduates in Ohio go to work within 80 miles of where they graduate. Among the 20 accountability measures identified in the strategic plan for higher education is the measure of the total number of STEM degrees awarded. Given the goal of increasing the number of STEM-related degrees awarded from Ohio's institutions of higher education, Chancellor

Fingerhut underscored the need to cultivate the STEM interests of students early on, and before college entrance. Cross-system collaboration on STEM education is enhanced by the fact that each STEM-focused school established by the state initiative in Ohio has a university partner. Additionally, the state's institutions of higher education were charged by the Governor's education reform plan with increasing the pipeline of teachers prepared to teach in the STEM areas.

### *Expanding the Pipeline of STEM Teachers*

Ohio will continue to be challenged by the need to recruit more quality STEM teachers to Ohio. Under the 2008-2009 biennial budget, incentives such as alternative teacher licensure programs, STEM teacher signing bonuses, and loan-forgiveness have received state funding. Ohio has created two alternative pathways to enable STEM-trained professionals to teach these subjects in the classroom. An industry-trained expert may become a full-time teacher by obtaining a 40-hour teaching permit. In addition, a STEM licensure is available for these same individuals who want to stay in the system and teach in STEM schools. In order to teach in a STEM school in Ohio, one must have a Bachelor's degree in a STEM field and have passed a state required licensure exam. Teachers in these schools are provided with an apprenticeship and a mentoring structure to help learn pedagogy.

### *STEM Schools: Driving the Redesign of Standards with a 21<sup>st</sup> Century Focus*



Marilyn Troyer, Senior Associate Superintendent of Education in Ohio, talking to trip participants

The Ohio Department of Education has put significant work into revising the state's content standards in response to educational reform efforts. Current work in this realm has challenged the Department to take its rigorous standards and go much deeper into integrating a focus on interdisciplinary, project-focused, real-world skills and applications. The state has also been engaged in benchmarking its math and science standards internationally. STEM schools have been models for the state as it further develops its standards, as these schools are developing innovative ways to teach the skills necessary for inquiry-based learning essential to STEM subjects. A goal of the department is to take learning from the STEM schools and infuse it across all of K-12 education in the state. One proposed approach is to use Ohio's STEM schools as a training ground for

educators by enabling teachers to temporarily rotate into these schools to learn teaching strategies in action. Dr. Marilyn Troyer emphasized that there is not yet a state assessment to measure success in reaching content standards in the STEM subjects that can be used for accountability purposes, and that what is tested and reported on state report cards is what garners attention.

### *A Regional Approach to Building STEM Capacity*

The Dayton region provides an excellent example of regional collaboration and coordination in order to advance STEM education. At the core of the region's success at clustering its resources is EDvention, a



collaborative dedicated to accelerating STEM talent to grow the Dayton Region. EDvention consists of over 80 partners across economic development and education and works to coordinate regional strategy, resource development, and advocacy around STEM. EDvention has articulated a portfolio approach to STEM education that shares resources and human capital around the goals of programming in early education (called “Ready, Set, Soar”), existing school transformation, and innovative schools and programs. The Dayton Regional STEM Center, funded initially by the NGA grant, is another critical entity at the regional level. The STEM Center serves as the hub of curriculum design, training, and support for educators in order to prepare all students with the skills and knowledge to participate in careers in the Dayton region.<sup>vi</sup>

One difficulty Ohio faces is providing equal funding for all regions. Neither the Northwest nor the Southeast STEM regions were awarded initial STEM school grants, making implementation of the regional hub model difficult. Also, where existing high schools have been granted state STEM funding, as is the case in Cincinnati’s Hughes STEM High School, shifting curriculum away from current models has been met with some resistance from school board members. There are also concerns of exclusivity among the new STEM high schools if entrance requirements are mandated.

### STEM Initiatives in Other States

AYPF conducted a [follow-up webinar](#) to the field trip, focused on statewide STEM plans in place in two states as a way to share information on how to build support for STEM initiatives and strategies that can help guide and inform the work of other states.<sup>vii</sup> Below are synopses of statewide STEM education plans in Pennsylvania and Minnesota, the two states that were showcased on the webinar.

#### Pennsylvania

Like Ohio, Pennsylvania has articulated a state strategy that sets broad goals for STEM education and has also encouraged regions to develop tailored strategies suited to the region’s needs and requirements. The Pennsylvania STEM Initiative is driven by a strategic plan that has established goals for a 10-year period, as well as short term goals articulated for a 2-year period. The STEM work in Pennsylvania has truly been a public/private initiative that has matched every public dollar with private investments from local foundations. Five regional STEM networks exist in Pennsylvania. Within each of these regions, the state has utilized asset mapping to identify where best practices, resources, and assets exist related to STEM.<sup>viii</sup> Similarly, asset mapping enables regions to identify gaps such as an under-representation of business participation or a lack of internship opportunities for youth. A statewide communications network that connects the five regions has also been a key component of the state’s STEM initiative.

#### Minnesota

Work to build the STEM pipeline in Minnesota has been under way for six years. Although the Governor began to support a STEM agenda in 2003, the business community had been voicing its concern over the STEM pipeline for many years. Advancement of a STEM agenda in Minnesota can be attributed largely to an effort to “brand” STEM across the state and to increase public awareness of and engagement in the STEM disciplines. In addition to a public awareness campaign, Minnesota has hosted STEM summits across the state, connected business to education, and encouraged local businesses to educate students about STEM-related jobs in their own communities. A web portal, called “getSTEM,” has been created to help educators connect with businesses and other resources with STEM expertise that can be shared.<sup>ix</sup>

State policy in Minnesota has been integral to driving school reform around the STEM subjects. The legislature has appropriated \$3 million to address 6-8<sup>th</sup> grade Algebra education, a known area of need. In addition, a STEM school redesign project grew out of model schools funded by state innovation grants. Minnesota has positioned STEM education for all as an issue of equity, which laid the groundwork for a state law that embedded STEM standards into the state's curriculum beginning with early education. The state's capacity for teaching STEM subjects is enhanced by integrating teachers into curriculum development and also through a statewide STEM teacher mentoring program.

### **State Policy Recommendations**

#### ***Build Awareness and Political Will around STEM***

In order to drive improvements in STEM education, states must have leadership buy-in and a sense of urgency to act. A strategy must be articulated by committed policy leaders and implementers about why STEM matters.

#### ***Define STEM as a Pipeline Issue***

The critical thinking skills learned through problem solving and hands-on learning are the building blocks of STEM education and must be integrated throughout all levels of education. States need to make STEM education a P-16 priority and encourage the coordination of STEM education from early education through postsecondary education.

#### ***Increase Collaboration across Systems and Sectors***

States that are successfully scaling up STEM education and utilizing the resources across several systems and sectors of society benefit from knowing where their STEM assets are, and then strategically connecting these resources. Mechanisms to connect and leverage resources include asset mapping, landscape assessment, and creation of a formal entity to coordinate STEM education at the state and regional levels.

#### ***Adopt Standards that Emphasize Skills Needed to Apply STEM Learning***

States should adopt math and science standards that integrate real-world, project-based skills and that are benchmarked internationally. Such standards would put emphasis not only on STEM content, but on the ways to teach the skills necessary for inquiry-based learning essential to STEM subjects.

#### ***Strengthen STEM Pedagogy in Teacher Training and Professional Development***

Both teacher training programs and ongoing professional development should equip educators to teach the skill set and critical thinking capacities, and not the content alone, that students need in order to apply science and math learning to real-world topics.

## Conclusion

Ohio has recognized that the state's economic health hinges largely on the education that is provided for youth, and their preparation for the jobs of the 21<sup>st</sup> Century. Ohio has embarked on an ambitious STEM agenda and will continue to build on this strong foundation and work on P-16 coordination of initiatives. As of August 26, the original five state-funded STEM schools are open for business. The next three are slated to open in Fall 2010. In 2009, it is expected that over 164 local partners from K-12 education, higher education, and business organizations will have joined with these regional schools, committing approximately \$54 million in external support. Ohio's statewide STEM efforts have worked to achieve strong buy-in from the Governor and have been supported by legislation, but are currently threatened by the effects of the economic downturn and declining budgets. In the coming years, it will be essential for bipartisan leadership and public-private partnerships to continue collaborating to ensure successful operation of the STEM initiatives.

<sup>i</sup> Office of Science and Technology Policy, Executive Office of the President. (2007) *American Competitiveness Initiative: Research and Development Funding in the President's 2007 Budget*. Retrieved 7/2009 from [http://www.ostp.gov/pdf/1pger\\_aci.pdf](http://www.ostp.gov/pdf/1pger_aci.pdf).

<sup>ii</sup> Carnegie Corporation of New York-Institute for Advanced Study. *The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy*. Retrieved 8/2009 from <http://www.opportunityequation.org/>.

<sup>iii</sup> McKinsey & Company. (2009). *The Economic Impact of the Achievement Gap in America's Schools*. Retrieved 7/2009 from [www.mckinsey.com/client/service/socialsector/achievementgap.asp](http://www.mckinsey.com/client/service/socialsector/achievementgap.asp).

<sup>iv</sup> Full agenda for the AYPF field trip to Ohio is available via the AYPF website: <http://www.aypf.org/tripreports/2009/tr030409.htm>.

<sup>v</sup> Ohio STEM Learning Network. Retrieved 7/2009 from <http://www.osln.org/regional/h-b-119-schools-programs/index.php>.

<sup>vi</sup> Montgomery County Educational Service Center. Retrieved 7/2009 from <http://www.montgomery.k12.oh.us/91810228102145740/site/default.asp>.

<sup>vii</sup> The AYPF STEM webinar is accessible via the AYPF website, at: <http://www.aypf.org/Webinars/Wb062909.htm>.

<sup>viii</sup> In Pennsylvania, regional asset maps, which are functionally similar to directories of STEM initiatives in a region, count "assets" as initiatives that increase education and workforce readiness for STEM occupations; increase STEM literacy, or the ability to use a STEM skill set; or address a workforce need that addresses innovation. For more on asset mapping, see <http://www.pasteminitiative.org/programs/asset-mapping.cfm>.

<sup>ix</sup> To access the getSTEM website, visit: <http://www.getstem-mn.com/Pages/Default.aspx>.