

*Building a System for
Mathematics Learning
and Achievement*

FINDINGS and RECOMMENDATIONS
from the Teaching and Learning Review in Pawtucket, Rhode Island

*Conducted by the Pawtucket School Department
in collaboration with the Annenberg Institute for School Reform at Brown University
and with the support of the Office of Progressive Support and Intervention
of the Rhode Island Department of Education*

Executive Summary

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Building a System for Mathematics Learning and Achievement

Findings and Recommendations
from the Teaching and Learning Review in Pawtucket, Rhode Island

Executive Summary

The Pawtucket School Department has made a substantial and sustained investment in building a mathematics curriculum and a professional development system that meet the high standards established, nationally, by the National Council of Teachers of Mathematics and the expectations of No Child Left Behind and, locally, by the New England Comprehensive Assessment System (NECAP), in which Rhode Island participates.

While there are improvements at the elementary school level, Pawtucket – like many urban districts – has yet to see rising achievement in its middle and high schools. More than half of students scored below proficient (i.e., at levels 1 or 2; NECAP defines levels 3 or 4 as proficient scores) in the first two years of data from NECAP (2005 and 2006). Between fifth and eighth grade, there is a sharp drop in the performance of Hispanic and Black students.

As part of its Progressive Support and Intervention initiative, the Rhode Island Department of Education (RIDE) funded the Pawtucket School Department (PSD) to work with the Annenberg Institute for School Reform to conduct a Teaching and Learning Review explicitly designed to examine mathematical learning of students in the district's three middle schools and in after-school programs the students attend.

Working together, district and Institute staff and consultants designed an in-depth examination of the entire system of mathematical learning in the district, in the following key areas:

- classroom instruction in mathematics
- cross-curricular opportunities for mathematics learning
- students' engagement in their own and others' mathematics learning
- extended learning opportunities and supports in mathematics (i.e., out-of-school learning)
- family-based mathematics learning
- professional development for mathematics teachers

This document summarizes the findings and recommendations for improving mathematics achievement of Pawtucket's middle school students. The findings (with illustrative examples) and recommendations are presented in full in the report *Building a System for Mathematics Learning and Achievement: Findings and Recommendations from the Teaching and Learning Review in Pawtucket, Rhode Island*.

FINDINGS

The findings, in each of the key areas listed above, were derived from data collected by Action Teams of observers made up of teachers, school and district administrators, coaches, family-outreach liaisons, representatives of community partners, and Institute staff. Teams examined mathematics learning in each middle school and in the after-school programs its students attend. The findings on Extended Learning Opportunities were generated through student interviews, focus groups, and a survey administered to 227 middle school students during the school visits. The findings describe the system for mathematics learning in Pawtucket as students currently experience it.

Mathematics Classroom Instruction

SUMMARY FINDING There are two cultures of mathematics instruction in the district. One focuses chiefly on mathematical procedures and skills; the other – consistent with the structure and pedagogy of the adopted curriculum materials, Connected Mathematics Project (CMP) – focuses on mathematical understanding, targeting the big ideas of the curriculum and using these to drive and derive computational procedures. This dichotomy poses a challenge to the district in implementing CMP: the procedurally focused teachers account for most of the approximately one-third of classroom observations in which district-adopted materials were not in use. At present, the two cultures are about equally common.

- ◆ There are two distinct cultures of mathematics instruction in the district. One focuses chiefly on mathematical procedures and skills; the other focuses on mathematical understanding, targeting the big ideas of the curriculum and using these to drive and derive computational procedures. Roughly half of the observed classes were of each type. Individual teachers' focuses were consistent across observations of their various classes.
- ◆ Each of these two mathematical cultures produces distinctive patterns of instruction and opportunities for student learning. The two patterns of instruction and opportunities for learning are seen at all levels of student achievement (inclusion, regular classes, honors) and in both whole-class and small-group work with students.
- ◆ Students at all levels of achievement (special education through honors) engage successfully in instruction focused on mathematical understanding and ideas.
- ◆ The district has a valuable resource in those middle school mathematics teachers who are skilled at observing and analyzing students' mathematical understanding and know how to engage a wide range of students in the discussion of mathematical ideas.

- ◆ Pawtucket middle school mathematics teachers hold a variety of opinions about the district's adopted curriculum materials, Connected Mathematics Project (CMP). Roughly one-third of the middle school mathematics teachers see the program materials as fundamentally sound, roughly one-third have fundamental objections to the materials, and roughly one-third report beliefs that occupy a middle ground.
- ◆ About one-third of the observed mathematics lessons were not CMP lessons but were, instead, based on non-CMP materials. This choice occurred across the range of middle school classes (inclusion through honors).
- ◆ Across all grades and approaches, student thinking was expressed in the classroom chiefly during the explore phase of the lesson (CMP lessons have three parts: launch, explore, summary) and occasionally, but less often, in the launch phase of the lesson.
- ◆ It was rare for the summary phase of the observed lessons to contain any mathematical content. In nearly all classes observed, summaries tended to last no more than a couple of minutes and tended to consist of the collection or distribution of materials, reminders about homework for the night, and/or a brief description of where the class would pick up the following day. In part, this reflects the fact that teachers are enacting lessons designed for sixty minutes in forty-five-minute periods. Whatever the cause, the result is that students miss key opportunities to synthesize and reflect on their mathematical learning.

Mathematics Learning across the Curriculum

SUMMARY FINDING Particularly in science classes, some teachers provide powerful extensions and applications of key mathematical concepts (e.g., rate, scale, linear functions, area). However, the majority of students reported using only the most basic calculation and measurement outside of their mathematics classes.

- ◆ Some teachers in subject areas other than mathematics reinforce and apply key mathematical concepts (e.g., scale, linear functions, area) in ways that enrich and extend mathematics learning. The most powerful instances were observed in science classes where there was genuine conceptual overlap (e.g., mathematics and science teachers planning together regarding measurement, probability, rates of change, etc.).
- ◆ The majority of students described basic calculation and measurement activities as the major ways in which they applied mathematics in other classes.
- ◆ Teachers reported that they would be interested in cross-curricular units and projects. They saw subjects like science and social science as powerful contexts in which students work with different kinds of representations and applications. But they noted that there was limited time to plan across departments or to be thoughtful about how to share responsibility for different concepts or grade-level expectations.

Students' Engagement in Their Own and Others' Mathematics Learning

SUMMARY FINDING Students at all grades and levels of achievement showed how actively they can engage in and reflect on their own and their peers' mathematics learning. Some teachers made excellent use of students' agency and the peer system in which they offer and get help. But in a number of classes, students were passive and isolated rather than active and collaborative learners. Overall, student agency and peer-to-peer interactions are a valuable but underused source of mathematical learning.

- ◆ Students at all levels of current achievement can actively promote their own mathematical understanding. They do so in and outside of school by seeking help with difficult problems, trying alternative solutions or representations, wondering about mathematical issues, and applying their mathematical thinking to everyday situations.
- ◆ This kind of active engagement was not equally encouraged across classrooms. It was often missing for lower-performing students or non-honors classes. Possibly as a result, individual students varied widely in whether and how they promoted their own mathematical learning, even within groups of students who were performing at similar levels.
- ◆ Students are also capable of investing in their peers' learning in ways that may increase understanding for all involved. Students depended on this peer-to-peer system in and outside of school.
- ◆ Some teachers made excellent use of student-to-student learning; others bypassed it.

Extended Learning Opportunities in Mathematics

SUMMARY FINDING As many as one in three students reported seeking help with mathematics outside the school day. On-site after-school programs offer timely support to students having difficulties. However, the quality of this support is entirely a result of the mathematical and pedagogical skills of the particular teacher. Observers saw few high-quality on-site programs that challenged or enriched students' mathematical learning. While community-based programs appeared successful at engaging students, their support of mathematics learning was focused squarely on homework help. Students reported game playing (e.g., calculating, scoring) as the only other mathematics that occurred in these programs. In sum, significant numbers of students spent their after-school time in ways that supported their keeping up and doing their homework but did not challenge or extend mathematical learning.

- ◆ Approximately one-third of students surveyed reported that they needed and sought help with their mathematics learning (especially homework) beyond the school day.

- ◆ Approximately one-third of those students who sought additional help were using community, rather than school-based, providers. Thus, community-based providers serve approximately one in ten students for homework and extended mathematics learning.
- ◆ The majority of school-based programs offered tutorial and remediation support for students. There were few building-based programs that offered mathematics enrichment programs rigorous enough to support students' increased mathematics achievement.
- ◆ Off-site programs had a range of advantages over school-based classroom instruction: smaller, often heterogeneous groups of students, longer periods of time, fewer academic demands, time for free-choice activities, etc. One result was a high level of student engagement.
- ◆ However, in describing their mathematics-related activities in off-site, after-school settings, students reported few activities that extended their mathematical learning. They reported chiefly homework supervision and game playing.

Family Involvement in Mathematics Learning

SUMMARY FINDING More than two-thirds of students reported turning to their family members for help with their mathematics learning. They also reported that their mathematics gave them skills that are seriously valued at home. But currently, schools and families have not worked out a partnership that reflects their strong mutual investment in student learning.

- ◆ CMP is very different in its approach to mathematics from what most family members themselves experienced in school. Even so, students reported learning major lessons about mathematics from their family members.
- ◆ More than two-thirds of students turned to family members and/or family friends for assistance with mathematics learning. For instance, they did homework with family members, asked family members to help them “practice math,” and saved up for or requested mathematics-related items (software, calculator) for birthdays and holidays.
- ◆ Students turned to their families for encouragement and acknowledgment about their progress in mathematics. As they acquire key skills, students may become a part of their families' mathematical “brain trust.”
- ◆ But families were frustrated by the ways in which school or district infrastructure got in the way of their children's mathematical learning and their own interest in supporting that learning.

Professional Development for Mathematics Teachers

SUMMARY FINDING Teachers' most frequent request was for help with the challenge of implementing CMP with the full range of students in their classrooms. This finding is backed up by what was observed in classrooms (see Mathematics Classroom Instruction findings on pages 2–3). Many teachers struggled to adapt materials to students' current levels without lowering expectations. Others simplified the content and pedagogy in an effort to ensure that students “have the basics.”

- ◆ Teachers reported having received quality district-sponsored training on the content of CMP units prior to teaching them. The majority of them reported taking useful courses through union-, university-, and RIDE-sponsored opportunities.
- ◆ However, teachers, including the most experienced and skilled individuals, wanted to understand how to implement CMP well with their particular student populations.
- ◆ Teachers acknowledged their peers as a major source of their professional learning. As a result, teachers wanted more common planning time in order to compare and develop assessments, conduct lesson study, and observe skilled teachers teaching difficult concepts and classes of diverse learners.
- ◆ Teachers saw a major need for training that allows them to work more effectively across subjects and specialties.
- ◆ While a district committee has mapped out the relationship between the CMP lessons and the grade-level expectations on the state assessment (NECAP), a number of teachers remained unclear and wanted more help understanding how the two sets of requirements fit together.

Serving the District's Neediest Children Well

One important overarching finding regarding equitable resources for mathematical learning emerged and touches on all the key areas.

- ◆ Mathematics achievement varies dramatically across the three middle schools. Student populations at the three schools have different needs. But, currently, major resources for learning – high expectations, strong instruction, experienced teachers – are not evenly present in each site.

RECOMMENDATIONS

As a district, Pawtucket has already made a substantial investment in improving the mathematical achievement of its middle school students through bold curricular adoptions and considerable investment in professional development, the search for coaches and consultants, and work with family liaisons. The recommendations outlined in this section – developed by Annenberg Institute staff in consultation with the Action Teams – are designed to help PSD and its community partners create a strong, equitable, and excellent system for mathematical learning that supports middle school students’ learning both in and outside of the school day and transforms all the districts’ students into proficient mathematical thinkers.

The recommendations are divided into items deserving immediate attention in the coming year and those more-demanding changes that will need sustained attention over the following two years. The recommendations, thus, provide the district and its partners with a three-year plan and a set of aligned strategies for building on their initial investment.

Mathematics Classroom Instruction

SUMMARY RECOMMENDATION Create an ongoing forum where teachers – with the support of teacher leaders or coaches – collaborate on the issues that arise for them in teaching CMP units. These groups will work from artifacts of their own practice (video clips, student work, etc.), jointly building shared professional knowledge of the mathematical and pedagogical strengths and challenges of specific CMP lessons and the program as a whole.

In the coming year

- ◆ Create an ongoing forum for teachers to work together on the issues that arise for them as they teach each of the CMP units. In constructing these opportunities, care should be taken to structure the working groups so that at least some of the participants in each group represent a CMP-compatible viewpoint.
- ◆ Create the expectation throughout the district that all middle school mathematics teachers use CMP materials and participate in this ongoing professional development.
- ◆ Identify a small group of teacher-leaders to serve as coaches/facilitators for this forum and follow-up work.

Over the following two years

- ◆ Develop and implement a more effective middle school schedule that supports stronger mathematics instruction.

Mathematics Learning Across the Curriculum

SUMMARY RECOMMENDATION Building cross-curricular links can extend and deepen mathematics learning if interdisciplinary units are high quality, well planned, and well implemented. For this to be the case, cross-disciplinary teams of teachers need time to document their own best work and select quality, field-tested interdisciplinary units from other sources. If this investment is to yield added student learning and engagement, these teams must field test, refine, and then share these units across the three middle schools.

In the coming year

- ◆ Identify rigorous cross-curricular units/assignments that are already developed in the system. Create in-building professional development time for planning, implementation, and review of these units.

Over the following two years

- ◆ Develop a set of common cross-curricular units for the middle schools that reinforce key concepts and grade-level expectations.
- ◆ Seek funding and support for this work, in collaboration with local universities, using the highly successful model of Prime Time.

Mathematics Students' Engagement in their Own and Others' Learning

SUMMARY RECOMMENDATION For all students to achieve at higher levels in mathematics, it will be important to engage students in their own and their peers' learning. This must become a part of classroom practice, supported by professional development. This can be achieved in a number of ways: videotaping classrooms where strong student-to-student learning occurs, explicit teaching of agency and peer-tutoring skills, and the development of cross-age mentoring skills based on successful national models.

In the coming year

- ◆ Include professional development sessions to address how to engage all students in taking responsibility for their own learning, with a particular emphasis on those currently performing below proficient.
- ◆ Create time in professional development sessions to address the process of students being peer and cross-age tutors in both informal and more extended ways.

Over the following two years

- ◆ Seek local, state, or national funding for a program to train Pawtucket middle and high school students to serve in after-school programs as peer and cross-age tutors.

Extended Learning Opportunities in Mathematics

SUMMARY RECOMMENDATION After-school programs can do more for students' mathematical learning. For this to be the case, on-site programs must be more widely used and the strongest mathematics teachers should teach in them, particularly at schools where mathematics achievement is lagging. Each school must also offer high-quality, open-enrollment mathematics clubs that challenge students to stretch and apply their learning. The district and off-site providers should be jointly planning the content and strategies for homework help sessions so that program staff can begin to question, probe, and help build mathematical understanding.

In the coming year

- ◆ School-based tutoring programs at the lower-performing schools need to market their resources so they will draw more of the students who need help.
- ◆ School-based mathematics enrichment resources (e.g., Math Club) must be equally available, rigorous, and engaging across the three middle schools.
- ◆ Because more than one in ten middle school students turn to off-site providers for help with mathematical learning and homework, the district must find feasible ways to provide basic CMP-compatible strategies for the staff of after-school programs.

Over the following two years

- ◆ The district and after-school providers need to work more closely together to ensure that after-school program staff can support students in homework sessions.
- ◆ The district, working with after-school providers, should identify or develop a set of mathematics enrichment projects that would engage students in practicing and extending key mathematics skills and concepts.

Family Involvement in Mathematics Learning

SUMMARY RECOMMENDATION The district, working with its family liaisons, should think about how to move outreach work out of central office and into homes and neighborhoods, working with family members on the ways in which they already support their children (e.g., homework, cross-sibling tutoring, home- and community-based opportunities to extend and apply mathematics). In addition, the district must address parents' concerns about arrangements such as transportation that prevent some students from getting the individual help and programs that they need in order to achieve mathematically.

In the coming year

- ◆ The district should consider altering the times, diversifying locations, and providing childcare to create incentives to help involve more families in mathematics-related programs at their children's schools.
- ◆ The district should examine its partnership with families and the city transportation department to create additional options for student travel that would facilitate after-school mathematics learning during the school year.

Over the following two years

- ◆ Working with its family liaisons, the district should develop and seek funds for ongoing forms of mathematical outreach that are likely to involve more families in order to acknowledge and extend the ways in which they already help their children with mathematics.

Professional Development for Mathematics Teachers

SUMMARY RECOMMENDATION The next wave of professional development must focus on the challenges of implementing CMP with fidelity for all populations of students. This cannot happen with "chalk and talk" sessions. New forms of professional development must be designed that involve direct confrontation with the dilemmas and choices of real-time teaching: responding to student work, taping and joint viewing of mathematics classes on the most challenging topics, or lab classes that can host visitors.

In the coming year

- ◆ Given that teachers report high-quality district-sponsored training on the content of CMP units, modules on CMP units should continue to be offered, based on ongoing surveys of teacher needs, to ensure consistent exposure and understanding of CMP content across the teacher population.

- ◆ At the same time, a second phase of mathematics-focused professional development should focus on the pedagogical ideas embedded in CMP and the challenges of implementing them effectively.

Over the following two years

- ◆ Given the strength of peer-to-peer networks, the district should consider developing lab classrooms that offer CMP demonstration lessons. These classrooms should be available across buildings to support cross-building learning.
- ◆ To capitalize on strong peer networks and a culture of learning within buildings, the district should provide more support for cross-school learning opportunities through the development of common grade-level assessments in math.
- ◆ Consider replicating university-school partnerships that have been successful in the past. In at least one middle school, a state-funded grant was widely reported as instrumental in teacher learning. The district might consider building on the earlier model of the Prime Time grant as a way of expanding resources for teachers and engaging university-based faculty who need or are interested in school-based work.

Serving the District's Neediest Children Well

SUMMARY RECOMMENDATION In the coming year, the district should conduct an intensive examination of the mathematics learning available to the districts' neediest students: those with IEPs, individuals who are still learning English, and students whose poverty and high rates of mobility place them at risk for underachievement.

The following overall recommendations address the possible uneven distribution of resources across different populations of middle school students (see the last finding on page 6).

Although the Teaching and Learning Review included too few students with disabilities and limited English proficiency to draw significant conclusions, the Review data, combined with NECAP data, suggest that some aspects of the curriculum, pedagogy, etc., may be problematic for these students. PSD's attention to this issue is urgently needed.

In the coming year

- ◆ Conduct a focused examination of the mathematics opportunities available to the districts' neediest students, specifically students with IEPs and students who are still acquiring academic English. The review should examine:
 - whether there are differences in how CMP materials are being used with these students;

- which aspects of CMP (e.g., algorithms and facts vs. understanding) they are learning;
- their access to additional, informal help from teachers;
- the quality and scheduling of after-school opportunities they can access; and
- the ways in which their parents are engaged with their learning.

Such a review is especially important at the middle school that serves the highest number of these students in order to develop basic structures (schedules, numbers of grades in the building, joint professional development focused on mathematics, etc.) that can make a major difference in creating a culture of high expectations and adequate supports for students with the greatest need.

Over the following two years

- ◆ Act to ensure that these students and their teachers receive additional and differentiated supports that address their specific needs.

About the Annenberg Institute for School Reform at Brown University

The Annenberg Institute for School Reform is a national policy-research and reform-support organization at Brown University that focuses on improving conditions and outcomes in urban schools, especially those serving disadvantaged children. The Institute works through partnerships with school districts and school reform networks and in collaboration with national and local organizations skilled in educational research, policy, and effective practices to offer an array of tools and strategies to help districts strengthen their local capacity to provide and sustain high-quality education for all students.

Additional copies of this executive summary or of the full report on the Teaching and Learning Review in Pawtucket can be obtained from

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Additional information about the framework and concepts central to the Teaching and Learning Review can be obtained from

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