Testimony

U. S. House of Representatives
Subcommittee on Research and Science Education, Committee on Science

A Systems Approach to Improving K-12 STEM Education

July 30, 2009

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Mr. Chairman, members of the Subcommittee, thank you for inviting me here today to speak to you about this issue. It is an honor to sit before you alongside colleagues whom I've worked with and learned much from.

Introduction

I am the Officer of Teaching and Learning for the Chicago Public Schools. The Chicago Public School system consists of over 600 schools, nearly 25,000 teachers, and more than 400,000 students. I began my career as a high school science teacher, and have played a leadership role in the design and execution of CPS's science, teachnology, engineering, and mathematics education programs for the past five years.

We have made great progress with mathematics and science instruction in Chicago. Student performance has risen considerably over the past five years, and the rate of improvement is faster than that of the state. (See Figure 1 and Figure 2.) To do this, we developed a comprehensive plan to coordinate all aspects of mathematics and science improvement, which we call the Chicago Math & Science Initiative. As part of this work, we created a vision for high quality instruction; built the support infrastructure to provide high quality, content-rich professional development to thousands of teachers over the course of an academic year; forged partnerships with local businesses, museums, laboratories, and universities to increase the content knowledge of our teachers; and enhanced our after-school offerings to include mathematics and science enrichment.

We've done this in a challenging context. Eighty-five percent of our students come from low-income families. Our resources are low; Illinois ranks 47th in the nation in the level of state support for education. Our capacity is limited—less than 5% of our K-8 teachers possess a state endorsement in mathematics. The Chicago Public Schools is an extremely decentralized school district. By state law, decisions about local school budgets, principal contracts, and curriculum are made by an elected body called the "Local School Council," not the Chief Executive Officer.

While I feel proud of the accomplishments to date, there still is much work to do. An achievement gap remains in many of our schools. The number of students meeting and exceeding standards remains far too low. Our high schools, in particular, still have graduation rates that are not acceptable. Improving schools at scale is a complicated, time-intensive work, and I'm reminded again and again at the need to approach these challenges with true humility.

Working Together

The gaps we face, and the resource and capacity limitations that we operate under make it unconscionable for us to turn down assistance. So my most important point today is that we really depend on the assistance and partnership of others—the local community groups, colleges and universities, museums and laboratories as well as the federal government to advance our work. I'll talk now about the major components of our strategy and the mechanisms by which we intend to continue the progress we've shown.

Teacher Quality

Teachers need to know the subjects they teach. That's pretty fundamental tenant of teaching and learning. In Chicago and Illinois, we've struggled to both attract and hire teachers with appropriate content-level backgrounds. Building on an earlier National Science Foundation grant called the Chicago Urban Systemic Partnership, we helped local universities create content-rich courses that enabled teachers to earn state endorsements in mathematics and science. Now, most local colleges and universities offer courses that help teachers supplement their teaching certificates with content-based credentials, and we've changed our internal staffing procedures to place an emphasis on teachers with strong content background. That said, there's still a considerable ways to go: in the Fall of 2008, we opened 82 K-8 elementary schools without a single adult with a state mathematics endorsement on their faculty.

The district's role in these conversations was to convene and organize our partners. With the CUSP grant and with the bully pulpit of the Chicago Public Schools, we've created a community of interested university faculty members and academic deans with whom we work with on a regular basis to design and manage these courses. The district has offered financial support to teachers to earn these content-based endorsements, and this "carrot" has certainly helped us encourage local universities to change the curriculum and structure of their teacher credentialing programs.

Core Support for Classroom Instruction

A major part of our strategy was to provide a complete suite of instructional supports to schools—textbooks, assessments, in-school instructional coaching, and workshop professional development—to help improve the quality of instruction within classrooms. Again, here we relied on public and private stakeholders to help develop this work.

We relied heavily on instructional materials developed locally—such as *Everyday Mathematics* from the University of Chicago—both because they were high quality but also because we had an implementation center in our backyard. Where we didn't have strong center of expertise, we helped create one: The Center for Mathematics and Science Education at Loyola University is now the headquarters for middle grades science in the city of Chicago. To date, schools that implement these programs consistently outperform schools that do not on state assessments.

At the high school level, we've created a market system around instructional supports using both public and private entities. Each year, we contract with partners—including the Illinois Institute of Technology, the University of Illinois at Chicago, Loyola University, and Northwestern University, as well as for-profit entities associated with the University of Texas at Austin and Carnegie Mellon University—to provide a similar suite of instructional materials, in-school instructional coaching, and teacher training. Through a combination of carrots and sticks, high schools utilize these services to improve their instructional performance.

The district played a major role in this work: most of the funding here comes from district or foundation funds, and we worked extensively to develop the partnership arrangements to ensure sufficient capacity both internally and externally to move the work ahead.

Extended Learning Opportunities

We also know that there are some aspects of mathematics and science that are hard to learn in the classroom. There's no better astronomy lesson than watching the star show at the Adler Planetarium. There's no better botany lesson than spending a few hours at the Chicago Botanical Gardens. We work with local museums and community groups to create after school clubs focused on science and mathematics; these programs often provide the spark that ignites a student's interest in STEM disciplines. And "Science 37," a component of After School Matters, provides science experiences for students after school time.

We've also created summer internship program and to create student and teacher research opportunities in the summer, sometimes using the GK-12 programs of the NSF, and other times using business funding. These programs enable both teachers and students to experience the real-life work of scientists and engineers, providing a learning experience that is modern and directly connected to the real work.

For the past three years, the City of Chicago has held a "Science In The City" celebration, a week long carnival that demonstrates that Chicago is a city of science to children of all ages. This event originated with the public schools, and we continue to play a leadership role in the design and execution of this event.

The district's role in this area is much more limited, primarily due to funding needs. Centrally, we help develop a few after school programs and partnerships, such as the annual science fair competition in cooperation with the Museum of Science and Industry, and the You Be A Chemist! competition with Harold Washington Community College. We're currently exploring mechanisms that will make the myriad of after-school and extended learning experiences more accessible to schools and communities, with the goal of increasing participation and coherence throughout the city.

New Schools

New school creation has been a hallmark of the Chicago Public Schools. We're please to have created several new schools with an emphasis on mathematics and science. For instance UIC College Prep high school, run by the Noble Street Charter Management Organization, provides a rigorous high school experience coupled with extensive health science learning thanks to the partnership with UIC's Medical School. Several business partners have helped fund and develop our networks of charter schools, connecting their technical resources with our school children right at their school.

Undergirding Systems and Structures

It's important to highlight the fact that the above strategies are grounded in a context of strong accountability for schools, a mechanism to work with external partners on program evaluation, and a new focus on performance management for all aspects of the educational enterprise. This systems approach has enabled much of the progress that the Chicago schools have delivered over the past half-decade.

Implications

What does it take to sustain and build such partnerships?

Coherence

A comprehensive system of supports for students within Chicago would not be possible without a coherent strategy for STEM education. In Chicago, we've maintained a consistent strategy for several years, with sustained leadership. A coherent direction enables relationships to deepen and work to improve.

Quality and Capacity

In Chicago, we're fortunate to have a wealth of capacity around STEM education work. This is important, as it enables us to create some selectivity around the nature of our partnerships. For instance, when one local university wanted to run summer programs focused on the integration of arts and science, but didn't have much direct curricular connection, we were able to convince them to change the direction of their work. When a local museum wanted to focus on teacher professional development and "edutainment" but didn't have a strong cadre of scientists or science educators, we had a stronger position from which to promote coherence and the importance of content knowledge.

Catalysts

Federal resources often are catalysts to make partnerships and connections even stronger. The Chicago Transformative Teacher Institute grant that Dr. Wink and I are co-PIs of is an example of this; as a result of National Science Foundation funding, we've created an even deeper partnership thanks to this work. Much of the groundwork for our progress in Chicago was set by a series of NSF grants over the years; it's important for the Federal government to realize the importance of this role as strategic and financial decisions are made.

Centralization

There's currently considerable debate in the education world about the degree and nature of centralization within school systems. Systems that foster innovation and entrepreneurship push decisions and resources closest to schools and classrooms, and are coupled with strong accountability systems that local communities can use to gauge progress. Yet the general public doesn't understand science or its practice; a recent *Education Week* poll showed that 66% of principals do not feel that upgrading math and science education is a priority.[1] Moreover, without strong content knowledge and considerable instructional capacity, it's difficult to design strong mathematics and science programs. Ultimately, this is a question about the best way to scale up improvements, and it remains a particularly vexing question for state and district administrators and policy makers alike.

Too often, the children in Chicago are considered "disadvantaged," because of the many social issues that confront them. Yet despite these issues, our students

[1] From Public Agenda's Quality Counts survey 2006

have a real advantage in that they grow up right next door to world-class universities, businesses, museums, and laboratories. Our collective challenge is leverage this advantage so that it serves the students of Chicago.

Questions

1. *What is the overall state of science, technology, engineering and mathematics (STEM) education in Chicago Public Schools (CPS)? Why is it important for all students to achieve proficiency in these subjects?*

As a district, we've developed a comprehensive strategy for mathematics and science improvement that consists of several components: (1) increasing content knowledge of teachers and teacher quality; (2) improving classroom instruction by providing teachers with research-based supports; (3) enhancing the after-school and extended-learning partnerships for students and families, and (4) new school creation. These are build on clear systems of accountability and autonomy for schools, sound finances, and clear performance management.

2. *How do you work with the local private sector, not-for-profit organizations, and colleges and universities to improve STEM education in CPS? Please describe these partnerships and activities. How do you develop such partnerships and activities, and how do you assess them in terms of impact on student achievement?*

   Answer.

3. *What are the major problems that limit the performance of students and teachers, and what do you feel is the single, most important step that the federal government should take to improve K-12 STEM education? What involvement have you had with math and science education programs at the National Science Foundation or other federal agencies as well as those in the state of Illinois? What are the most important and effective components of these programs?*

   Answer.

4. *What role should parents play in improving K-12 STEM education? Do you have outreach programs intended to engage parents in their children's K-12 STEM education?*

   Answer.

Figures

Add PSAE data; update for 2009

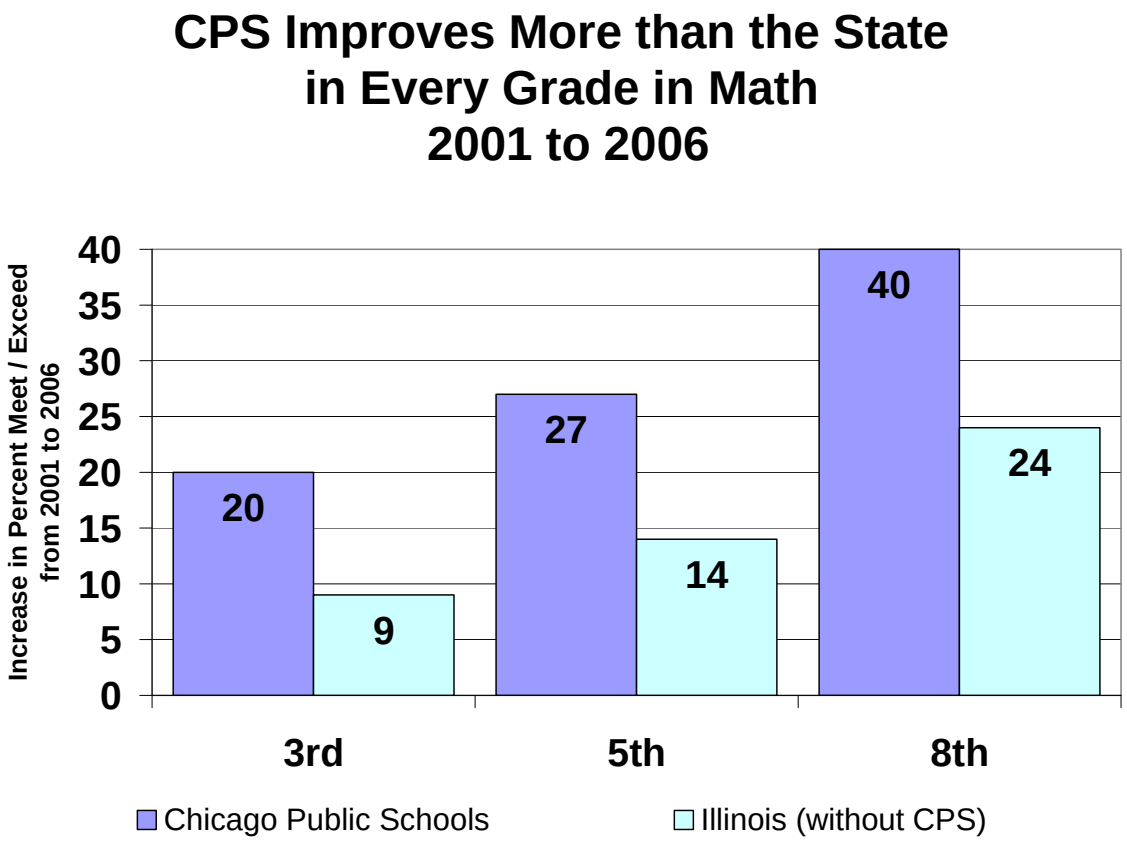

Figure 1: CPS Mathematics Performance on the Illinois Standards Achievement Test versus Illinois, 2001-2006

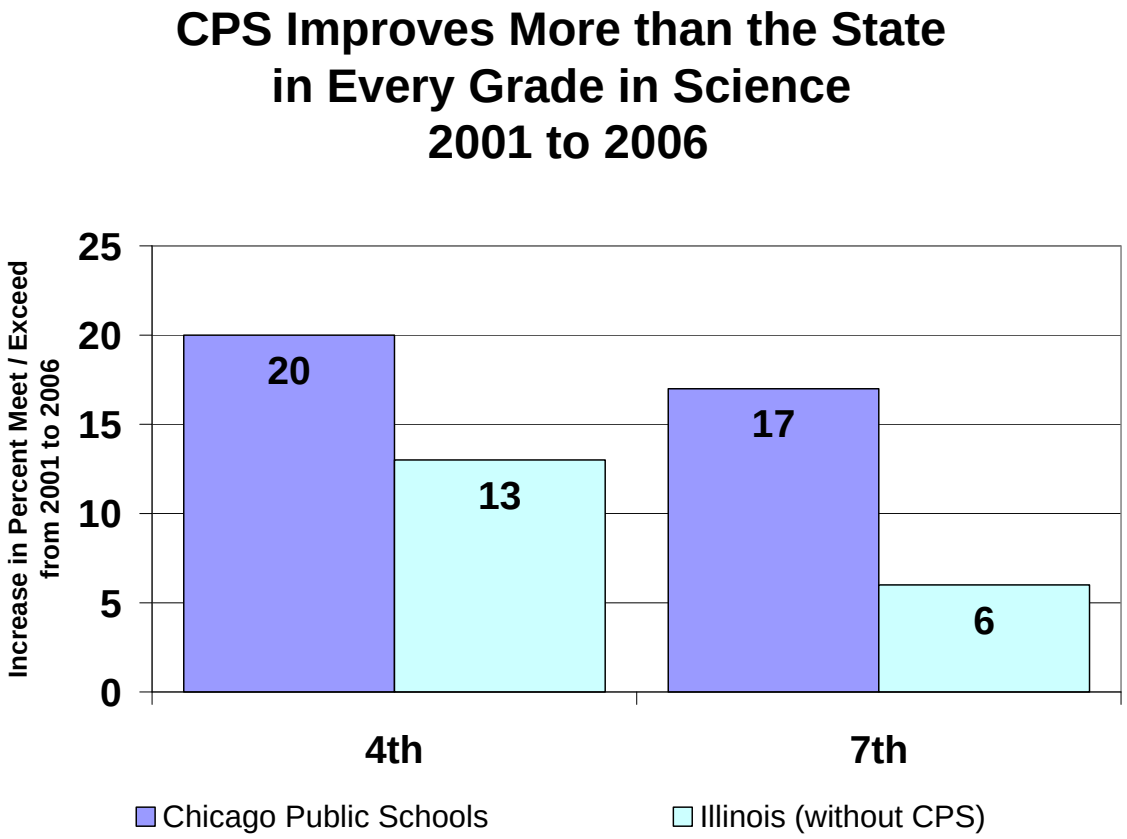

Figure 2: CPS Science Performance on the Illinois Standards Achievement Test, 2001-2006

Biography

Michael C. Lach is currently Officer of Teaching and Learning for the Chicago Public Schools, overseeing curriculum and instruction in the 600 schools comprise the nation's third largest school district. Mr. Lach began teaching high school biology and general science at Alceé Fortier Senior High School in New Orleans in 1990 as a charter member of Teach For America, the national teacher corps. After 3 years in Louisiana, he joined the national office of Teach For America as Director of Program Design, developing a portfolio based alternative-certification system that was adopted by several states. Returning to the science classroom in 1994 in New York City Public Schools, and then back to Chicago in 1995 to Lake View High School, he was named one of Radio Shack's Top 100 Technology Teachers, earned National Board Certification, and was named Illinois Physics Teacher of the Year. He has served as an Albert Einstein Distinguished Educator Fellow, advising Congressman Vernon Ehlers (R-MI) on science, technology and education issues. He was lead curriculum developer for the *Investigations in Environmental Science* curriculum developed at the Center for Learning Technologies in Urban Schools at Northwestern University and published by It's About Time, Inc. As an administrator, he has led the district's efforts in science and mathematics instruction in a variety of roles between 2003 and 2007. He has written extensively about science teaching and learning for publications such as *The Science Teacher*, *The American Biology Teacher*, and *Scientific American*. He earned a bachelor's degree in physics from Carleton College, and master's degrees from Columbia University and Northeastern Illinois University.