CONTENTS
Program Descriptions

If program title is different than the session title, then session title appears in parentheses after the program title.

iPhone App for School Data Collection and Critical Thinking About Ecology and Biodiversity

The 2012 Science Standards will place an emphasis on data collection and explanations. This session will provide a free iPhone app that supports grades 4–12 students in data collection and explanation building about biodiversity in schoolyards in the Great Lakes region. The session will provide inquiry activities and Web resources that guide students to construct explanations to questions such as, What habitats are in my schoolyard? and Which zone in the schoolyard is the most diverse?

Background
The activities and apps presented in this session were developed by educators, scientists and curriculum developers associated with the Center for Essential Science, (www.essentialscience. umich.edu), a group based at the University of Michigan committed to developing and evaluating educational materials focused on some of the most pressing environmental issues of our time, such as biodiversity, climate change, and the impacts of global climate change on organisms. Our 6- to 14-week curriculum units address inquiry, life (ecology and biodiversity), and atmospheric science (climate change) standards through exploration of local biodiversity; collection of animal species; and the investigation of individual animals and how animals interact with one another. Through these activities, students gain a clearer understanding of how organisms meet their basic needs and the role the environment plays in supporting a variety of organisms. In our programs, students use technology in a variety of ways, including the BioKIDS app, an animal-tracking program that runs on iPhones, iPads, or Androids to log animal sightings seen in their schoolyard. Students then analyze the data for class and team experiments. Another salient feature of the curriculum is the Critter Catalog, an online animal species database developed by the team. Students use this as the main resource when they write species accounts and conduct research on individual animals.

Documented Results
Over the past 12 years, we have developed and implemented 6- to 14-week curriculum units with accompanying technologies and professional development resources in schools in the Detroit metro region, with a particular emphasis on the Detroit Public Schools. Learning results consistently show strong pre-post achievement gains on science inquiry and content as measured by standardized state tests (MEAP). In addition, students show very strong achievement gains on tests measuring explanation building around focal content. One sample study and results will be briefly presented.

Potential Applications
Our curriculum and technology resources have been scaled to over 80,000 students and teachers in the past 15 years. We welcome schools or individuals who are interested in using any of our materials.

For More Information
Please contact Nancy Songer (songer@umich.edu) or Vanessa Peters (vlpeters@umich.edu) for more information on resources or participation in our pilot studies of upcoming curriculum units and technologies.

National Inventors Hall of Fame® School…Center for Science, Technology, Engineering and Mathematics (STEM) Learning and the Ohio STEM Learning Network (OSLN) Akron Hub

Opened in 2009, the National Inventors Hall of Fame® School…Center for Science, Technology, Engineering and Mathematics (STEM) Learning is designed to be a unique and comprehensive STEM middle school that promotes problem-based learning. The Akron STEM School is unique in its ability to partner not only with local businesses and institutions, but also with national organizations. Instruction by local engineers and world-renowned inventors is built into the curriculum. Every part of the school day—from classroom learning and assignments to daily activities—incorporates the spirit of Akron, a philosophy of innovation and creativity.

The school's vision is to provide the highest quality education experience for students that ensures creativity and inventive thinking through a focus on science, mathematics and technology. To ensure this goal is met, the school follows nine program design qualities that serve as a framework for student success. These components are high performance standards; leadership; knowledgeable and skilled educators; curriculum, instruction and assessment; environment for learning; family, community and school partners; student as learner; systems for sustainable operations; and, learning organization. This approach is proving to be successful so far. In the school's first two years of Ohio Achievement Assessments, the school ranked excellent each year. In addition to this, the school serves as a research site for various institutions, such as: The Institute for Health and Social Policy at The University of Akron, the Metiri Group and the University of Chicago's Center for Elementary Mathematics and Science Education (CEMSE).

The Akron STEM School has quickly become a national go-to source for how a school can teach students to be creative. "Perry's Principles," a segment of Anderson Cooper's 360° on CNN, followed Akron STEM School learners in a problem-based learning activity helping park rangers rid an area of its autumn olive trees. A *Newsweek* feature article titled "The Creativity Crisis" focused on a noise reduction project at the Akron STEM School that required learners research material, budgets, aesthetics, and maintenance proposals. The result, as the article worded it, was that, "They'd unwittingly mastered Ohio's required fifth-grade curriculum—from understanding sound waves to per-unit cost calculations to the art of persuasive writing."

The OSLN Akron Hub exists to build, capture and connect the disciplines of science, technology, engineering and mathematics (STEM) to each other and to those in the community who can benefit. While doing so, it leverages partnerships in alignment with economic development priorities. Based at the Akron STEM School, the hub staff is employed by the University of Akron. This is a perfect example of partnership at work. Partnerships helped found the school and the hub and they continue to increase the spread of knowledge and opportunities for creative endeavors. The founding partners of the NIHF-STEM School and OSLN Akron Hub are

- Akron Public Schools
- Akron Tomorrow/Greater Akron Chamber
- City of Akron
- Invent Now (formerly the National Inventors Hall of Fame®)
- The University of Akron.

For More Information

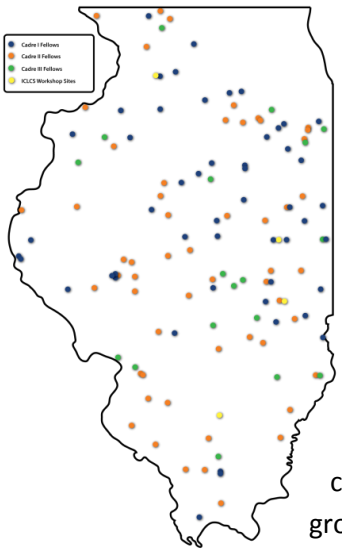
The Akron STEM School

Please contact Traci J. Buckner, Instructional Leader, National Inventors Hall of Fame® School … Center for STEM Learning at tbuckner@akron.k12.oh.us or visit http://akronschools.com/scienceschool/

The OSLN Akron Hub

Please contact Alison White, Grant Communications Coordinator, The University of Akron and Ohio STEM Learning Network Akron Hub at awhiteua@akron.k12.oh.us or visit http://osln.org/state-stem-landscape/akron-hub/index.php

Institute for Chemistry Literacy Through Computational Science (ICLCS or "Icicles")



The Institute for Chemistry Literacy through Computational Science (ICLCS) is a National Science Foundation-funded MSP program designed to increase the chemistry literacy and chemistry-related pedagogical skills of rural Illinois high school teachers through the use of authentic and near-authentic computational simulation resources. As a true partnership with K-12 education, the ICLCS is an example of how higher education and K-12 schools can work together to improve student success.

For the past 5 years, we have partnered with schools to provide their Chemistry teachers with intensive, multi-year summer Institutes built upon existing, successful curricula and methods, enhanced with state-of-the-art science research data and applications for the 21st Century. During the academic year **124 teachers** from **119 rural districts** are connected through an online **Professional Learning Environment (PLE)** to support their growth as teachers sand leaders.

Computational Simulation

Computational simulations are used to increase student interest in and understanding of chemical principles. In modern research, computational science is used to solve problems that are too fast, too slow, too small, too expensive, too complex, or too dangerous to solve using observational or experimental methods of science. The same is true in an educational context where students are able to "see" and manipulate molecules and chemical systems in a safe and inquiry-based environment. ICLCS scientists and faculty work alongside our high school teacher partners to develop materials and effective uses of readily available computational tools to **improve student achievement and interest in STEM.**

External Evaluation:

The ICLCS, using quasi-experimental, non-equivalent comparison group and multiple baseline research designs, has shown **statistically significant improvement** over time and in comparison to a matched sample of students in non-ICLCS schools in chemistry content knowledge as measured by the standardized high school examination of the American Chemical Society (ACS). Over 30,000 student test scores have been analyzed as part of the external evaluation.

A summary of recent evaluation results of teachers show:

Cohorts 1 and 2 made significant incremental improvements every year in the areas targeted by ICLCS intervention:

- **Higher mean scores on the ACS exam for teachers**
- **Increased use of computational science tools in the classroom**
- **Increased use of Inquiry teaching methods**

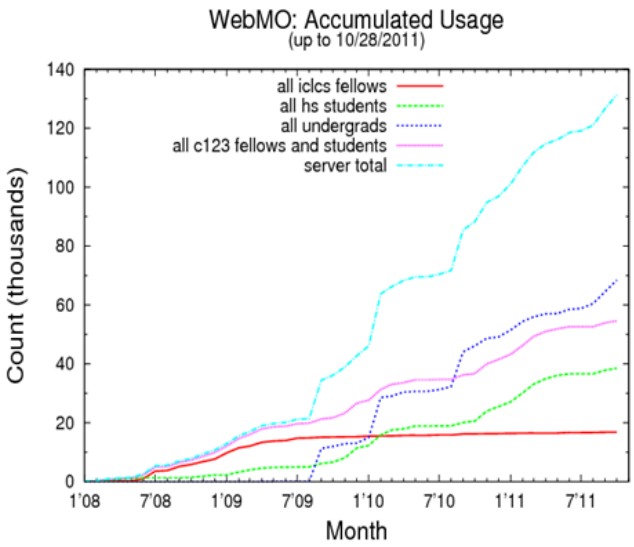
In the academic year after Cohort 2's final summer Institute (only cohort with PLE usage variables currently available), a hierarchical regression using only ICLCS-related teacher variables to predict their student ACS scores explained 56% of the observed variance in student achievement (56% = adjusted R^2; cumulative unadjusted=63%). Incremental amounts: (1) 24% of the variance in student achievement was accounted for by whether teachers scored ≥70% on the Teacher ACS exam; (2) an additional 31% by the frequency of teachers' use of computational tools in conjunction with alternative student-centered teaching (inquiry lessons as demonstrations & relatively structure inquiry class activities); and (3) an additional 9% by the number of times teachers viewed significant PLE posts.

According to self-reports, before ICLCS 91% of these teachers had poor or very poor skills using computational tools to teach general chemistry concepts, and afterward, 82% reported good or excellent skills. Before ICLCS 85% were not at all or somewhat confident employing alternative student-centered instructional strategies; afterward, 69% were confident or extremely confident.

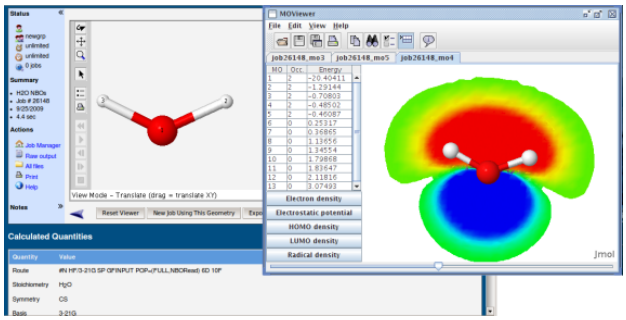
Professional Learning Environment (PLE)

Often professionally and/or geographically isolated, rural ICLCS Fellows have communicated extensively through the virtual professional learning environment. Over the past 4 years (April 2007-May 2011), Teachers from all three cohorts logged in to the PLE 63,008 times, viewed discussions 310,218 times, and posted 21,235 forum posts. Findings on the PLE have indicated a **significant** relationship (p =.003) between changes in teaching practices and the amount of vicarious experience gained by participating teachers (N=56) through the PLE. *Further, a positive correlation has been found between teachers' participation in the PLE and their students' achievement gains on the ACS standardized chemistry test.*

Use of Computational Tools by High School and Undergraduate Students



A central goal of the ICLCS is to improve students' understanding of chemistry through the use of computational and visualization tools. One tool in particular is WebMO, a web-based interface that allows users to construct molecules, to perform computational chemistry calculations easily with research-grade software, and to visualize the resulting data. The WebMO interface hides the complexities of the data handling, thereby enabling students to focus on the chemistry content and enhancing the learning experience. To provide for a robust WebMO service for thousands of high-school and undergraduates, NCSA enhanced the original WebMO application to run in a "cloud" environment. This effort has resulted in a dynamic, highly scalable, high-performance computing service capable of providing computational resources for a vast number of student users.



Now in its fourth year of operation, this cloud-enabled WebMO implementation is host to over **4,600 accounts** whose users have submitted over **130,000 jobs**. Approximately **3,000 high-school students** have logged into WebMO via individual or shared accounts. UIUC undergraduates use WebMO in an organic chemistry course.

The accompanying figure shows the current usage history (jobs submitted) by high-school students (*green line*) whose teachers have been members of the ICLCS program (*red line*) and also by chemistry undergraduates at the University of Illinois and other institutions (*blue line*). Total usage of the NCSA WebMO server is indicated by the *light blue line.*

The ICLCS is funded by the National Science Foundation MSP under Award No. NSF EHR 06-34423

Milwaukee Mathematics Partnership

Sharing in Leadership for Student Success

Background

The *Milwaukee Mathematics Partnership* (MMP) comprises the University of Wisconsin-Milwaukee (UWM), the Milwaukee Public Schools (MPS), and the Milwaukee Area Technical College (MATC). As an initiative of the Milwaukee Partnership Academy, a community-wide PK-16 collaborative, the MMP began in fall 2003 with a five-year $20 million award from the NSF Mathematics and Science Partnership program. The MMP involves mathematics and mathematics education faculty in collaboration with PK-12 educators in building the capacity of schools for continuous improvement toward student success with challenging mathematics.

The work of the *MMP* is grounded in the acknowledgement that continuous growth in students' mathematics achievement is heavily dependent on quality and consistency across teachers and mathematics programs within schools. For the school to be successful, there must be a common vision of mathematics learning, aligned to state standards, district learning targets, and accountability expectations. Specifically, the MMP has embraced four major goals in order to improve student achievement:

(1) **Comprehensive Mathematics Framework**: Implement and utilize the Comprehensive Mathematics Framework to lead a collective vision of deep learning and quality teaching of challenging mathematics.

(2) **Distributed Leadership**: Institute a distributed math leadership model that engages all partners and is centered on school-based professional learning communities.

(3) **Teacher Learning Continuum**: Build and sustain the capacity of teachers, from initial preparation through induction and professional growth, to understand mathematics deeply and use that knowledge to improve student learning.

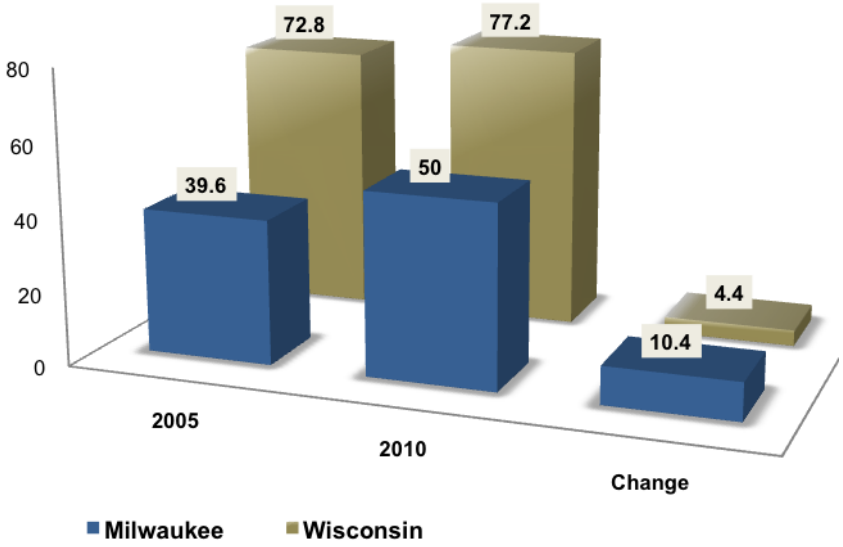
(4) **Student Learning Continuum**: Ensure all students, PK-16, have access to, are prepared and supported for, and succeed in challenging mathematics.

With Wisconsin's adoption of the *Common Core State Standards (CCSS),* the MMP is working to ensure that educators across the district and the state understand that effective mathematics teaching involves careful attention to the Standards for Mathematical Practice, and to strengthen teacher understanding of the mathematics (both Content and Practices) in the CCSS—not just which topics are to be taught, or at which grade level, but *how* the CCSS expect teachers and students to understand and reason about these topics.

Essential to the MMP approach has been the development of teacher leadership for mathematics. The school-based Math Teacher Leaders (MTL) participate in monthly seminars that (1) increase their mathematics content knowledge, (2) deepen their understanding and use of formative assessment practices, and (3) develop their leadership skills. These seminars are developed and facilitated by teams of district Math Teaching Specialists (MTS) in collaboration with university mathematics and mathematics education faculty and staff. The MTLs draw upon the knowledge and skills developed in their monthly training and bring those resources to their school-based learning teams and to teachers and staff in the schools. The steady growth and development of these individuals as leaders over the years is a hallmark of the success of the MMP. In addition, the cadre of district Math Teaching Specialists has evolved as critical to our success. They are responsible for leading district-wide MMP initiatives and for providing school-based support to Math Teacher Leaders, Learning Teams, and school staffs.

Documented Results

Since the inception of the MMP, students in the Milwaukee Public Schools (MPS) have increased their mathematics achievement on the annual Wisconsin Knowledge and Concepts Examination (WKCE), and also narrowed the achievement gap between the district and the state. The figure shows the increase in proficiency in mathematics from 2005 to 2010 for all students in grades tested (grades 3-8 and grade 10);



the disaggregated data show that all MPS subgroups demonstrated increased achievement over this same time period. Moreover, a study carried out by the MMP in 2009 concluded that schools more involved with the MMP over time demonstrated greater student proficiency on the 2008 WKCE, and higher student achievement growth from 2005 to 2008.

Over and above these measurable results, however, has been a change in the culture of mathematics teaching and learning in the district as a result of the MMP. This change can be illustrated with a quote (one of many that could have been chosen) from a middle school MTL:

> *Before I came into this position as MTL, no one at my school was taking time to study school mathematics. Math was never discussed. Math instruction was very different in every classroom. … It is now common to find a grade-level team studying math lessons and planning instruction, or sharing student math work and discussing what they notice about the work as evidence of student math understanding.*

Potential Applications

The MMP has developed many resources over the years, including professional development materials, classroom assessments and assessment tools, and a *Continuum of Professional Work for Mathematics*, which became an important tool for guiding and directing the work of Math Teacher Leaders in the schools, and for having conversations with administrators and school learning teams. These materials and tools are widely applicable in teacher professional development settings, or to guide in-school conversations, and may easily be adapted as required to suit local needs.

For More Information

All materials developed by the MMP are available on the MMP website, mmp.uwm.edu. Alternatively, you may contact the current session's presenters, Kevin McLeod (kevinm@uwm.edu) and Hank Kepner (kepner@uwm.edu), or DeAnn Huinker (huinker@uwm.edu, MMP Principal Investigator) with any questions or requests for materials.

This material is based upon work supported by the National Science Foundation under Grant No. 0314898. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation (NSF).

Engineer Your World, a Project of UTeach*Engineering*

Background

Engineering design is not simply a useful tool for teaching science and mathematics content, but a unique discipline in which science and mathematics are employed as tools for solving design challenges. The UTeach*Engineering* project at The University of Texas, in partnership with NASA, has undertaken to demonstrate how rigorous engineering content can be deployed in secondary classrooms by developing and piloting *Engineer Your World*, a year-long high school engineering course built on a foundation of solid research in the learning sciences, couched in the context of a rigorous engineering design process and scaffolded to build engineering skills and habits of mind.

Engineer Your World actively engages students in authentic engineering practices to build engineering skills and habits of mind. The course scaffolds student learning over six units, each of which is structured as an engineering design challenge. The *Engineer Your World* classroom is a project-based environment in which approximately 80 percent of students' time is spent in hands-on activity, and the balance is spent on documenting and reflecting on their work, preparing presentations and reports, and participating in direct instruction. Students in the course employ a standardized engineering design process to address design challenges that can only be completed through the purposeful application of engineering principles and relevant mathematics and science concepts. These concepts, which may include both prior knowledge and new knowledge, are employed when and only when they are necessary for students' successful completion of the challenge at hand.

Prior to teaching *Engineer Your World*, teachers attend a targeted two-week professional development workshop designed to enhance both their engineering content knowledge and their pedagogical content knowledge. The workshop, the content of which is aligned to the course and its underlying learning standards, is appropriate for teachers from diverse backgrounds. It emphasizes active engagement and problem solving, conveys clear ideas about effective teaching and learning, and offers participants frequent opportunities for critical reflection on teaching.

Once in the classroom, *Engineer Your World* teachers have access to additional support from virtual sources (*e.g.*, online videos, discussion boards) and, for teachers involved in an upcoming pilot project with NASA engineers, in-person mentors. It is anticipated that many of these supporting resources will eventually be connected to one another and to the course content through a hybrid of a learning management system and an online collaboration tool.

Documented Results

Engineer Your World is being piloted by eight teachers with more than 230 students in seven Texas high schools during the 2011–2012 academic year. The pilot schools range from rural to suburban to urban, with student populations between 860 and 2800 students. The smallest pilot class has just seven students, while the largest has 30. Half of the pilot teachers have an engineering degree or engineering work experience. Teaching experience among pilot teachers ranges from two to 20 years.

All pilot teachers are participating in research and evaluation activities. Early feedback has come from examination of student artifacts and pre-/post-tests, evaluator-led focus group results, and informal feedback gathered during classroom visits. This information has led directly to such revisions as modifications of course scaffolding, reorganization of materials to support the development of engineering classroom norms, and initiation of efforts to develop validated assessment instruments.

Potential Applications

The original target student audience for *Engineer Your World* was defined by the opportunity to which the UTeach*Engineering* project has responded: the approval of Engineering Design and Problem Solving to be offered for fourth-year science credit to students in an academic track in Texas. While *Engineer Your World* was developed assuming knowledge of Geometry, Algebra II, Chemistry and Physics, the development team has since identified adaptations that make the course appropriate for use with students in earlier high school grades.

Engineer Your World aligns with the emerging Next Generation Science Standards and is anticipated to satisfy all engineering learning requirements for high school students under those standards. During the 2012–2013 academic year, through a partnership with NASA, teachers in up to eight additional states will be paired with engineer mentors who will support them in offering *Engineer Your World* in urban, suburban, and rural settings; in comprehensive high schools and STEM academies; to single-gender and mixed-gender populations; and in grades 9, 10, 11 and 12. Feedback from this effort will offer a broader picture of the course's effectiveness in a variety of settings, allow for refinement of the mentorship model, and inform project decisions about courseware and online resources.

For More Information

For detailed information about the course development and the underlying research- and practice-based design principles, as well as a view into the course content and future plans, please see:

> Farmer, C., Allen, D., Berland, L., Crawford, R., and Guerra, L. (2012). *Engineer Your World:* An Innovative Approach to Developing a High School Engineering Design Course. American Society for Engineering Education: accepted for publication in annual conference proceedings.

For a contextualized exploration of the research- and practice-based course design principles, please see:

> Berland, L., Allen, D., Crawford, R., Farmer, C., and Guerra, L. (2012). Learning Sciences Guided High School Engineering Curriculum Development. American Society for Engineering Education: accepted for publication in annual conference proceedings.

For an explanation of the design process underlying the course content, please see:

> Guerra, L., Allen, D., Berland, L., Crawford, R., and Farmer, C. (2012). A Unique Approach to Characterizing the Engineering Design Process. American Society for Engineering Education: accepted for publication in annual conference proceedings.

Visit www.engineeryourworld.org and www.uteachengineering.org

Acknowledgments

This work was made possible by a grant from the National Science Foundation (Award DUE-0831811). Support was also provided by NASA through an Intergovernmental Personnel Act agreement.

Structured Play with Arts & Crafts and Games in an After-School Program Boosts Math and Math-related Developmental Skills for High Risk K-1 Children

A contentious debate is occurring in the educational community over the role in pre-school and kindergarten of early direct academic instruction vs. a less structured environment incorporating more play. New research is addressing this question by showing that structured play with arts & crafts and games may build foundational skills that are critical to later math achievement. Skill deficits in these foundational skills may be the source of math achievement gaps for children at risk that are present at pre-school and continue throughout schooling. Such gaps are one contributor to the low incidence of such children in STEM learning and careers. This presentation will focus on recent research that may help to explain why so little progress has been made closing achievement gaps and a new direction for closing gaps.

Closing math/science achievement gaps between children from advantaged and disadvantaged families and from different racial/ethnic groups has been a primary objective of national and state educational policies over the last 25 years. Limited progress has been made. Over the past 21 years, 4th grade math gaps have narrowed by about 20% and 8th grade even less. At the present rate, it would take over 100 years to eliminate gaps.

The educational policies adopted over the past 25 years to address achievement gaps have included (1) teaching math earlier, (2) spending more time on math by reducing time on other subjects and activities, (3) raising the quality of math instruction with better curriculum and higher quality teachers, (4) establishing math standards for grades 3-8 linked to annual testing and teacher accountability, and (5) intense remediation for lower scoring students. The limited success of these policies suggests that their rationale and assumptions should be examined.

The achievement gaps are substantial, and the population of students in groups with gaps is large and expected to become a larger share of the U.S. student population and future labor force. Approximately 50% of 8th grade students are considered advantaged (not eligible for free lunch, white or Asian students) and score significantly higher than the remaining 50% of students who are minority and/or disadvantaged. No other developed nation has a large achievement gap based on demographic characteristics for such a substantial part of their population. These gaps are one factor in our mediocre international ranking in math, and for the low involvement of disadvantaged children in STEM learning and careers.

Math achievement gaps at 8th grade are similar to gaps at kindegarten entry, suggesting that much of the later gaps are formed before school entry and are not primarily caused by schools. Rather, achievement gaps may be linked to deficits in at least three early-developing skills that are usually thought of as being peripheral to math learning. These skills are executive function, visuo-spatial, and fine motor skills. These skills have been linked to later math achievement through longitudinal surveys and neuroscience research. Neuroscience evidence suggests that learning these skills builds neural networks that are later used in math learning and performance. Disadvantaged children have large deficits in these skills.

A recent experimental intervention that focused on building these skills for K-1 children at high risk through structured play with popular arts & crafts and games improved these three skills and also improved math scores. Math scores improved even though there was no implicit or explicit math instruction in the intervention. The results suggest that increasing STEM participation may involve providing structured play opportunities either prior to school entry or in pre-K or K curricula rather than through more direct and earlier math instruction. The results also suggest that remediating poor math performance through increased math instruction (drill and kill) likely has limited effectiveness unless these deficits in foundational skills are addressed.

For More Information
Please contact David Grissmer at grissmer@virginia.edu

Metro Early College High School

Metro Early College High School opened its doors six years ago with 96 freshmen representing the 15 school districts in Franklin County, Ohio. Today, Metro, still a lottery-based public STEM school, offers students an accelerated course load with problem-based real-world experiences. After students complete the Core coursework, they select a themed Learning Center that is taught by Metro teachers in conjunction with experts in that field. Here, students begin to explore college coursework, as well as participate in in-depth real-world challenges based on the theme of the center. In addition, each of Metro's Learning Centers has been developed in partnership with and is housed within other city schools within Franklin County. The end goal, after two years, is for the Learning Center to become an embedded component of each partner school district in order to maximize the schools impact on the community.

Metro also provides students with other unique learning experiences such as internships, STEM competitions, and research. These experiences take full advantage of the community-based partnerships that have been developed over the past six years. Metro students are placed in university research laboratories, local businesses, or other public interest venues where they apply the skills, knowledge, and dispositions they have learned during their core coursework.

Metro's partnership with The Ohio State University is supported in many ways. Students have access to an OSU academic advisor located in the school building. Additionally, there is a joint Metro/OSU committee that oversees the administrative process of the early college experience of all Metro programs including the learning centers.

Over the past six years, Metro students have taken advantage of the early college opportunities offered. For example, nearly 50% of Metro's current enrollment has earned some college credits and many could be considered college sophomores. Additionally, two members of Metro's first graduating class (class of 2010) will be graduating from The Ohio State University this June.

For More Information
Please see Metro's website, www.themetroschool.org.
Or contact Principal Aimee Kennedy at kennedy@themetroschool.org or founding faculty member Andrew Bruening at bruening@themetroschool.org.

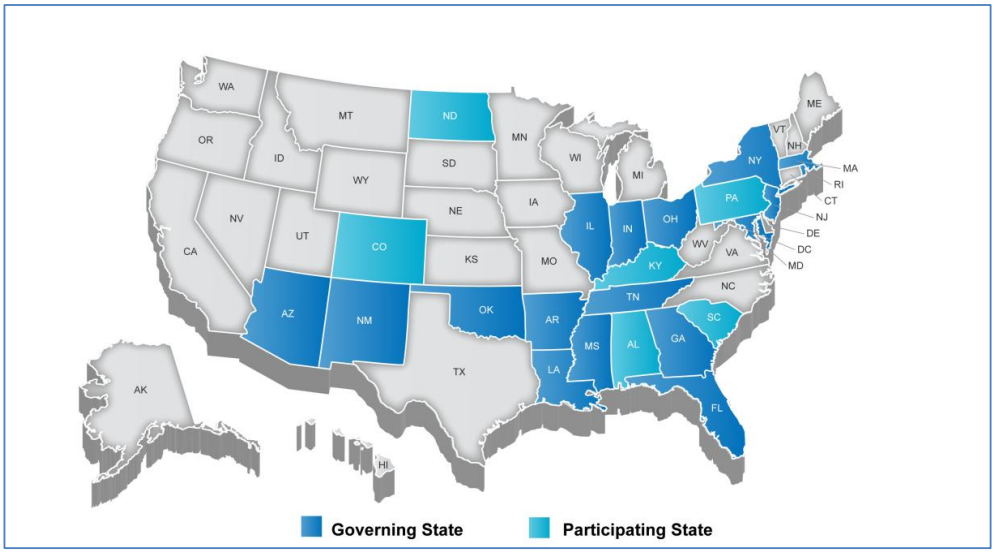
Career and College Readiness for the Next Generation

PARCC is an alliance of 24 states working together to develop a common set of K-12 assessments aligned to the Common Core State Standards (CCSS) in English Language Arts and mathematics, anchored in what it takes to be ready for college and careers. The CCSS call on students to have not only solid content knowledge but also the skills to apply their knowledge in ways demanded by colleges, careers and citizenship in the 21st century. Measuring the full breadth of the CCSS will require new kinds of tests that measure what matters for students' futures. Moving to such an assessment system will require re-imagining assessments as we know them.

The next-generation assessment system envisioned by PARCC will have several benefits not found in current assessment systems including benefits to: ***students***, who will know if they are on track to graduate ready for college and careers; ***teachers***, who will receive regular results to guide learning and instruction; ***parents*** who will have clear and timely information about the progress of their children; ***states*** who will have valid results that are comparable across the member states, and; ***the nation***, since the assessments are based on the college- and career-ready, internationally-benchmarked CCSS.

The PARCC States

State-based collaboration is the hallmark of PARCC, and collectively these states educate about 25 million students. PARCC is state-led and a subset of 18 PARCC states makes up its Governing Board. PARCC is managed by Achieve, a nonprofit group with a 15-year track record of working with states to improve student achievement.



Our Vision

PARCC's assessments will yield significant advantages for educators, state policymakers, and most importantly, parents and students. PARCC assessments will measure what matters – the full range of the content and skills called for in the English Language Arts/Literacy and mathematics Common Core State Standards. Students will take parts of the assessment at key times during the school year – closer to when they actually learn the material – giving teachers more timely information so they can adjust instruction and student supports as appropriate throughout the school year. PARCC assessments will also be computer based in order to maximize technology and deliver faster turnaround of student results. PARCC's high school assessments will be

Updated December 2011

PARCC: Career and College Readiness for the Next Generation

developed in collaboration with higher education and will tell students whether or not they are ready for entry-level college courses. Finally, states in PARCC will adopt common performance standards that will allow policymakers to compare results within and across states to identify pockets of innovation and achievement.

PARCC's Vision is to:

1. **Build a Pathway to College and Career Readiness for All Students.** Anchoring the assessments in college and career readiness by the end of high school will create a more meaningful target for students. Students who score proficient on the assessments will know they are on track for the next steps in their education. In high school, students will receive an early signal about whether they are ready for entry-level, non-remedial courses at postsecondary institutions in all PARCC states. Targeted interventions and supports will be created so that students can fill missing gaps and graduate from high school ready for postsecondary education while they are still in high school. Postsecondary partners in PARCC – more than 200 institutions and systems covering hundreds campuses across the country – will help develop the high school assessments.

2. **Create Better Assessments.** Having a mix of items – short answer, longer open response and performance-based, in addition to richer multiple choice items – will enable PARCC to create assessments that better reflect the full range of content and skills found in the ELA and math CCSS. Testing at key points throughout the year will give teachers, parents and students better information about whether students are "on track" or need some additional support in particular areas. This is how many good classrooms function already; what's different about the PARCC vision is that these high-quality assessments – and the instructional tools and supports to back them up – will be available in all classrooms, in every state, for the benefit of every student.

3. **Support K-12 Educators in the Classroom.** PARCC will support educators by providing teachers with the tools they need to be successful. These tools – created with and for educators – will include model content frameworks, model instructional units, and sample item and task prototypes. The timely student achievement data on tests given throughout the year will be designed and reported with teachers in mind so they can maximize their use. Finally, professional development, including educator–led training, on the new assessments as well as professional development on how to interpret and use the assessment results will be developed and made available online.

4. **Make Better Use of Technology in Assessments.** Traditionally, assessments have been pencil-and-paper/fill-in-the-bubble tests administered once a year. But these days, faster and more affordable technology makes it easier than ever to offer computer-based assessments at key moments throughout the school year. This is PARCC's approach – producing timely snapshots of students' knowledge, giving parents and students better information and teachers the ability to adjust instruction and student supports accordingly.

5. **Advance Accountability at All Levels.** Creating common assessments grounded in common standards is the logical next step to ensure that *all* students get the knowledge and skills they need. Many PARCC states intend to use the assessments to inform accountability in a way that is not possible now. PARCC will support the ability of states to develop robust accountability systems that meets multiple needs, including state and federal requirements. States will also be able to get an accurate view of how they stack up against one another.

For more information, contact svangundy@achieve.org

Updated December 2011

School Conditions to Support Successfully Teaching Challenging Coursework

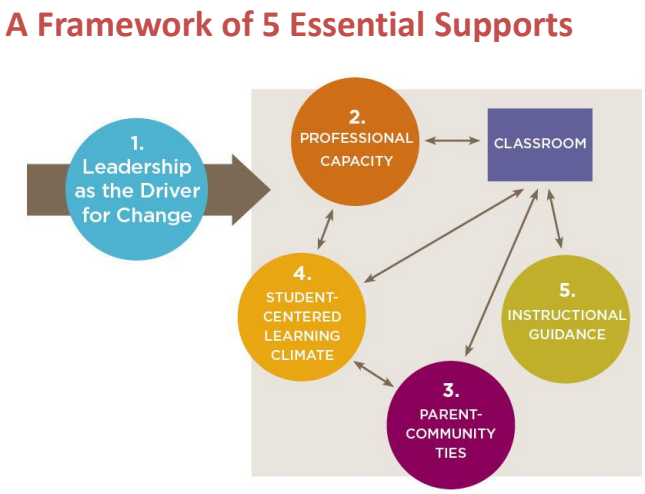
Pressure is on public schools to prepare all students for college and to encourage more students to enter careers in science and math. These challenges require a dramatic change in educational practice, as less than half of students in typical schools graduate with sufficient skills to be likely to succeed in college, and few students enter careers in STEM. Schools are being asked to raise the skills of the lowest-achieving students to levels that were previously achieved by the highest-achieving students. The hope is that improving the teacher workforce and making curricula more rigorous will provide the needed change.

Research from Chicago, however, suggests that a narrow focus on improving the curriculum or evaluating individual teachers is unlikely to improve student achievement, and may even bring a decline in learning and educational attainment. There are substantial challenges to implementing rigorous curricula and ensuring that teachers know how to teach it and how to effectively support students. These challenges can be especially problematic in STEM courses, where students may withdraw when they perceive the work to be challenging and lack adequate teacher support. Instead, there is evidence that sustained improvement in student achievement comes from paying attention to the organizational capacity of schools and the context into which curricular and human capital policies are implemented.

As noted in the National Research Council publication *Successful STEM Education: A Workshop Summary* (2011), the University of Chicago Consortium on Chicago School Research found:

> The teachers' qualifications were less important than the way in which teachers worked together to take collective responsibility for the school. Similarly, the parents needed not just to participate in school activities, but also to be brought in as partners in their children's education, and community organizations needed to be involved in a way that was aligned with the school's instructional programming.

The Consortium's research showed that there are five essential supports for school improvement (see diagram below):



Of great importance was the research done to explore whether these elements are equally important in all types of schools. Chicago schools were divided into groups based on their racial compensation and economic backgrounds. The research found:

- that schools serving disadvantaged communities are less likely to show improvements over time, and
- that schools serving the most disadvantaged schools are least likely to have the five critical areas of support, BUT
- if these schools had strong internal supports in all five areas, they were just as likely to improve as advantaged schools that had these supports.

Resources

Allensworth, Elaine M., Stephen Ponisciak and Christopher Mazzeo. 2009. *The Schools Teachers Leave: Teacher Mobility in Chicago Public Schools*. Consortium on Chicago School Research, Chicago, Illinois. Accessed at http://ccsr.uchicago.edu/content/publications.php?pub_id=134

Allensworth, Elaine M., Takako Nomi, Nicholas Montgomery, Valerie E. Lee. 2009. College Preparatory Curriculum for All: Academic Consequences of Requiring Algebra and English I for Ninth Graders in Chicago. *Educational Evaluation and Policy Analysis*, 31 (4). Accessed at http://epa.sagepub.com/content/31/4/367.full

Bryk, Anthony S., Penny Bender Sebring, Elaine Allensworth, Stuart Luppescu, John Q. Easton. 2010. *Organizing Schools for Improvement: Lessons from Chicago*. Chicago: University of Chicago Press. Accessed at http://ccsr.uchicago.edu/content/publications.php?pub_id=140

DeAngelis, Karen J. and Presley, Jennifer B. (2011) Teacher Qualifications and School Climate: Examining Their Interrelationship for School Improvement, *Leadership and Policy in Schools*, 10: 1, 84–120. Accessed at http://www.tandfonline.com/doi/abs/10.1080/15700761003660642

Montgomery, Nicholas and Elaine M. Allensworth. 2010. *Passing Through Science: The Effects of Raising Graduation Requirements in Science on Course-Taking and Academic Achievement in Chicago*. Consortium on Chicago School Research. Accessed at http://ccsr.uchicago.edu/content/publications.php?pub_id=138

National Research Council. (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics.* Committee on Highly Successful Schools or Programs for K-12 STEM Education. Board on Science Education and Board on Testing and Assessment, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Nomi, Takako and Elaine Allensworth. 2009. "Double-Dose" Algebra as an Alternative Strategy to Remediation: Effects on Students' Academic Outcomes. *Journal of Research on Educational Effectiveness*, 2: 111–148. Accessed at http://www.tandfonline.com/doi/abs/10.1080/19345740802676739

Nomi, Takako and Elaine Allensworth. 2011. "Double-dose algebra as a strategy for improving mathematics achievement of struggling students: Evidence from Chicago Public Schools." Chapter in Russell Gersten and Rebecca Newman-Gonchar (eds.) *Understanding RTI in Mathematics: Proven Methods and Applications*, Brookes Publishing.

For more information

Please contact Elaine Allensworth at elainea@ccsr.uchicago.edu or visit: http://ccsr.uchicago.edu/content/index.php

The Chicago Pre-College Science and Engineering Program

The Chicago Pre-College Science and Engineering Program (ChiS&E) envisions producing a generation of young minority Chicago adults prepared to take their place in this new global economy and compete successfully with children in any place in the America and the world. We realize that a dream without a plan is just a wish. By employing our theory of change that focuses on developing the early interest of African-American and Latino children in STEM and deeply engaging their parents in the process, we believe that we can realize this vision. Out of this vision, SETSEP was conceived to provide highly engaging, age-appropriate, hands-on science and engineering activities for Chicago Public Schools students in grades K–3 and their parents. SETSEP is based on a tested model and best practices of the long-standing DAPCEP program in Detroit—a program noted for its excellence in preparing youth to be the future scientists and engineers of tomorrow.

The overarching goal of SETSEP is to increase the participation of underrepresented groups (African-American and Latino) in the STEM fields through the following three objectives:

1) increasing the knowledge, skills, and interest of K–3 students from underrepresented populations groups in STEM fields;
2) increasing parents' knowledge and skills in science and engineering and their capacity to support their children in pursuing education and careers in these fields; and
3) increasing the effectiveness of teachers in engaging students and parents in the Saturday science-related learning activities.

In our second program year, we are already producing strong outcomes—benefiting more than 298 low-income minority students and their parents—which suggest that we are well on our way to realizing ChiS&E's vision. In addition, ChiS&E has developed curriculum guides, aligned with the exhibits at the Museum of Science and Industry, for Kindergarten (Little Civil Engineer), First Grade (Little Chemical Engineer), Second Grade (Little Electrical Engineer) and Third Grade (Little Mechanical Engineer). Also, ChiS&E developed a ChiS&E Parent Resource Guide with information for parents about social service agencies in Chicago. ChiS&E will be using the expertise of a local marketing and sales firm to develop strategies to scale up its program. ChiS&E has two websites: www.chiprep.org (English) and www.mylittleengineers.com (Bilingual)

Research Findings

- Dr. Beatriz Chu Clewell , *Breaking the Barriers (Helping Female and Minority Students Succeed in Mathematics)*, Jossey-Bass, 1992
- Return on Investment, Tracking Report by the Detroit Area Pre-College Engineering Program (DAPCEP) 1976-1996

Evaluation

Evaluator: Dr. Maurice Samuels, Center for Elementary Math and Science Education, University of Chicago

Evaluation Methodology: A mixed-methods approach including document reviews, interviews, assessments, observations, focus groups, student portfolio and digital artifact analysis, and attendance records to measure project impacts, content knowledge, motivation, STEM interest, and overall project success.

Highlights of Project Evaluation

- CHiS&E IS IMPLEMENTING ITS THEORY OF CHANGE—Saturday sessions are meeting program needs, quality of instruction is improving, the cyberlearning component is developing, program attendance has remained consistent, a Chicago-based coordinator will enable the program to expand.
- THE PROGRAM IS BUILDING PARENTS' CAPACITY TO SUPPORT THEIR CHILDREN'S EDUCATION—parents are satisfied with the program, parent engagement is high, parents' understanding of the fields of technology and engineering has been strengthened, parents would like their children to continue in ChiS&E after third grade, ChiS&E is expanding Spanish language materials for parents.
- CHiS&E IS PREPARING STUDENTS TO PARTICIPATE IN THE STEM FIELDS—students are using information learned at ChiS&E at their school, students have expanded notions of what technology and engineering are, students have a strengthened awareness of engineering careers, additional materials will increase that awareness.
- DAPCEP STAFF IS PREPARING CHiS&E TEACHERS TO EFFECTIVELY ENGAGE STUDENTS AND PARENTS—teachers have an increased knowledge of the STEM fields, additional PD will further build their capacity.

For More Information

Please contact Kenneth Hill at hillkenneth@comcast.net

Why Linking In- and Out-of-School Experiences Matters for Students Historically Underrepresented in STEM

Project Exploration's youth programs allow students to explore a variety of scientific disciplines alongside scientists. Project Exploration targets students who are open-minded and curious, regardless of academic standing. All of the youth programs are free, eliminating the cost barrier that prevents low-income students from accessing dynamic out-of-school time science programs. Project Exploration works with more than 300 Chicago Public School students each year.

Sisters4Science, one of Project Exploration's in-school/out-of-school programs, is a year-round after-school and field program that combines science exploration with leadership development for approximately 100 minority middle school girls. Currently the program is run in partnership with four schools across Chicago—Perspectives Middle Academy, Perspectives Charter School—Rodney D. Joslin Campus, Reavis Elementary School, and Barbara A. Sizemore Academy. The program goals are to:

- Create a safe space for girls to explore science and develop leadership skills.
- Expose girls to the wide variety of roles played by women in science.
- Improve girls' overall attitudes about science by developing team building, communication, and leadership skills.

Girls participate in hands-on science activities led by women scientists as well as participate in science-based field trips. The interests of the girls drive the curriculum; in the past, participants have investigated topics ranging from genetics to chemistry to girls' health. Sessions are held weekly at each school site.

For More Information
Please contact Gabrielle Lyon, Cofounder and Senior Explorer, Project Exploration at glyon@projectexploration.org

Saint Louis Science Center believes that building and sustaining collaborative partnerships between schools, educators and the Saint Louis Science Center brings with it the opportunity to have an unprecedented impact on students' academic achievement. Once such program, the Challenger Learning Center-St. Louis, offers hands-on, space science experiences for students. Students complete their classroom curriculum unit on space science and then enter the Challenger Learning Center-St. Louis to become part of the flight crew and mission control. Students experience unparalleled excitement of space exploration by flying a simulated mission into space. As an educator, when you enroll your class in a Challenger Learning Center-St. Louis program, you receive a free professional development workshop. The professional development workshop provides invaluable resources and activities that will take you well beyond your day-off Challenger Learning Center experience.

For More Information
Please contact Diane Miller, Chief Educational Outreach Officer, Saint Louis Science Center at dmiller@slsc.org

The **Peggy Notebaert Nature Museum** wants students to be fascinated by science. One of the museum's programs, Science on the Go!, is a state-of-the-art, professional development program designed to help k-8 educators become more comfortable teaching science through inquiry-based, hands-on lessons and

cooperative learning. The curriculum includes a standards-based curriculum including assessment tools, data-sheet masters, topic resources, and extension activities. Curriculum is revised on an ongoing basis, based on teacher and museum educator feedback. Professional development includes an in-depth, hands-on, introductory curriculum workshop to prepare teachers for using curriculum (includes dinner). All of the necessary materials needed to teach the quarter-long curriculum are packed and prepared for teacher use. An outreach educator will visit each participating classroom three times during the quarter to conduct hands-on science lessons alongside the classroom teacher. Participating classrooms receive a 50% transportation reimbursement as part of their field trip. A Museum representative will be available at the curriculum workshops for teachers to sign up for field trips on the spot! Each participating teacher is eligible to receive seven CPDUs toward re-certification upon completion of the program.

For More Information

Please contact Rafael Rosa, Vice President of Education, The Chicago Academy of Sciences and its Peggy Notebaert Nature Museum at Rafael.Rosa@naturemuseum.org

Educational Policy, School Administration, and the Technical Core: The Local Infrastructure and Instructional Improvement Challenge

Background

Over the past decade, researchers in The Distributed Leadership Studies (DLS) at Northwestern University have been developing a framework for examining school leadership and management with an emphasis on their relations to classroom instruction. Drawing on theoretical and empirical work in distributed cognition and socio-cultural activity theory, our distributed perspective involves two aspects: principal plus and practice. The principal plus aspect acknowledges that the work of leading and managing schools involves multiple individuals. The practice aspect foregrounds the *practice* of leading and managing, framing this practice as emerging from the *interactions* among school leaders and followers, mediated by the situation in which the work occurs. Practice is more about interaction than action. At the same time, any effort to understand practice has to pay careful attention to social structure, both the immediate infrastructure of the school organization and the more distal infrastructure of the education system. The school subject–mathematics, science and language arts—has figured prominently in our efforts to build knowledge about and for the practice of leading and managing.

The Distributed Leadership Studies are committed to developing knowledge about leading and managing, especially knowledge for practice—knowledge of the *how* of leading and managing. While there is a sizable knowledge base about the *what* of leading and managing, we know less about the *how*—the practical knowledge that school leaders use in their day-to-day practice. Still, the available knowledge base has much less to say about the *how* of monitoring instruction. Without a rich understanding of the *how*, it is difficult for policymakers and researchers to contribute to improving school leadership and management.

One component of our work involves designing and validating research or diagnostic instruments such as logs of practice and social network instruments. A second component of our work involves describing and analyzing leadership and management arrangements for instruction in schools. Third, especially critical when it comes to developing knowledge for practice, DLS work involves engaging district policymakers and school practitioners with research findings for their schools. The final component of the DLS work involves designing curriculum modules that engage school staff in diagnostic and design work using the distributed perspective and instruments and findings from our empirical work.

Documented Results and Potential Applications

Our work has generated several findings about relations between the school infrastructure and the practice of leading and managing. For example, our work suggests that interactions among school staff are not only influenced by homophily (e.g., race and gender) but also the school's formal structure (e.g., grade-level assignment, formal leadership position, organizational routines) (Hopkins, Spillane, & Heaton, in preparation; Spillane, Kim, & Frank, under review; Spillane, Parise, & Sherer, 2011). Another important finding is that the school subject matters with respect leadership and management practice (Spillane, 2006). Second, our work has developed and piloted several instruments (Pitts & Spillane, 2009; Pustejovsky & Spillane, 2009) that have been taken up and used by others. Third, our research work has severed a foundation for professional development in the field both in the U.S. and abroad.

For More Information

For products and publications based on this work, visit http://www.distributedleadership.org.

Illinois Pathways: Improving Education, Workforce, and Economic Development Coordination to Build More Effective STEM Talent Pipelines

Illinois Pathways, funded through Race to the Top, was recently launched by Governor Quinn to support P–20 education and workforce training systems that enable learners to explore their academic and career interests in STEM fields. In addition, Illinois Pathways is set to launch the first STEM Learning Exchanges later this year, a new and innovative network of statewide public-private partnerships organized by career cluster that work to coordinate planning and investment to support local STEM programs. Join a panel of State of Illinois agency representatives and the Illinois Business Roundtable to learn more about this new and important initiative and how it will be implemented throughout Illinois.

Background

As Illinois' economy continues to recover, it is critically important to understand how our economy is both growing and changing. More importantly, we need to make sure our education system is supporting students in developing the skills and knowledge that will ensure they are competitive in a 21st century economy. We know that the majority of job opportunities in the future will require some level of college education or training. As part of this effort, the State of Illinois' P–20 Council has established a goal to increase the proportion of Illinoisans with high-quality degrees and credentials to 60 percent by the year 2025. Illinois Pathways supports the increase of credential attainment aligned to the state's economic development objectives.

Illinois Pathways, funded through Race to the Top, is a new and innovative State of Illinois-led STEM education initiative designed to support college and career readiness for all students. Coordinated through a partnership between the State of Illinois' education and economic development agencies, Illinois Pathways supports local programs that empower students to explore their academic and career interests in STEM fields while also supporting new statewide, public-private partnerships known as Learning Exchanges that better coordinate investments, resources and planning for those programs.

As part of Illinois Pathways, the Illinois State Board of Education, the Illinois Board of Higher Education, the Illinois Community College Board, the Illinois Department of Commerce and Economic Opportunity, the Illinois Department of Employment Security, and the Illinois Student Assistance Commission created the IPIC through a landmark intergovernmental agreement to support education and workforce pathways for youth and adults aligned to the state's economic development objectives. Illinois Pathways is intended to improve education, workforce, and economic development coordination in order to build more effective talent pipelines throughout the state in critical STEM fields. As part of the IPIC, each state agency is committed to aligning its programs and policies to support STEM talent pipelines across education and workforce systems.

The Illinois Pathways initiative proposes a new and innovative approach to increasing credential attainment by supporting two strategies: (1) better support education and training systems to enable learners to explore their academic and career interests in STEM fields, and (2) improve coordination of public and private investment, including business and industry, in supporting the development of a workforce that can be competitive in tomorrow's economy.

To that end, the Illinois Pathways initiative is utilizing federal Race to the Top funds to support high schools in implementing career pathway and program of study models in cooperation with their postsecondary and workforce partners. These programs will provide opportunities for students to explore careers in STEM fields; develop academic, employability, and technical skills; and connect to a wide range of work-based learning opportunities.

In addition, Race to the Top funding is being utilized to seed new and innovative statewide public-private partnerships, called Learning Exchanges, for each of these targeted STEM sectors. These statewide Learning Exchanges will coordinate with regional networks to aggregate curricular resources, assessment tools, professional development systems, work-based learning opportunities, and to support performance evaluation across the P–20 education and workforce system.

As Illinois continues to grow its economy, it is important that we leverage new and innovative public-private partnerships that span P–20 education and workforce systems and provide access to career pathway opportunities for youth and adults to explore their academic and career interests, develop their skills, access employment, and grow their careers.

Documented Results
Illinois Pathways supports the scale-up of Programs of Study in critical STEM fields. Programs of Study are currently implemented through Career and Technical Education programs approved by the Illinois State Board of Education and the Illinois Community College Board. The Office of Community College Research and Leadership and the National Research Center for Career and Technical Education have both studied Programs of Study implementation and have consistently found that they have proven effective in increasing student achievement and relevance as well as improving transitions to postsecondary education and employment. Links to both organizations and their research findings can be found below under "For More Information."

Potential Applications
Programs of Study are designed to improve access for underrepresented populations in STEM fields, including women, minority, low-income, and disabled populations. Central to Programs of Study is personalization and the ability to empower learners to explore programs and opportunities aligned to their academic and career interests. To accomplish this goal, Programs of Study are designed to utilize a diverse delivery network leveraging life-wide learning communities, including K–12 schools, regional center of education, community colleges, universities, virtual schools, and other assets to expand academic and career exploration opportunities for students. STEM Learning Exchanges are organized to increase access to resources and partnerships for educators and learners by achieving economies of scale for a network of Program of Study in a STEM field. By reducing the transaction cost among education partners and employers they will expand access to opportunities in STEM education.

For More Information
- Pathways to Prosperity: http://www.illinoisworknet.com/NR/rdonlyres/55AD8FEE-2FD0-42BB-88B0-AB239B5B9CCC/0/Pathways_to_Prosperity_Report.pdf
- Georgetown University Center on Education and the Workforce: http://cew.georgetown.edu/
- National Research Center for Career and Technical Education: http://www.nrccte.org/
- Pathways to Results: http://occrl.illinois.edu/projects/pathways
- Illinois Pathways: http://www.illinoisworknet.com/ilpathways

Providing Ongoing Support for STEM Teachers

Background

The Math and Science Partnership Knowledge Management and Dissemination (MSP-KMD) was funded as a Research, Evaluation, and Technical Assistance project to support knowledge management within the MSP program and to disseminate information to the broader mathematics and science education community. The overall goal of MSP-KMD was to synthesize findings in the K–12 arena in a small number of important areas, articulating the contribution of the MSP program to the knowledge base and identifying "gaps" and promising practices/strategies for further investigation. In this way, MSPs and the field at large can benefit from MSPs' research and development efforts.

MSP-KMD focused its knowledge acquisition and knowledge sharing efforts in three primary areas: deepening teacher content knowledge (including disciplinary content knowledge, pedagogical content knowledge, and understanding science/mathematics as ways of knowing); preparing, deploying, and supporting teacher leaders; and lessons learned about STEM faculty involvement in the K–12 arena. In its last year, MSP-KMD examined STEM PLCs as an approach for improving mathematics/science teaching and learning. The MSP-KMD process involved the collection and synthesis of both research-based findings and practice-based insights. The analysis of research was conducted using the Standards of Evidence process developed by MSP-KMD to operationalize best practices in empirical research involving various quantitative and qualitative methodologies (Heck & Minner, 2009). In addition, practice-based insights were collected from online panels composed of representatives from MSP projects and other experienced practitioners. The processes used for collecting and vetting practice-based insights will be shared with the field in an article: *What Do We Know and How Well Do We Know It? Identifying Practice-Based Insights in Education* (Miller & Pasley, in press). The products of these syntheses are over 30 knowledge reviews that provide guidance to STEM educators based on what is known from research and practice.

In addition, MSP-KMD developed cases studies that describe actions of, and lessons learned by, MSP project leaders, which serve as a resource for current and future program designers. There are three case volumes available to the MSP and broader education community:

1. *Designing for Sustainability: Lessons Learned about Deepening Teacher Content Knowledge from Four Cases in NSF's Math and Science Partnership Program.* (http://www.mspkmd.net/cases/tck/sustainability/)

2. *Toward Sustainability: Strategies from Four Cases of Teacher Leadership in NSF Math and Science Partnerships.* (http://www.mspkmd.net/cases/tl.php)

3. *Deepening Teachers' Mathematics and Science Content Knowledge: Lessons from NSF Math and Science Partnerships*. (http://www.mspkmd.net/cases/tck/perspectives)

MSP-KMD has also developed a searchable, online, database with information about instruments used to assess mathematics and science teacher content knowledge. The database, which includes 167 instruments, is searchable by a number of categories including content area, grade level, and

nature of the instrument (e.g., multiple-choice/constructed response). In addition, the project prepared materials to help in the design, implementation, reporting, and interpretation of research on STEM interventions. *Learning Together: A User-Friendly Tool to Support Research on STEM Education Interventions* and a briefer version aimed at consumers of research are currently being reviewed.

Potential Applications

There is an increasing emphasis in education for the use of research-based strategies, evidence-based outcomes, and data-driven decision-making. Often, people equate research, evidence, and data with a certain kind of knowledge: empirical knowledge. Despite this emphasis, many important decisions made in educational settings are drawn from practice. MSP-KMD developed a methodology by which practice-based insights might be systematically collected, analyzed, and interpreted, so that they can be credibly held next to what is known from empirical research. In this way, practice-based knowledge along with what is known from empirical research can be used by administrators, teachers, and other educators needing to make informed decisions in practice; and by policy makers wanting to move beyond anecdotal information to guide policy decisions. The products that were developed by this process and made available by the MSP-KMD project can be used by various education professionals to guide the design, implementation, and support of STEM education interventions for teachers.

For More Information

For more information about the MSP-KMD project and to access the resources and products developed by this project, visit http://www.mspkmd.net

References

Heck, D. J. & Minner, D. D. (2009). Codebook for standards of evidence for empirical research. Chapel Hill, NC: Horizon Research, Inc. (http://www.mspkmd.net/pdfs/soe.pdf)

Miller, B. & Pasley, J. (in press). What do we know and how well do we know it? Identifying practice-based insights in education. Evidence and Policy.

UIC College Prep High School

UIC College Prep High School (UICCP) opened its doors in Chicago in 2008. The school was established in partnership with the University of Illinois at Chicago (UIC) and is one of 10 campuses of the Noble Network of Charter Schools, a highly regarded local charter school network. The school's academic focus is on mathematics and science, with a special emphasis on the health sciences. UICCP's curriculum includes four years of mathematics and science. It also includes a unique four-year health sciences program that is being co-developed by UICCP faculty members with faculty and staff from UIC's six health sciences colleges—Applied Health Sciences, Dentistry, Medicine, Nursing, Pharmacy, and Public Health—as well as UIC's Jane Addams College of Social Work. UICCP's location within the Illinois Medical District enables the high school's students to have regular interaction with UIC personnel, programs, and facilities, especially with the faculty, staff, and health professionals who work at the University of Illinois Medical Center. An in-school health clinic, which is located on UICCP's ground floor and is operated by the UIC personnel, provides another, regular opportunity for the high school's students and staff to interact with health care professionals. The school has quickly emerged as one of the city's leading high schools, with 2011 ACT scores that were the highest in the city among all non-selective-enrollment schools. Ninety-five percent of the school's seniors this year have been accepted to a four-year university. UIC College Prep is one of 11 campuses of the Noble Network of Charter Schools, though the only one with a close partnership with a major university.

For More Information
Please contact Audrey Borling, Dean of Instruction, aborling@uiccollegeprep.org; Tressie Dust, Principal, tdust@uiccollegeprep.org; and Kate Meixner, Health Sciences Program Coordinator, kmeixner@uiccollegeprep.org

UIC College Prep
The LSV Campus of Noble Street Charter School
312-768-4858 (office)
630-768-5899 (cell)
http://www.uiccollegeprep.org /

What Do The Next Generation Science Standards and NRC Framework Mean for Teaching and Curriculum Materials?

Background
The session will discuss how the NRC Science Education Framework and Next Generation Science Standards call for changes in science teaching and curriculum materials. The Framework and NGSS present two major evolutions in standards that challenge current widely used curriculum materials and the way science is often taught in classrooms: (1) organizing learning around core explanatory ideas; and (2) engaging students in scientific and engineering practices to develop and apply these explanatory ideas.

Brian J. Reiser is a member of the panel that developed the National Research Council 2011 *Framework for New Science Education Standards* being used to guide the design of *The Next Generation Science Standards*. Reiser's research projects examine how to support teachers and students in scientific practices such as argumentation, explanation, and modeling meaningful and effective for science classrooms. This work has involved the development of curriculum materials that support teachers in leading students through a trajectory of investigations to develop explanations, arguments and models that lead to constructing the core explanatory ideas, and research studies documenting the teacher and student learning through this approach.

The Scientific Practices project is developing an empirically-based learning progression for scientific practices that specifies how learners can engage in constructing, applying, and refining scientific knowledge with increasing sophistication from elementary to middle school. Reiser, in collaboration with University of Michigan researchers, has developed IQWST (Investigating and Questioning our World through Science and Technology), a middle school project-based science curriculum that supports the development of classroom argumentation leading to construction and refinement of the explanatory models reflecting the core ideas in science.

Documented Results
Analyses of classroom interactions and student learning across grades 5-8 have shown the feasibility of involving students in constructing, applying, and refining explanatory models. Upper elementary students have developed models of evaporation and condensation that account that can explain at the particle level why evaporation and condensation occur, and reflect the types of explanations targeted in the NRC framework and NGSS performance expectations, and middle school students have developed deeper models of the nature of matter they use to explanation a wide range of phenomena, including phase change, conservation of mass. Students' can explain *why* it must be that all matter, whether in solid, liquid, or gas form, must be made of particles that are actually moving with empty space between them, citing evidence from experiments and everyday phenomena to support their arguments.

The utility of developing explanatory models and engaging in argumentation to evaluate and refine those models has been shown across scientific disciplines in middle school, including explaining cases of population change using natural selection in biology; explaining color, filter, and shadow phenomena with a model of how light interacts with matter in physics; and explaining how a storm arises using a model of flow of matter and energy through atmospheric systems in earth science. The focus on more explanatory models leads to effective learning gains as assessed through typical state assessment items as well as more practice-focused assessment items.

Applications
The examples in the session demonstrate the feasibility of the scientific practices called for by the NRC framework and NGSS standards as vehicles for science learning across thousands of students and dozens

of teachers. The embodiment of the teaching approach, educative support for teachers, and supports for students have been demonstrated in a full three year program of curriculum materials for grades 6-8, that can be used as a scalable model for curriculum materials and professional development aligned with the NGSS standards.

For More Information
http://northwestern.academia.edu/BrianReiser
Research on scientific practices: http://www.models.northwestern.edu/ (in development for May 2012)
http://scientificpractices.sesp.northwestern.edu/
Published version of these NSF-funded curriculum materials: http://www.sangariglobaled.com/iqwst/