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Practices Worthy of Attention: A Search for Existence Proofs of Promising Practitioner Work in Secondary Mathematics

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The goal of the practices worthy of attention (PWOA) project was to surface innovative practices currently in use by urban schools and districts that show promise of improving students' secondary mathematics performance. Each school and district explored has a different perspective and a unique set of practices in place to improve secondary mathematics achievement. The goal of this project was not always to discover innovations in how practitioners address similar issues, but rather to document what practitioners are doing to strengthen secondary mathematics education. Thus, although the practice highlighted might be commonplace, the specific structures and strategies being employed by the school or district to implement it are worthy of attention. A cross-case analysis of the 22 practices revealed two main categories: raising student achievement and building teacher capacity.

KEYWORDS: secondary mathematics, student achievement, teacher capacity

In the last half of 2006, I led a national search for practices in urban schools and districts that show promise—on the basis of early evidence and observation—of increasing student learning in secondary mathematics. I call these "practices worthy of attention" (PWOA), and my work on them had three overarching goals:

1. To better understand existing initiatives, innovations, and programs that are being used to improve secondary mathematics teaching and learning around the country, and mark these for further scientific inquiry.

2. To identify common themes in these practices that can be used to strengthen student achievement in urban systems across the country.

3. To provide research support to help the practitioners more rigorously evaluate how well their practices are working, which in turn can help to strengthen their methods of operation.

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Theoretical Framework and Connection to the Literature

Recent federal and state education policies call for a substantial increase in the breadth and depth of mathematical knowledge that students must acquire in order to graduate from high school. For example, a growing number of states that once required knowledge only of middle-school-level mathematics for high school graduation have, over the past 5 to 7 years, begun to require that all students demonstrate mastery of Algebra I and geometry content (Center on Education Policy, 2006). To give students opportunities to take higher-level mathematics courses in high school, which will better prepare them for mathematics in their postsecondary lives, many states and districts have policies encouraging students to take Algebra I in the 8th grade. These policies have had an effect: The National Assessment of Educational Progress (NAEP) shows that in 2000, only 27% of eighth-grade students nationwide took Algebra I, whereas by 2005, 42% of eighth graders nationwide had taken Algebra I (Mathews, 2007).

Outside of policy requirements, improving student access to and achievement in mathematics is important because students' performance in middle school and high school mathematics correlates with their overall academic success in high school and beyond. The National Educational Longitudinal Study (NELS) indicated that students who took rigorous high school mathematics courses were much more likely to go to college than those who did not take such courses (U.S. Department of Education, 1997). Research suggests that specific mathematics courses, like Algebra I, serve as gatekeepers to more advanced mathematics courses and can affect mathematics enrollment and achievement in high school, which in turn affects enrollment in college and completion of a four-year degree (Adelman, 2006; Ma, 2001). The NELS study showed that 83% of students who took Algebra I and geometry enrolled in college within 2 years of graduating from high school, whereas only 36% of those who did not take these courses enrolled in college. Therefore, understanding the factors that contribute to improved student learning in Algebra I and a successful transition to geometry is a critical first step toward increasing the postsecondary opportunities available to students.

Unfortunately, few school districts in the nation have the capacity to help their students meet these rigorous mathematics requirements. National- and state-level reports document a critical shortage in the supply of appropriately trained and certified mathematics teachers as well as a high rate of attrition among those teachers, especially in urban areas (National Science Board, 2006). Many secondary mathematics teachers lack deep knowledge of the mathematics content they are expected to teach (Barth & Haycock, 2004; Massell, 1998). In fact, Ingersoll (1999) found that a third of all secondary school teachers of mathematics nationwide had neither a major nor a minor in mathematics. Moreover, research shows inconsistencies in instruction across classrooms within the same district and even

within the same school. Teachers interpret the same instructional ideas in various ways (Marzano, 2003; Stigler & Hiebert, 1998, 1999) and accordingly make independent decisions about whether to ignore, adapt, or adopt policymakers' recommendations for instruction (Spillane, Reiser, & Reimer, 2002).

In urban districts faced with these and other difficult issues—including heavy turnover among administrators, administrators who do not understand what is needed to support a high level of mathematics learning, and low expectations for student performance from both teachers and administrators—mathematics instruction has proven very difficult to improve (Bamburg, 1994; Beck-Winchatz & Barge, 2003; Tauber, 1997). As a result, all too often, students in urban school districts are not given adequate opportunity to enroll and succeed in challenging mathematics courses in their secondary years (National Science Board, 2006).

The PWOA project was inspired by these challenges and by the need for education systems to invest resources wisely. Thus began the work of identifying practices in secondary mathematics education that might merit further attention, greater investment, and wider dissemination.

Defining Practices Worthy of Attention

Research on PWOA differs from other work describing "best practices" or "promising practices" in that the PWOA work starts from where schools and districts presently are, focusing on work and ideas currently in progress. Starting by investigating practices that have not yet been identified as "best" or "promising" through specific national criteria, such as those of the What Works Clearinghouse or the National Center for Educational Achievement, means that there is often little or no documentation of how a practice is being implemented and scarce evidence of the practice's impact or effectiveness. Therefore, the first step in researching a practice is spending time with the practitioners in each school or district to discover the theory-of-action behind the practice and to document the implementation of the practice and the evidence of its effectiveness so far. This step not only provides a historical record of activities, but also honors the work, giving practitioners a chance to see their ideas and efforts documented in a way that shows a picture of the work to date. This step also provides a starting point for researchers to continue to work with practitioners to better measure the effects of the practices on secondary mathematics teaching and learning.

Developing methods to accurately and comprehensively measure and assess the impacts of these practices on mathematics teaching and learning helps to meet a current need of urban districts and schools. Ironically, just as policymakers and district leaders are looking to raise the evidentiary standard for adopting a school improvement practice, the size of district offices—including that of their research and evaluation staff—is being greatly curtailed, or staff is being diverted to deal

with the reporting exigencies related to No Child Left Behind Act of 2001 (NCLB).[1] Thus, many urban districts do not have the staff and financial resources to clearly determine what data are needed by each person in the system and how such data can be used. Most important, these districts have not yet worked out how to translate the knowledge gained from the data into effective decision making at each level of the education system.

Methods

Initial Selection of Programs, Schools, and Districts

The first step in the PWOA project was to interview administrators and teachers at schools and districts across the United States that embody diverse educational systems but that primarily serve students classified as economically disadvantaged and/or as racial and ethnic minorities. I contacted networks of mathematics leaders and teachers known to staff at our institution and partner institution and drew on my knowledge of schools and districts to develop an initial pool of administrators and teachers to interview regarding practices in their schools and districts that were potentially worthy of further examination.

Protocol for Initial Interviews

At the June 2006 Urban Mathematics Leadership Network (UMLN)[2] meeting, I used a four-question protocol to interview mathematics administrators from the 12 participating UMLN districts. The interview protocol included the following definition of what constitutes a practice worthy of attention:

> A practice worthy of attention (PWOA) is a practice being used in your district that shows promise of improving mathematics education within your district and across districts. The PWOA I seek specifically look at the grade range of middle school through college. A PWOA is an example of how you have solved problems or challenges your district faced, ideally with tools that measure the effects of change.

The first question asked the administrators which practices they would nominate for their district. The second asked what types of documentation of the practice existed (e.g., training protocols or documents describing school or district

[1] *No Child Left Behind Act of 2001*, Public Law 107-110, 20 U.S.C., §390 *et seq*.

[2] UMLN serves as a vehicle for rapid dissemination of advances and promising practices, and enables state mathematics leaders and the leaders of large urban districts to work together to better align their mathematics improvement efforts and thus raise student achievement.

initiatives) and what evidence was used to show the effectiveness of the practice (e.g., school/district evaluations of students and/or teachers, third-party evaluator reports, improvement in test scores). The final two questions were logistical, concerning scheduling a site visit and establishing a contact person at the school or district.

Follow-up phone interviews with UMLN district staff were conducted with two main goals in mind: (1) to get more details about the nominated practice, including documentation or evidence of effectiveness available to date, and (2) to schedule a site visit. On the basis of these interviews, eight practices were chosen for further investigation.

For non-UMLN schools and districts, most initial interviews were conducted by phone, although in a handful of cases, I was able to learn about the practices by attending presentations on them at conferences. The protocol for these phone interviews was a combination of the two protocols already discussed.

Ultimately, I gathered information on about 30 programs, schools, and districts, and scheduled site visits with 22 of them. The remaining eight were not followed up on either because the practice did not fit the goals of the project or because the site did not respond to requests for a visit.

Site Visits and Profiles of the Practices

I visited most of the 22 sites to develop a fuller picture of how the practices were actually being implemented and evaluated. During most of these visits, I attended a professional development workshop centered on the practice being studied; this allowed me to get more detailed information about the practice by witnessing how schools and districts were explaining and teaching it. The visits also included time to talk further with the person interviewed on the phone and the opportunity to gather any materials related to the practice. I also had informal, face-to-face conversations with other staff members to learn what they thought about the practices. For a few sites, an actual visit was not feasible, but enough information about the sites' practices was available to write a profile, with feedback from the district or program to ensure that the profile correctly reflected the practice. Practices that exemplify these categories are described next in two separate cross-case analyses, with snapshots of each practice.

Results

On the basis of the site visits, the interviews with teachers and campus and district leaders, and the documentation of the practices, I concluded that the innovations within the practices could be classified into one of two main categories:

(1) approaches to raising student achievement and improving student learning in mathematics, and (2) approaches to increasing teacher capacity.

Raising Student Achievement through Academic Intensification

All of the schools, districts, and programs profiled in this study have increased their expectations for student achievement, but some of them focused particularly on academic intensification strategies to help students meet the higher expectations. The types of practices that emerged in support of academic intensification include: building summer bridge programs, requiring and supporting more rigorous mathematics courses, and providing intense and ongoing support throughout the school day.

Summer Bridge Programs

Two of the practices deemed worthy of attention involve summer bridge programs, which help students transition from middle school to high school mathematics: the Academic Youth Development (AYD) Initiative and Step Up to High School (a Chicago Public Schools program). These programs are not remedial programs; rather, they focus on developing problem-solving skills that form a foundation for success in Algebra I. Both programs are based on the demonstrated efficacy of social interventions on student engagement and academic success. Step Up to High School, for example, models its format on the Emerging Scholars Program, a college-level program developed to improve minority and female participation in mathematics.

Academic Youth Development (AYD) is an Algebra I readiness program being implemented by many urban districts in the United States (e.g., Chicago, Atlanta, New York City) that focuses on helping students better understand content by presenting it from multiple perspectives and applying it in real-life situations. At the heart of AYD is a 3-week transitional summer school and yearlong follow-up program. Rather than focus on the behavior of all students, the initiative focuses on the beliefs, attitudes, and behavior of a cadre of student allies upon whom the algebra teachers can rely to model respectful engagement and academic success and thus help shape the classroom culture during the regular school year.

Teachers nominate for the program students who not only are at risk of failing a future Algebra I course but also who have good attendance and show potential leadership skills. In addition to mathematics problem solving, AYD concentrates on teaching students persistence and giving them the power to be in charge of their own learning. For instance, students who view intelligence as a factor that can be improved with learning and habits of mind are more likely to persist through initial failure (Dweck, 2002). AYD gives students information about the

changing nature of intelligence and encourages them to see failure not as a sign that they cannot learn, but as a signal to change strategy.

Step Up to High School, in the Chicago Public Schools, is a 4-week literacy and mathematics program for students in the summer before their ninth-grade year. Step Up targets students who are likely to be overlooked by other programs—their low test scores indicate that they are at risk for academic failure as they transition into high school, but their scores are not quite low enough for them to be placed automatically in other academic support programs.

In addition to building the academic skills in reading and mathematics that are key to high school success, Step Up focuses on helping students build teacher–student relationships and student–student relationships around shared academic interests. Step Up includes orientation seminars and activities, information about high school resources, and discussions of study skills, such as organization and time management. Students attend Step Up at the high school they will attend and are taught by teachers, who teach at that school in the regular academic year, ideally by the teacher who will be their first-year algebra teacher. This arrangement gives the students the opportunity to meet teachers and classmates before high school begins and to learn to navigate through their new physical surroundings.

Both AYD and Step Up to High School show promise for improving teachers' understanding of student learning processes and for supporting students' mathematical learning and academic engagement. Pre- and post-surveys in both programs show gains in students' confidence about their ability to do well in challenging academic courses.

More Rigorous Course Requirements

Three sites profiled in this study set specific course completion goals for their students and then backward-mapped the curriculum to better prepare students on the strands and topics they would later be required to know. Each site also found ways to support students and help them do well in the more advanced courses.

El Paso Collaborative for Academic Excellence (EPCAE) has built and implemented a cohesive K–16 mathematics program for all 12 of the school districts it serves in the greater El Paso, Texas area. EPCAE leaders realized that if students could successfully complete Algebra II in high school, they could usually avoid remedial mathematics courses in college and enter college algebra fully prepared.

Large-scale collaborative effort: The 12 districts that EPCAE serves collaborate with the local community college, the local four-year university, and the entire El Paso community in an effort to achieve coherence in their curricula,

promote success for students past high school graduation, and establish a common vision for a K–16 effort.

Curriculum alignment: EPCAE formed a K–16 mathematics alignment initiative composed of mathematics educators—elementary, middle, and high school teachers and college and university faculty—who spent 2 ½ years producing a curricular framework that aligned high school and first-year college mathematics. This group then backward-mapped the curriculum to prepare students for successfully completing Algebra II before high school graduation. After the curriculum frameworks were developed, EPCAE provided teachers with professional development to use the frameworks as the foundation for Algebra II in high schools.

Grant High School in Portland, Oregon set the goal of having all students pass geometry by their sophomore year of high school. The school's mathematics teachers set this goal themselves when they became frustrated with what seemed like two schools within one building—one in which students who were predominantly racial or ethnic minorities took the pre-algebra courses, and another in which predominantly white students took the precalculus courses. The teachers felt that this unequal access to higher-level mathematics courses would limit some students' postsecondary opportunities. Four teachers developed an intensive mathematics program, and the school started a freshman academies program to help students transition successfully into high school.

Intensive mathematics program: Grant's intensive mathematics program is for students who enter high school behind in mathematics. Teachers intensified mathematics instruction by providing double periods of mathematics for 2 years, in effect giving the students 3 years of mathematics—pre-algebra, Algebra I, and geometry—in just 2 years, beginning in their freshman year. One goal of the 2-year program is to allow students to have the same mathematics teacher both years. This arrangement has helped teachers create a culture of learning and support that students can benefit from in their two periods of mathematics and in their first 2 years of high school.

Norfolk Public Schools in Norfolk, Virginia want to ensure that their students have every opportunity not only to take geometry in high school, but also Algebra II and other higher-level mathematics. School leaders believe that getting students through Algebra I earlier—in 8th grade—creates greater opportunities for students to take and excel in the higher-level courses in high school. The district developed the *Algebra for All* project, which requires students to take and pass an Algebra I course and the state's end-of-course algebra exam in 8th grade. Norfolk knew that the project could not only consist of changing enrollment patterns, but also needed to involve an improvement in the quality of mathematics instruction. To that end, the district is focusing on curriculum and extending the time students spend working on mathematics each day.

Curriculum: Norfolk focused on vertical articulation and coherence of mathematics across grades. The district realized that a foundation of algebra content was needed in all grades preceding Algebra I. Mathematics content staff integrated algebraic reasoning across all topics in the K–7 curriculum in a coherent content strand involving patterns, functions, and algebra. The new articulation ensures a progression of concepts, so that when students reach Algebra I, they are prepared with basic algebraic ideas and concepts.

Extended instructional time: Mathematics is taught for a minimum of 90 minutes per day at all grade levels. The district provides teachers with an instructional manual that shows how they can use those 90 minutes to fully engage students in learning mathematics. Teachers also help students learn mathematics in "academic success sessions" during the school day or after school.

EPCAE, Grant, and Norfolk all show promise in helping students meet rigorous mathematics course requirements. EPCAE has seen an increased number of students enrolling and passing Algebra II as well as increased graduation rates. At Grant, the enrollment of black students in Algebra II has increased from 8.9% to 17.9% since the first cohort completed the intensive 2-year course; 100% of students in the 2-year course plan to enter college. In Norfolk, the percentage of middle school students enrolled in Algebra I has increased, as has the percentage of students passing the course and exam: from 41% to 69%.

Embedded Student Support within the School Day

Schools and districts that engage in academic intensification must find ways to support students who come to the mathematics classroom with diverse experiences. Two small schools, Eastside College Preparatory School and High Tech High, have found ways to embed such student support in the daily schedule as a regular part of students' schooling. This scheduling is especially important given that most students do not arrive at Eastside and High Tech adequately prepared for high school. In these schools, a low student-to-teacher ratio helps teachers give students more individualized attention, and the school culture includes planning for college as a regular part of students' schooling. Larger schools, like Evanston Township High School, are challenged by large classrooms and high student-to-teacher ratios, so these schools must rely on strategies like tutorial programs and extra time for mathematics instruction.

Eastside College Preparatory School in East Palo Alto, California is an independent school serving students in grades 6–12 from populations that are historically underrepresented in higher education. Enrollment is just over 200 students. Eastside's goal is to provide a strong, student-centered academic environment and requires that, at a minimum, students have completed precalculus before graduating. Students receive various forms of support that are embedded into the

school day, including daily tutorials and individual advising, to meet these high expectations.

Tutorials: Two 90-minute tutorials are built into the school day to ensure that students are getting support to understand the core course content (English and mathematics) and are completing their homework. The tutorial sessions come immediately after the targeted course and are led by the same teacher, who tutors around 20 students. The tutoring sessions ensure that students receive timely help on concepts and ideas. The framework ensures consistency of instruction and allows teachers extra time to work with students who are struggling and to provide more intensive opportunities for students to engage with the academic content.

Advisory system: Students meet daily with an advisor, who works with them specifically on their personal and academic challenges and issues. Advisors are teachers assigned to a group of 6–8 students with whom they work closely over the 4 years of high school. Advisors also provide students with resources for extracurricular activities that can help support their academic interests and portfolios for applying to college.

Academic support: Additional academic courses that focus on reasoning and analytical skills as well as topics in college admission and transitioning to college are required. These courses provide students with a strong foundation in the skills and habits that are necessary for academic success in high school and beyond.

High Tech High (HTH) in San Diego, California is a charter school that focuses on solutions for dealing with student disengagement and low academic achievement. The school develops personalized, project-based learning environments and expects all students to graduate well prepared for college. The school's enrollment is just over 500 students. HTH encourages student learning through project-based learning and close work with advisors and mentors.

Project-based learning: HTH offers hands-on experiences in mathematics through project-based learning. After mathematics teachers provide a lesson and tasks for students to engage in, students break into small learning groups to work on projects that require them to apply the mathematics concept to a hands-on activity. Because the classrooms are grouped by grade level and students come in with differing levels of mathematical proficiency, classes are taught in ways that cover the span of several mathematics courses; for example, Algebra I, geometry, and calculus are taught in the same class, and the teacher focuses on a mathematics strand and differentiates the difficulty in the project activity for students. Students work within and across groups to gain advice and input for their projects, and the teachers check in with each group to monitor the projects and provide support and guidance as needed.

Advising: The advisory program was designed to support students in their academic preparation for college. Each HTH student is assigned a staff advisor who also acts as a liaison to the student's family, so parents are aware of their

child's growth and challenges at HTH. Advisors work closely with students to help them plan for their futures, navigate the college admissions process, and apply for financial aid and scholarships.

Internships: Beginning in their junior year, students work as interns two afternoons a week for at least one semester at local businesses, schools, nonprofit organizations, or professional associations. Each student works on a specific project overseen by a mentor who understands and supports HTH's design principles and works individually with the student to cultivate a productive learning experience that exemplifies the project-based learning in school in an actual work-related setting.

Evanston Township High School in Evanston, Illinois has an enrollment of over 3,100 students. The school is working on building student success in Algebra I and has taken steps to ensure that students receive daily, individual support in mathematics.

Intensive daily support: Algebra I classes are structured to provide more instructional time for all students. Students work in small groups to discuss an idea and then share their findings with the whole class; students feel comfortable asking questions of each other and of the teachers when they do not understand a concept. Students in upper-level mathematics courses have been recruited to assist in Algebra I classes, helping students understand concepts and serving as teachers' aides. In addition, to make sure struggling students receive support, the chair of the mathematics department meets individually with students who have failing grades to discuss their performance and talk about what kind of help they need. Algebra I teachers also have 30 minutes each morning to work with struggling students.

Eastside, High Tech, and Evanston Township all have programs in place that show promise for supporting students on a daily basis to ensure their long-term success. In the two small schools that mainly serve economically disadvantaged, first-generation college-bound students, 100% of students graduate high school and enroll in four-year universities. In Evanston, students are passing Algebra I at higher rates.

Summary for Raising Student Achievement

Raising student achievement requires changes in the attitudes and practices of administrators, teachers, and students. In summer bridge programs, students learn about the value of academic effort and build peer and teacher relationships that will support them throughout high school. Success in these programs necessitates firm belief on the part of teachers that their students really can succeed in high school mathematics and that collegial student peer groups can be a strong support for that success. Requiring rigorous courses of all students demands both

a change in how districts and schools think about student ability and much more support for both students and teachers. Intense, embedded daily support, for example, constantly reiterates the idea that mathematics is important and that, with hard work and a strong network of teacher and peer support, all students can take and pass rigorous mathematics courses.

Building Teacher Capacity

All of the schools, districts, and programs profiled in this study have increased their expectations for what teachers should do, but some of them have focused intense attention on improving teacher practices. The practices designed to build teacher capacity provide opportunities for teachers to interact with other teachers in focused and specific ways, share knowledge, and thus improve and expand their current practices. The practices designed to build capacity also increased individual support for teachers and expanded their access to resources. These practices require support from administrators if the traditional ways teachers have interacted are to be overcome. As teachers are asked to support students with various experiences and backgrounds, districts and schools are asked to support teachers the same way, instead of providing all teachers the same training and expecting all of them to perform the same way. Three main approaches to building capacity emerged: redefining mathematics teacher roles and responsibilities, making instruction public, and having new, customizable tools for teaching.

Redefining Mathematics Teacher Roles and Responsibilities

Four districts focused on broadening the sphere of mathematics teachers' roles and responsibilities in two main ways: by improving the teaching of specific subpopulations and by increasing teacher participation at the district level.

Improving teaching for specific subpopulations. In New York City and Denver Public Schools, mathematics teachers work closely with teachers who specialize in teaching students with special needs, learning how to maintain rigorous content standards while supporting students learning English or students in special education. The practices encourage good teaching by focusing on the types of instructional tasks that teachers can use for differentiating instruction to meet the diverse needs of students, encouraging the use of academic vocabulary, and providing various entry points for students to learn the mathematical concepts. These practices also provide teachers with feedback on specific ways that some students may struggle as a result of language acquisition issues or cognitive impairment.

Denver Public Schools developed a collaboration between mathematics and special education teachers. The district believes that special education teachers

often do not have expertise in mathematics and thus have difficulty supporting their students in higher-level mathematics. Mathematics teachers do not always know how to accommodate special education students' individualized education plans without "dumbing down" the mathematics content. Denver saw a need to broaden teachers' roles by having mathematics and special education teachers work together to best support all of their students in secondary mathematics.

In Denver's program, teachers are matched in pairs (one special education teacher and one mathematics teacher) for the academic year. The whole group meets about every 6 weeks. In each meeting, each pair of teachers writes a single mathematics lesson plan, working together to build in accessibility and accommodations to address the range of their students' individual challenges and needs. The goal is for teachers to maintain the integrity of the mathematics while also following a process for planning accessibility strategies that address learning barriers. To make their work concrete, the teachers each choose three students who represent a range of mathematical abilities and write their lessons with those students in mind. Built into each meeting are opportunities for teachers to reflect on their use of specific strategies and share their goals and cautions regarding accessibility strategies. This type of sharing builds a supportive group that shares ideas and actual practices in the field, giving the teachers a common set of goals to aim for and cautions to keep in mind.

New York City Department of Education created the English Language Learners (ELL) Mathematics Initiative to raise the academic achievement of ELL students through a strong network of district and school-based mathematics and ELL leaders. The initiative is designed to raise the quality of mathematics instruction while providing for the diverse needs of students with various language and academic backgrounds.

At the core of the initiative is a professional development program for mathematics teachers that emphasizes techniques specifically geared to teaching students whose first language is not English. At the core of the program is the belief that mathematics is not "language-neutral"—meaning that mathematics pedagogy depends on the language of instruction—and therefore the professional development opportunities focus on how teachers must teach in ways that incorporate students' native languages, English, and academic mathematics language.

Teachers are trained in WestEd's Quality Teaching for English Learners (QTEL), which helps them develop a theoretical foundation and corresponding strategies for effectively teaching academic language to ELL students. The tools and processes taught in professional development modules focus on developing adolescent students' abilities to read, write, and discuss academic texts in English. Reflection activities for teachers provide opportunities to think about past lessons and plan how to address specific challenges. Teachers also analyze case studies and videos that show a range of teaching styles, in order to better understand

some obstacles to their own as well as their students' understanding. Additionally, teachers are asked to develop resources and lesson plans and to problem-solve specific teaching and learning situations.

District roles and responsibilities. In Lamoille South Supervisory Union and Portland Public Schools, mathematics teachers are taking on leadership roles and working with district leaders to learn more about specific district mathematics needs; this in turn improves their own practices. In the Partnership for High Achievement, district leaders and teachers work to communicate common goals and sustain them with concrete steps for improving classroom practices.

Lamoille South Supervisory Union in Morrisville, Vermont consists of three school districts serving students in grades K–12. LSSU is creating a local, balanced assessment system in mathematics that is aligned with the K–12 curriculum. To support that work, teachers' responsibilities now include developing assessments at the district level. Teachers receive training in assessment development and assessment for learning, which helps them understand how assessment can provide the information they need to improve their practices.

LSSU incorporates the use of ongoing and embedded professional development structures that broaden teachers' knowledge and understanding of the development, use, and analysis of assessment. LSSU leaders involve teachers in writing assessment items because they believe that, to affect instruction at the classroom level, teachers need to understand what is expected at the district level. They also believe that teachers need to be involved in the kinds of conversations that help them reflect on their practice.

As they develop assessment items, teachers talk about different types and uses of assessments (formative, benchmark, and summative), learning how to make judgments about student learning depending on the type of student work or data they have available. In addition, given that teachers use the same assessments, they can collaborate to analyze the results and then plan interventions and modifications together.

Portland Public Schools in Portland, Oregon has developed a set of district-level leadership opportunities for all interested mathematics teachers. The district mathematics specialists believe that developing local leaders at each school as agents of change is the most effective way to sustain a common set of mathematics goals across the district. They hope that this leadership development will increase teacher capacity at each school and lead to better and more consistent mathematics teaching so that students have equal opportunities for mathematics achievement.

Leadership opportunities are organized within a large group of teachers and district mathematics specialists. Each year, the large group divides into subgroups focused on different ways of approaching mathematics education improvement. One year, the topics the subgroups focused on were determining the content for a

new, third year of high school mathematics graduation requirement; supporting the transition of students from eighth-grade to high school mathematics; and developing and piloting districtwide common formative assessments in grades 6–8. The next year, the third-year math and transition to high school topics remained, and two new topics were added, one focused on implementing the College Preparatory Mathematics program and the other on using technology in mathematics classrooms. The subgroups and topics change shape as the responsibilities and needs of teachers change.

The subgroups generate guidelines for interaction to support individual teacher voices and develop a clear set of steps to meet goals. Teachers volunteer to facilitate monthly meetings, and the district mathematics specialists help them plan the agendas. In their teacher-leader roles, teachers feel they have the power to make a difference beyond their own classrooms, and leading and participating in these district-level groups is a way for them to be directly involved in district improvement in student mathematics learning.

The Partnership for High Achievement (PHA) is a program designed to strengthen the capacity of leaders and teachers in Texas school districts to implement a research-based instructional support model to continuously improve teaching and learning. The model integrates leadership development for department, school, and district leaders with support for classroom teacher development.

PHA's strategy is to provide technical assistance and professional development to a district's teachers and leaders to support the district in ensuring that every student has access to the same curriculum. To implement this strategy, a leadership advisor works with the district leadership team, and a mathematics advisor works with designated teacher teams. The advisors teach district leaders and teachers about the instructional support model and how to implement it, and provide supplementary resources based on the unique needs of the district. The advisors work with the district leadership team and teacher teams throughout the school year to ensure that the elements of the instructional support model are accomplished.

In Denver, New York, Lamoille South, Portland, and PHA-partnered districts, the broadened teacher roles and responsibilities promise to increase teacher skill sets and renew investment in student learning. Certainly, the teachers seem to be embracing their new roles. In Denver, reflective feedback collected from the participating teachers indicates that they are learning more about content and improving their teaching strategies. New York City teachers appear receptive to improving their practice to accommodate ELL students. In LSSU, teachers are having epiphanies about the role of assessment in learning and are eagerly engaging with one another and their students. In Portland Public Schools, 36% of secondary mathematics teachers are involved in a mathematics leadership subgroup. In PHA,

participating districts' mathematics and science scores have gone from below the Texas average to above the Texas average.

Making Instruction Public

Deprivatizing instruction, or making instruction public, is a powerful means for changing teacher practice. This process requires teachers to open up their classrooms, trusting that observers are not evaluating them but are providing valuable feedback to help them reflect on their practices. Making instruction public allows teaching and learning to be captured in multiple ways from multiple sources, giving teachers regular feedback so they can continually work on improving their teaching. Three districts and one multi-district initiative have made open classrooms a major part of their mathematics improvement plans.

Bellevue School District in Bellevue, Washington has set the goal of "getting rid of walls of classrooms" and building a culture of openness and sharing among teachers and the district mathematics curriculum coaches. The curriculum coaches observe classrooms, learn what teachers are doing successfully, share the successful practices with all mathematics teachers, and help teachers with their concerns and challenges. Although some teachers were defensive at first, feeling that observations were a threat to their autonomy, they soon saw the value in sharing their successful practices, especially when they were working together toward the same goals.

Bellevue further encourages collaboration by sharing among teachers the results of common assessments, so that teachers can see how all students are performing on the same types of tasks and discuss how their practices contributed to their students' performance. The district develops common assessments for every unit at every grade level, and teachers are required to administer the assessments, score students' work, and post results on the district's intranet. With assessment results accessible to the entire professional community in Bellevue, the hope is that teachers will seek out and share best practices with each other in the ongoing effort to improve work with students.

Further, the operations and results of teacher practices are available to greater numbers of people, including parents, because the district requires all teachers to have a classroom website that includes the course syllabus and/or grade-level goals and expectations. The website also includes online access to grades.

Columbus Public Schools in Ohio has made classrooms public by instituting a peer observation program for teachers. At each school, a teacher leader, trained at the district level to support professional learning communities, conducts weekly meetings to help other teachers work as a team to address challenges. Most of the time in these meetings is spent developing specific strategies for addressing student needs, but the work also involves reviewing progress on school-specific ac-

tion plans, student testing results, and teacher-student survey results. These meetings have helped encourage teachers to stop working in isolation and to open their classrooms and their practices to observation.

Teacher leaders have developed and refined a data collection tool they use in observing classrooms and collecting information about instructional strategies. The teacher leaders use the data they collect to promote discussions with teachers about how to learn from these observation experiences; the culture surrounding these discussions is collaborative, not evaluative.

Principals observe classrooms to see if there is systematic use of the standards-based mathematics curriculum guides. Most principals do classroom walkthroughs daily, as required by the district. The principals have been trained to ask reflective questions of teachers and have also learned how to focus on what they should be seeing in mathematics classrooms. District-level administrators also visit classrooms, and several mathematics curriculum specialists spend at least a half-day per week visiting schools and monitoring the implementation of the mathematics curriculum.

YES College Preparatory School in Houston, Texas has embedded into the teaching culture a teacher feedback and evaluation system that includes regular observations by coaches, mentors, peers, and supervisors. This system supports teachers with goal setting and reflection, providing feedback to improve teacher practices throughout the school year as part of their ongoing professional development.

At the beginning of the year, teachers set goals, using a summative rubric as a guide. The rubric covers four domains: classroom management and culture, instructional planning and delivery, YES responsibilities, and YES values. Each domain has multiple indicators, so observers rate teachers on each indicator to develop a composite domain rating. This detailed rubric helps observers identify the areas in which teachers need the most assistance and support, which enables them to customize mentoring and coaching to improve teacher pedagogy.

Throughout the year, teachers receive feedback from their peers, from supervisors, and from students. At the end of the school year, the summative rubric, along with a teacher's course material, progress on professional development goals, self-reflections, self-evaluations, administrator evaluations, student performance, and student feedback, is used to evaluate the teacher's performance.

Phoenix Union High School District in Phoenix, Arizona uses professional learning communities to create a culture that focuses on how to change the way teachers engage with students. Teachers in Phoenix Union began to change the culture of their practice by opening their doors to peer review and learning from one another about best strategies for improving student learning in mathematics.

When teachers opened their doors to each other, no teacher worked in isolation. Teachers began to share what worked well and went to one another for help

when they struggled with a concept or topic. They make all student work public so they can analyze what students really know and what they are struggling with. Teachers began to change their thinking about classroom observers, no longer assuming they were evaluative and critical; instead, teachers learned ways of improving their practice through observation of their peers. These changes resulted in more consistent instruction and assessment strategies across the district.

The district also asks teachers to work in teams to provide meaningful lessons and assessments that are congruent with the curriculum. Although methods for building lessons and assessments are discussed in teacher preservice and in-service workshops, the teams allow teachers to help each other better understand the development process as they look at specific instructional examples, resources, and strategies. By developing and working with common lessons and assessments, teachers can learn from one another and develop more consistent methods of delivering instruction.

Silicon Valley Mathematics Initiative (SVMI) in the San Francisco Bay Area believes that the key to improving student achievement is improving instruction through intensive, hands-on professional development for individual teachers. To that end, the initiative has mathematics coaches frequently observe classrooms and discuss their observations with teachers one on one. This practice makes teachers' instruction open to outside feedback while providing a structure for teachers to learn how to improve their instruction.

The main job of the coaches is to assist the teachers they work with to focus on student thinking and mathematical pedagogy. Coaches visit the classrooms of each of their teachers about 20 times per year. The general structure of each visit includes a pre-conference, observation of a lesson, and a post-conference. Coaches encourage teachers to reflect on the lesson, examining student work as evidence, to help inform and adjust future instruction.

The mathematics coaches tend to relate to their teachers in one of three ways—as collaborators, models, or leaders. In the collaborator role, coaches are a resource to the teacher, providing materials, information, and encouragement, and collaborating with the teacher to plan lessons. In this role, coaches do not give direct feedback about the teacher's pedagogy, but focus more on student work, which makes the teacher feel less defensive about being evaluated or criticized. In the model role, coaches model instruction of deep problem-solving tasks for students. Teachers can use this model lesson as a guide for developing their future lesson plans. As a leader, the coach guides the teacher in nonevaluative ways. For instance, the coach's comments are grounded in what was just observed—what the teacher understood about how well the lesson went and what students seemed to learn. The coach then assists the teacher in figuring out how to address the content the students did not seem to understand well.

The various strategies for making instruction public practiced in Columbus, at the YES school in Houston, in the Phoenix Union district, and SVMI schools are helping teachers better understand their own practices and improve their teaching. Teachers in these districts have found that deprivatized instruction encourages collaboration and allows them to support each other. In Bellevue, teachers are much more comfortable now sharing their information with each other and with parents. In Columbus, teachers indicated that the weekly meetings were useful for establishing collaboration and consistency of instruction, and they are now accustomed to regular visitors in their classrooms. At YES, all teachers are meeting a minimum standard for providing quality teaching to their students. In Phoenix Union, teachers have an open-door policy that fosters consistent observation and learning from one another. Teachers involved in SVMI coaching are using evidence of what students have learned rather than anecdotal information to gauge students' understanding.

New Tools for Teaching

An issue in training teachers in the use of new tools and resources is that professional development is usually the same for all teachers in a given school or field. The success of such strategies and tools, however, differs significantly in different cases, because teachers come into professional development workshops with different knowledge, experiences, and pedagogical practices. To remedy this problem, one program and three districts provide customizable trainings to assist teachers appropriate new tools and strategies to improve their teaching practices.

Agile Mind is an online tool that supports and models sustainable teaching in secondary mathematics courses (from middle school mathematics through AP Calculus). Curricula are aligned to state standards in the states in which Agile Mind is used, the National Council for Teachers of Mathematics (NCTM) standards, and various mathematics textbooks so that teachers can use Agile Mind to support the textbooks they are required to use.

Instructional resources are available for teachers to use in planning and delivering instruction and effective assessment. Each course includes several topics, and within each topic, an online instructional guidance system provides teachers with specific resources for instruction planning, teaching, assessment, addressing various teaching challenges, and alignment to state standards and textbooks. Teachers can use all of these resources or select specific ones. Within each online resource, teachers have the option of adding their own notes, which helps them customize their practice.

Agile Mind provides instructional guidance for all aspects of the lesson, from opening questions that enable teachers to introduce key concepts and engage students in discussion to framing questions that support teachers in helping stu-

dents apply the lesson to real life. Further questions are suggested to help probe students' thinking and to uncover misconceptions. Teaching tips offer strategies for dealing with possible challenges students might face. Assessments are built into each topic, with different types of reports available so teachers can review both what the entire class understands and what individual students understand. Teachers are offered a range of resources they can use in secondary mathematics courses, giving them the flexibility to choose the resources best suited to their instructional goals.

Anchorage School District in Alaska has developed its own Assessment Reporting System, a comprehensive database system that follows students longitudinally with all the data that was previously kept in their paper cumulative folders. The purpose of this system is to give teachers access to data on their students at any time. For instance, if a student transfers to another teacher or school within Anchorage, that student's data are immediately transferred electronically into the new classroom, so teachers have up-to-date access to all the student information they need.

Data are available for individual student performance on district and state assessments across several years. While teachers can view their own classroom data, school administrators can view an entire school or any classroom within their assigned school. The system allows the district to customize professional development opportunities to the needs of individual teachers and schools. District-level mathematics curriculum specialists work with individual teachers and schools that have lower than average performance in the district.

The Assessment Reporting System allows users to sort students' proficiency on various mathematics assessments by demographic information like race/ethnicity and gender according to the entire assessment or selected mathematical strands. The four proficiency levels are color coded to give teachers a visual snapshot of where students need the most help, allowing them to target specific students struggling in each strand. The format of all data output has been customized based on teachers' requests, and the reports continue to be revised in response to teacher feedback. Because the system is homegrown, not an off-the-shelf product, Anchorage has the flexibility to further customize the system to improve its usefulness as a tool to inform teacher practices.

The Assessment Reporting System also features a grade-level expectation item bank. Teachers can pull items from this bank that are linked to the grade-level expectations they are focusing on and use those items to develop customized mini-assessments. The data from these items can then be used as part of the instructional cycle for measuring and improving student learning on different mathematics expectations.

Boston Public Schools' secondary mathematics coaches use asset-based instruction to develop teacher capacity. Asset-based instruction encourages teachers

to focus on students' strengths rather than on their deficits. Coaches model the asset-based approach for teachers by emphasizing instructional experiences they observe that enhance teachers' understanding of and competence in teaching mathematics. This approach builds on teachers' strengths, helping them see how they can then use those same techniques to engage their students. The asset-based approach allows teachers to customize their instruction and allows coaches to customize their approaches to teacher professional development. Because coaching is at the individual teacher level, coaches can customize the training to emphasize what they believe a teacher needs to work on.

After observing a teacher's classroom, a coach talks with the teacher about student-centered coaching and the strategies teachers can use to take advantage of the known strengths of each student and the class as a whole. The coach usually focuses on the interaction of the teacher with a particular student to exemplify the techniques. The teacher and coach discuss the importance of both affective and cognitive experiences in helping motivate students, again from the perspective of building on students' strengths. They also talk about how to improve ability beliefs. Together, the teacher and coach also identify patterns of students' strengths by analyzing student work and assessments. The coach reinforces how to motivate students with genuine positive support and encouragement as often as possible. The teacher and coach also identify places in the curriculum where students are currently successful and map out a lesson that guarantees at least one successful experience for each student.

Cleveland Municipal School District is using a program called Keeping Learning on Track (KLT) in its 10 lowest-performing K–8 schools. KLT is a formative assessment program developed by Educational Testing Service. KLT focuses on using evidence of learning to adjust and customize instruction as it is taking place so that teachers can immediately address students' learning needs.

Because teachers' instructional styles vary, KLT provides a variety of ways for teachers to measure student learning on the fly, giving teachers the flexibility to choose the strategies that best allow them to make instructional adaptations right at that moment. These types of formative assessment checks can provide teachers the feedback they need to change their daily practice, and that small change might result in large changes in teacher pedagogy, the classroom culture, and student learning.

Teachers using KLT meet regularly to reinforce and build upon the techniques, strategies, and ideas behind the program. Teachers use these meetings to discuss the implementation of assessment-for-learning techniques in their classrooms and to refine their understanding of KLT techniques.

Agile Mind and the practices in use in Anchorage, Boston, and Cleveland all show promise for improving teacher practices. Agile Mind users tend to increase the implementation of the resources each year they use it, and schools tend to ex-

pand the courses that can be supported by it. In Anchorage, teachers report that they appreciate the Assessment Reporting System and use it to analyze and understand how their instruction affects student performance. In Boston, teachers appreciate the individual coaching and modeling they receive and recognize how asset-based instruction changes the culture of their classrooms. In Cleveland, teachers report that they regularly use assessment-for-learning techniques; the schools using KLT have seen substantially greater gains in student achievement than have non-KLT schools.

Summary for Building Teacher Capacity

Building teacher capacity requires changes in district and school attitudes about how to best support teachers as they improve their teaching. With broadened roles and responsibilities, teachers redefine how they think of teaching and what they can contribute. They learn that they can gain the expertise to work successfully with subpopulations of students in need of their help, be part of a development team for building common assessments at the district level, or participate as leaders in the district for promoting change in mathematics. When instruction is public, teachers learn about the power of collaboration for improving their practice and lose the fear of having observers in the classroom. With structured observation protocols and regular opportunities for feedback, teachers forget about working in isolation and focus more on the ways they can work together to improve student achievement. Finally, with new tools and customized support, teachers can access the individual training and feedback they need to make good practices part of their daily instruction.

Discussion and Next Steps

The practices I have identified address challenges that virtually all American school districts must face. In too many cases, however, school districts create their solutions to these challenges from scratch and in isolation. The Practices Worthy of Attention Project is designed to offer a more effective approach to collaborative learning and to the dissemination of creative solutions to difficult educational problems. To successfully tackle the challenges faced by all educators and leaders in improving mathematics teaching and learning, researchers must spend more time in schools and districts, observing and analyzing how the broad approaches and big ideas are actually codified, implemented, and assessed within and across districts. This project is a first step toward creating a nationwide group of practitioners who can share specific strategies with and learn from one another, which will serve to open doors across districts much as classrooms have been opened within schools. By taking the time to observe and evaluate actual practic-

es, researchers can find out directly how research is interpreted and implemented and therefore advise mathematics leaders and teachers in ways that directly affect their work.

The next phase of this work is to partner researchers with schools and districts to raise the standards of evidence by which the researchers measure the effectiveness of these practices. This partnership will allow for the fulfillment of a key purpose of this work: not only to identify common themes in these practices that can be used to strengthen teachers' practices and student achievement in urban systems across the country, but also to determine the effects of districts' initiatives for improving teacher practices and, in turn, the effects of those practices on students' secondary mathematics progress and achievement.

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