

*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*

*Prepared by the*



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AT BROWN UNIVERSITY

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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

### INTRODUCTION

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<sup>1</sup> in the first two years of data from NECAP (2005 and 2006), and 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, including:

- classroom instruction in mathematics
- cross-curricular opportunities for mathematics learning in other subject areas
- 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 middle school mathematics teachers

This report outlines the findings and recommendations for improving mathematics achievement of middle school students attending the Pawtucket public schools. The findings 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. Each team examined mathematics learning in one of the district's middle

<sup>1</sup> Students scoring at levels 1 or 2 are considered below proficient; NECAP defines levels 3 or 4 as proficient scores.

schools and in the after-school programs its students attend. The findings describe the system for mathematics learning in Pawtucket as students currently experience it. The recommendations, developed by Institute staff in consultation with the Action Teams, propose action steps for building a stronger system for mathematics learning.

## A New Understanding of Mathematics Proficiency

Over the last quarter century, mathematics educators have spurred a revolution that has sought to change the content, pedagogy, and results of K–12 education based on two insights. First, research has shown that students are far more active mathematical thinkers than was once believed. Students walk into class – even in the earliest grades – with mathematical knowledge and the ability to take an active role in developing their mathematical understandings by building models of problems, drawing diagrams, working with equations, wondering, making generalizations, and posing questions of themselves and others.

Second, additional research has given educators a broader and more complex view of mathematical proficiency, one that goes far beyond the facts and calculations that were once the “bread and butter” of instruction. This broader understanding of mathematical proficiency – what educators aim for students to develop – is described in Kilpatrick, Swafford, and Findell’s *Adding It Up* (2001, p. 116) as five interwoven strands of mathematical proficiency.

- **Conceptual understanding:** comprehension of mathematical concepts, operations, and relations;
- **Procedural fluency:** skill in carrying out procedures flexibly, accurately, efficiently, and appropriately;
- **Strategic competence:** ability to formulate, represent, and solve mathematical problems;
- **Adaptive reasoning:** capacity for logical thought, reflection, explanation, and justification;
- **Productive disposition:** habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy.

## Challenges to Achieving Mathematics Proficiency for All Students

Many challenges remain before this new understanding is widely reflected in the practice of mathematics teaching and learning. One major challenge is that large numbers of students – particularly minority and poor children – are not benefiting from the new knowledge about mathematics learning. How can educators foster this kind of active, complex learning *at scale* – that is, for *all* students in *all* schools? How can steady improvement be sustained over time? And what are the special challenges for teaching and learning mathematics at the middle school level?

### *Learning Inside – and Outside – the Classroom*

Mathematics educators across the country have thought carefully about how broad changes in classroom instruction might support the development of this multi-stranded proficiency. Much of what these educators have learned is embodied in a new generation of curricular materials for use in mathematics classrooms and new approaches to professional development to support teachers as they use these materials. Across the country, districts are adopting and using these materials, setting ambitious goals for students.

Evidence of the effectiveness of these efforts is beginning to accumulate (see, for example, Carpenter et al. 1998; Fuson, Carroll & Drueck 2000; Lubienski, Camburn & Shelley 2004); but improving achievement for all students is a huge undertaking, and progress can be slow. Particularly in urban districts, where student learning is at risk for many reasons, educators must constantly judge when a slow rate of improvement indicates gradual but solid change and when it indicates poor choices or weak implementation.

While the lion's share of improvement efforts in mathematics education have focused on *classroom instruction* alone, it is increasingly clear that the double promise of equity *and* excellence in mathematics cannot be achieved solely by well-prepared teachers doing their best inside of classrooms. Good mathematics teaching is only one component in the high mathematical achievement of students whose favorable economic and ethnic status guarantees them “the best of the best.” These privileged students are also encouraged to apply their mathematical understanding in other classes, such as science, and they have access to high-quality and specialized after-school learning opportunities that may focus on engineering or technology, trips to science museums, tutoring if necessary, and homework help from family and community members who have had the opportunity to complete high school and college. Inequitable access to learning opportunities *outside* the classroom – often based on racial, ethnic, and economic status – mirrors and reinforces inequitable access to high-quality instruction *inside* the classroom.

### *Special Challenges for Middle Schools*

Mathematics reform at the middle school level faces a special set of challenges.

- Middle school is often the moment at which the mathematics of everyday calculation and measurement turns into the more formal and abstract work associated with algebra: the moment of “Let  $x$  equal . . .” With this “jump” in content and pedagogical demands, it often proves difficult to build full teams of highly qualified mathematics educators at middle and high school levels because not all school administrators have the requisite mathematics background to effectively support and supervise high-quality mathematics instruction. It is also difficult to replace retiring teachers with ones trained in new curricula; and skilled mathematics coaches are in short supply.

- Because of the changes in middle school mathematics curricula, these years can be a time when it becomes increasingly difficult for students to get additional help outside mathematics classes. After-school personnel and family members may lack the content and pedagogy to help with topics like linear equations, functions, or exponents.
- Middle grades are often the level at which explicit and continuous mathematics tracking occurs. Depending on how this kind of homogeneous grouping is handled, the practice of tracking can lead to enduring segregation from high expectations.

## Meeting the Challenges: A Comprehensive Learning System

Building a strong system for learning in any discipline entails building a coherent network of learning opportunities for students and for the adults in their lives both in and outside of school. Currently, many research and school reform organizations, along with community renewal and organizing projects, are exploring visions of interconnected and coherent learning opportunities for children and youth that run seven to seven, all year long, combining services across sectors such as schools, libraries, health, and housing (Gordon, Bridglall & Meroe 2005; Harvard Family Research Project 2007; Time, Learning, and Afterschool Task Force 2007). Such “smart education systems” (Rothman 2007) recognize that significant portions of student achievement are either enriched or largely built in settings other than classrooms.

Lessons about teaching and learning from this research include:

- Students learn in multiple *school-based settings*. Classroom instruction is front and center, but there are other powerful components as well: students’ engagement in their own and other students’ learning; learning in other disciplines (e.g., learning mathematics as part of science, technology, or social studies); and school-based informal learning (e.g., getting extra help before school or at recess or lunch). Each of these settings needs to be improved.
- Students’ learning continues in multiple *outside-of-school settings*. High-achieving students often draw on extended learning opportunities that include after-school programs, tutoring, and supports from siblings, parents, and other family members.
- Students’ learning is affected by the *learning opportunities for the adults around them* (administrators, teachers, community service providers, and adult family members) about the content and pedagogy of contemporary standards-based mathematics.

Based on this research, the Institute developed a framework for a comprehensive learning system. This framework provides a lens through which to examine a particular district’s teaching and learning in six key areas that research has shown to affect students’ learning (see Figure 1). The framework can be applied to any academic discipline.

To help districts examine their practices and results in these six areas, the Institute created the Teaching and Learning Review, a set of tools and processes that is adaptable to the context and needs of a particular district and that culminates in a set of findings and implications for action steps in each of the key areas.

## THE TEACHING AND LEARNING REVIEW IN PAWTUCKET

The Teaching and Learning Review in Pawtucket focused specifically on mathematical learning in the district’s three middle schools and in the after-school programs these schools’ students attend. The Review applied the Institute’s comprehensive learning system framework, depicted in Figure 1, to a *mathematics* learning system, thus enabling the district to

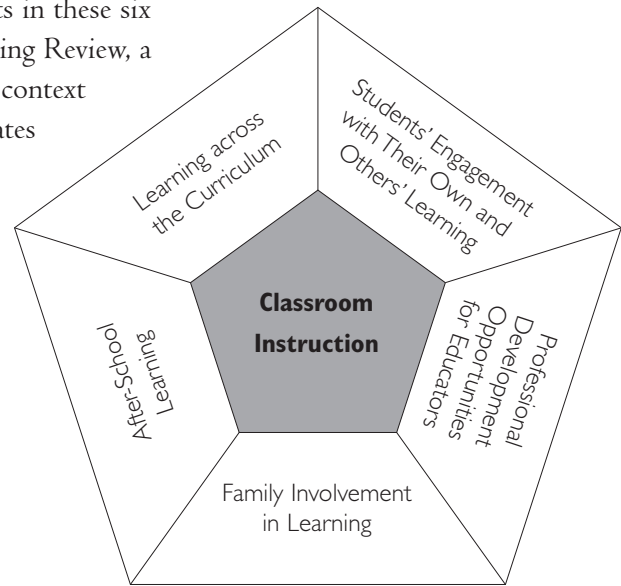


Figure 1. Framework for a comprehensive learning system

examine its practices and outcomes in the six key areas as they affect mathematical learning: classroom instruction; cross-curricular opportunities for learning; students’ engagement in their own and others’ learning; extended learning opportunities and supports (i.e., out-of-school learning); family-based learning; and professional development for educators.

## The Context for Mathematics Learning in Pawtucket

The demographic characteristics of Pawtucket and the district’s comprehensive mathematics curriculum provide the context in which mathematics teaching and learning occurs.

### *Demographic Characteristics of the District*

Pawtucket is a small city of 73,000 in the post-industrial Northeast. The district is one of seven urban districts in an otherwise suburban and rural state. Compared to the state as a whole, Pawtucket has a high proportion of minority students, English-language learners, and students at risk due to poverty (see Figure 2).

Figure 2. Demographic and economic data on Pawtucket and Rhode Island students

	White	Black	Hispanic	LEP	IEP	Free/reduced lunch
Rhode Island	71%	9%	17%	6%	17%	32%
Pawtucket	47%	22%	29%	12%	18%	65%

*Demographic data from the U.S. Bureau of the Census (2007). School and district data from Rhode Island Information Works! Web site (2006).*

Even within the district, the three middle schools differ markedly in their ethnic and economic composition (see Figure 3). In addition, one of the middle schools houses the majority of students who are still acquiring English as young adolescents, many from immigrant families. These differences are reflected in the percent of students achieving proficiency by eighth grade.

**Figure 3.** Demographic and achievement data on middle schools in Pawtucket

	Black, not Hispanic	Hispanic	White, not Hispanic	Free/reduced lunch	LEP	IEP	Percent 8th-graders proficient in mathematics
Goff	7%	12%	80%	45%	n/a	23%	45%
Jenks	23%	42%	35%	82%	29%	23%	18%
Slater	33%	33%	32%	82%	n/a	21%	36%

Demographic data from the U.S. Bureau of the Census (2007). School and district data from Rhode Island Information Works! Web site (2006).

### *The District's Mathematics Curriculum*

Seeking to raise standards for all its students, the district has, over the last six years, invested in high-demand mathematics curriculum materials in elementary (*Growing with Mathematics*, supplemented with a unit from TERC, *Investigations in Number, Data, and Space*), middle (*Connected Mathematics Project*, or CMP), and high school (*Interactive Mathematics Program*). Unlike earlier curricula that stressed routine problems, student mastery of algorithms, and teachers as the keepers of mathematical knowledge, the new curricula represent an expanded view of students as mathematical thinkers and of mathematics content; they also emphasize open-ended problem-solving, student understanding, and student agency (e.g., question asking, self-assessment, making connections).

The promise of these new curricula, especially when used continuously from kindergarten through grade 12, is that large numbers of students will develop mathematical skills and understanding that enable them to thrive in their post-secondary lives as learners, workers, and citizens. The corresponding challenge is that students, teachers, principals, families – in fact, entire communities – have to support this approach to mathematics.

### *Current Student-Achievement Results*

Five years into the adoption of CMP at the middle school level, a large number of students enter ninth grade without the mathematics skills necessary to negotiate the high-demand high school curriculum. Two years of data (2005 and 2006) from the new state test (NECAP) show that the percentage of students failing to meet mathematics proficiency standards (i.e., scoring at levels 1 and 2) is higher in middle school than in

elementary school, rising to over 60 percent in seventh and eighth grade (see figures 5 and 6 in Appendix A). As a result, high school teachers and principals have struggled to put in place a differentiated curriculum that includes a range of options from basic numeracy classes to the challenging sequence of a four-year mathematics program.

When fifth-grade (late elementary school) and eighth-grade (end of middle school) data are disaggregated by student ethnicity for 2005 and 2006 (the last year for which the data are available), a still more sobering picture emerges (see figures 7 and 8 in Appendix A). The disparity widens between the number of Black and Hispanic students who fall below proficient and their White counterparts – the grade 5 data show all groups with similar rates of below-proficient performance (ranging from 53 percent to 62 percent), while the grade 8 data show about 60 percent of Whites and around 75 percent of Blacks and Hispanics score below proficient.

## The Review Process in Pawtucket

The Teaching and Learning Review in Pawtucket was undertaken as a three-way collaborative process by the Pawtucket School Department, RIDE's Office of Progressive Support and Intervention, and the Annenberg Institute for School Reform.

In fall 2006, the Institute conducted planning sessions with RIDE and PSD central office staff to identify the goals and structure of the Review. Review protocols were modified to meet Pawtucket's goals, sites for school visits were selected, and three Action Teams were formed, consisting of teachers, school and district administrators, coaches, family-outreach liaisons, and representatives of community partners (see inside front cover for a list of members and their affiliations).

### What Is the Teaching and Learning Review?

The Teaching and Learning Review is a collaborative process that brings district and school staff together with community partners to investigate three key questions:

- Where is effective teaching and learning occurring? How can that work be acknowledged, supported, and built upon?
- Where is there a need for added investments and improvement?
- What immediate and longer-term actions can the central office, educators, families, students, and community members take to strengthen the quality of teaching and learning experienced by all students?

The Review provides a set of research, observation, and interview tools, developed by the Annenberg Institute, that are adapted to address the goals of a particular community. Using these tools, in a process facilitated by Institute staff, Review participants – district and school staff, students, community organizations, families – gather and analyze data on the expectations, materials, school policies, and daily classroom practices in their community that are key to high student achievement.

The ultimate purpose of the Teaching and Learning Review is to help a community to engage in informed, inclusive, and honest discussion about the extent to which its public schools effectively serve all its children and youth and to reflect on the choices and commitments that are needed to make education a source of development and opportunity for *all* students, leading to thoughtful recommendations for urgent, intermediate, and longer-term actions to improve both teaching and learning systemwide.

Appendix B contains detailed information about the Teaching and Learning Review process.

In January and February 2007, the Action Teams were trained in using the Review tools to gather data about mathematics learning, both in and out of school, through review of PSD data; classroom observations; interviews and focus groups with teachers, students, and families; and student surveys and “learning logs” designed to examine students’ mathematics learning outside of school.

In April and May, the Action Teams and the Institute analyzed the data and produced the findings described in this report. Based on the findings, Institute staff, in consultation with the Action Teams, developed recommendations for action steps and prepared this report.

Appendices C and D provide detailed information and a timeline for the Teaching and Learning Review in Pawtucket.

### *Looking at Students’ Mathematical Learning Lives*

In the Review, Action Teams of school visitors used a suite of tools to examine students’ learning across multiple contexts.

To gather data on *in-school teaching and learning*, each Action Team of ten observers conducted a structured, two-day visit to one of the district’s three middle schools to examine teaching and learning from the point of view of both professional educators and students. Day 1 focused on the learning lives of educators. Day 2 focused on the learning lives of two groups of students: those who were currently struggling in mathematics and those who were currently thriving. Each day included in-class observations followed by individual interviews. Similar half-day visits were conducted in elementary and high schools to develop a context for the middle school findings. See Figure 9 in Appendix C for a detailed schedule of the classroom visits.

To gather data on *out-of-school learning*, Action Team members conducted one-on-one interviews with students about where and how they worked on mathematics both in and out of school hours; they also administered a survey about students’ use of after-school time, supplemented by focus group interviews. Students were asked to complete a learning log in which they recorded information on their mathematical thinking and activities over one twenty-four-hour weekday.

### *Data Collection and Analysis*

The Action Teams, along with Institute staff, collected data in: 44 mathematics classrooms and 10 non-mathematics classrooms in which mathematics was involved; 34 teacher observations and interviews; 51 student observations and interviews; 227 student surveys on after-school mathematics activities; six focus groups with student and family members;

and seven student mathematics learning logs with follow-up interviews. Figure 10 in Appendix C presents a summary of the type and quantity of data collected in the middle schools.

Action Team members also spent a half day in elementary schools, where they observed nine classes and interviewed nine teachers and twelve students; and a half day in high schools, where they visited six classrooms and interviewed ten educators.

The Action Teams and Institute staff used the data from the Review to create a detailed scan of mathematics learning in and outside of the district's middle schools, asking these questions:

- In what settings were students learning mathematics? With whom? To what effect?
- What was each of these settings currently contributing to the mathematics learning of young adolescents?
- What would have to happen so that the people and activities in each of these settings could make a maximum contribution to students' mathematics learning?

### *Developing the Findings and Recommendations*

Action Team members, working with Institute staff, developed the findings and recommendations in a five-phase process:

- **On-Site Summaries:** At the end of each day in the schools, Action Team members, working in pairs, summarized what they had seen during their classroom visits.
- **School Visit Reflections:** At the end of the two-day visit, the entire Action Team for each school summarized what they saw as the current strengths and what investments they felt needed to be made at that school.
- **Coding of Data to the Key Areas:** Institute staff who had been part of Action Teams reviewed the data from classroom observations and from the student and teacher interviews, reading for each of the six key areas (see Figure 1, page 5), with special attention to two of the areas: classroom instruction, and student engagement in personal and peer learning. Based on Action Team notes and this reading, they developed a set of major findings in each of the six key areas under consideration.
- **Integration of the Out-of-School Learning Data:** Data from the surveys were tabulated. Audio tapes of student interviews and focus groups were reviewed.
- **Review of Findings:** Action Team members reconvened to review their original data, review and critique the proposed set of findings, and develop recommendations.

## FINDINGS

The findings from the Review are grouped in six key areas. Five reflect the multiple settings that contribute to students' achievement and attitudes toward mathematics; the sixth focuses on teachers and their professional development as learners.

- mathematics classroom instruction
- mathematics learning across the curriculum
- students' engagement in their own and others' mathematics learning
- extended learning opportunities and support in mathematics (tutoring, after-school programs, etc.)
- family involvement in mathematics learning
- professional development for mathematics teachers

A final finding, which emerged from the other findings, addresses services for the district's neediest students.

### Findings on Mathematics Classroom Instruction

At the center of mathematics achievement is the way in which mathematics is taught and learned in classrooms: who has the opportunity to learn what kind of mathematics with what level of understanding. Therefore, this is the first and most detailed section of the findings.

<sup>2</sup> For each class, the time allotted to the major segments of the lesson was noted: launch, explore, summarize, and any other lesson parts (e.g., quiz, journaling, assigning homework) observed in that lesson. See Figure 4 and Figure 11 in Appendix E for samples of how this coding was applied.

All of the observations from the first of two days of school visits (the day focused on educators; see Appendix C) were coded first by Action Team members in terms of where they saw major strengths and needs in the classroom instruction that they had observed. Subsequently, a pair of Institute researchers coded the classroom observations in greater detail to examine the issue of what learning opportunities were available to what proportion of the class.<sup>2</sup> The first four specific findings about classroom mathematics instruction rely on this coding of classroom observations.

#### 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.

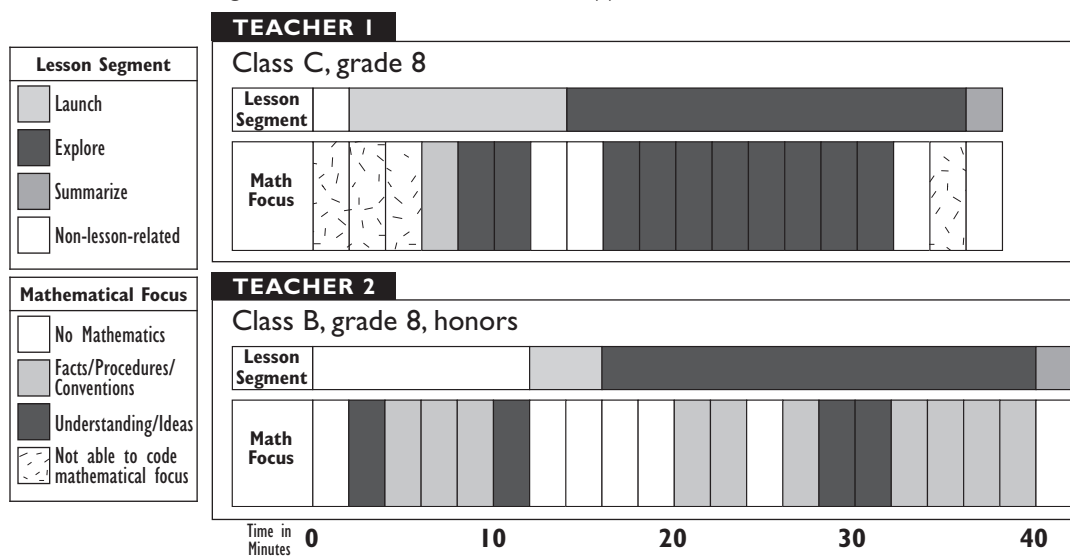
- ◆ There are two distinct cultures of mathematics instruction in the district. One focuses chiefly on mathematical procedures and skills and the other focuses on mathematical understanding, targeting the big ideas of the curriculum and using these to drive and derive computational procedures. Roughly half of the observed classes were of each type. Individual teachers' focus was consistent across observations of their classes.

Sources: Classroom observations (educator day), teacher interviews, student interviews

- ◆ 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 (see Figure 4; an expanded version [Figure II, with two sample classes for each teacher] appears in Appendix E, along with corresponding teacher and student interview transcriptions.)

Source: Classroom observations (educator day)

Figure 4. Two cultures: Two teachers' approaches to mathematics instruction



- ◆ Students at all levels of achievement (special education through honors) engage successfully in instruction focused on mathematical understanding and ideas. (Teacher 1 in Figure 11 and the text of Appendix E provide one example of a teacher whose focus on mathematical ideas is consistent across regular and inclusion classes.)

Sources: Classroom observations (educator day), teacher interviews

- ◆ 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.

Sources: Classroom observations, teacher interviews

## EXAMPLES

During class, a grade 8 teacher noticed that some students were struggling with exponential decay functions. The teacher described to the classroom observer that, as the values approached zero, some students began to subtract rather than to multiply by one-half. The teacher was interested both in this shift in operation and in the resulting negative values for area and was puzzling about the implications of this for where they would pick up with these ideas the next day. (*Grade 8 classroom observation*)

A grade 7 teacher stopped to listen in on a small group working on a problem in which they were using a scaling factor of 2.5. As the teacher observed the students working, he noticed one student who was rounding the scale factor to three rather than rounding the result of the scaling (to avoid half people). The teacher worked both to understand the student's thinking and to engage the student in an exploration of his assumptions and therefore a deeper understanding of what the scale factor is accomplishing in the problem context. The question the teacher posed – “Is it possible to have a scale factor that isn't a whole number?” – was one that the student worked on for about five minutes and in the end resolved. (*Grade 7 classroom observation*)

- ◆ 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.

In general, those teachers whose observed classroom practices were more ideas or understandings oriented expressed positive opinions of CMP and enacted math lessons that stayed closer to the CMP lessons as written – in both mathematical content and in pedagogy – while those teachers whose observed practices were more procedurally focused expressed dissatisfaction with CMP and more often used supplemental materials or made significant adjustments to lessons as written. (See Appendix E for examples.)

*Sources: Teacher interviews, classroom observations (educator day and student day)*

## EXAMPLES

### *Fundamental endorsements*

“I like CMP. I like it a lot. I think the kids today get way more math than they did when I was working with the Glenco books. So that part I really like. This book happens to be in the second series of CMP, which did come out with more additional practice pages and additional practice problems which are excellent and I do use those quite often. It is hard. With the kids who I want to go to Algebra II, we're still struggling with that whole idea of how to make

sure that they're ready and they have all the things – not specifically with this book, but just with all of the books that I do, how are we going to get them there.” (*Grade 8 teacher, interview*)

“I think that CMP is a very good math program to be using. I think that they have interesting investigations. A lot of the activities the kids do like. However you do need a personality to teach this. If you can't change the words into a visual display for the children, they're not going to be able to understand it. There's a lot of words. Their reading skills are not as high as they should be for most of them. They're at least a grade or two below.” (*Grade 8 teacher, interview*)

### ***Fundamental objections***

“CMP is just way too difficult for them. Never mind understanding the whole process, they have difficulty even reading the question. Just way too difficult. Like I said, if they could do it, I don't understand why they would be in here, why they wouldn't be in an inclusion class doing the Connected Math with a special educator in there.” (*SPED teacher, interview [Uses non-CMP program]*)

“What I do with CMP, I look at the book. And then I say, OK, they're going to this section of the book, but they haven't talked about the negative exponent, but they want to do a decay problem. Say, ooh, that could be a problem because they might not know how to do it. And they haven't done a division exponent. So I differentiate. So this was kind of like the prerequisite before I got into chapter 2 of *Growing, Growing, Growing*.” (*Grade 8 teacher, interview*)

### ***Middle-ground positions***

T: “The Connected Math Program is very difficult for the students that I teach because the language is written on an eighth-grade level and my students – especially that class – not one child is reading on grade level. We have four children below a first-grade level in that class. So it is very, very difficult. . . .

Interviewer: “What about the kids who are close to grade level?”

T: “We still have, I have difficulty. I tend to be their translator, that's what I tell them. I'm like, 'I'm gonna be your math-to-English translator or English-to-math translator and we'll get through this.' So I try to use the vocabulary that they'll need but I also have to change words around to make it easier for them to understand.” (*Grade 8 teacher, interview*)

“The CMP book, I have to be honest. The problems I see with it – one was fixed, that we didn't have enough practice. Once the kids got it, it was hard, you had to go and get our own practice and it didn't always fit right with it. But they did fix it, we do have a practice. . . . And the other thing that I do find – and we weren't in the book today so you didn't hear me – but I always

say to the kids, we stop and we have to clarify because the wordiness of the math book, it is tough for our kids.”

*Note: several teachers mention the language of CMP as a difficulty or challenge. Those teachers whose observed classroom practices were more ideas focused tended to see the language issue as a problem to work around – they saw something of value in the general approach of CMP to mathematics and mathematics teaching and learning. Those whose teaching was more procedurally focused however, saw CMP’s language as a larger problem, and for them it wasn’t offset by something of mathematical value.*

- ◆ About one-third of the observed math 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).

*Source: teacher interviews*

### E X A M P L E S

In their interviews, teachers articulated three reasons for using non-CMP materials:

**1. *The teacher supplements the CMP lessons with a project that extends the topic and is designed to be especially motivating and enjoyable.***

“I think one thing I’m finding, which is why I’m doing this project that I kind of made up on my own, is that the Connected Math Program is fairly strong; as they’ve been making modifications, if anything, they’ve been making their projects more lame – for want of a better word. I don’t think they’re engaging to kids, I don’t think they’re really at where the kids are. Maybe just because now the books are six years old, some of them, and they’re not as relevant. So I’m finding a little bit more of a need to modify in terms of a culminating activity project for kids to do at the end of a unit.” (*Grade 7 teacher, interview concerning classroom observation*)

**2. *The teacher provides students with mathematical formulas that CMP intended for students to discover.***

“What I do with CMP, I look at the book. And then I say, OK, they’re going to this section of the book, but they haven’t talked about the negative exponent, but they want to do a decay problem. Say, ooh, that could be a problem because they might not know how to do it. And they haven’t done a division exponent. So I differentiate. So this [today’s class] was kind of like the prerequisite before I got into chapter 2 of *Growing, Growing, Growing*.” (*Grade 8 teacher interview describing the lesson observed*)

**3. *The teacher chooses materials that the teacher feels better meet her students’ needs for a mathematical topic not covered by CMP grade 7 and 8 materials.***

In one classroom, the teacher and students worked on addition and multiplication of decimal numbers. While this topic is not addressed by grade 7 and

8 CMP units, it is addressed by CMP's *Bits and Pieces III*. In the interview, this teacher said that she feels that non-CMP materials best meet her students' needs.

- ◆ 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.

Source: *Classroom observations (educator day)*

#### E X A M P L E S

More- and less-ideas-focused expressions of student thinking in the launch and explore phases of the class:

##### *Launch*

In a grade 8 class, the lesson began with journal writing in which students write whatever they can remember or are thinking about with respect to their previous days' work on exponential growth. This is followed by ten minutes of reporting out of the results of their journaling and a weaving together through student and teacher discussion of the various contributions of different students. From this foundation, that day's problem concerning exponential decay is launched.

A grade 8 class is working on linear equations. They begin with a warm-up problem,  $y = 2x + 2$ , for which they are to create a T chart and a graph. Students work individually on this problem, and then the teacher asks a few students to put their work on the board. The teacher asks the class for comments. There is little discussion.

##### *Explore*

A grade 8 class is working on exponential growth, and on this day students are working through problems from *Investigation 1*'s additional practice section. The problem today involves repeatedly cutting paper into fourths. Step one involves cutting a single sheet into fourths. Step 2 piles these fourths on top of one another and cuts these in fourths, step 3 stacks these and cuts them in fourths. Students are to consider how many pieces of paper they would have at the end of steps 1, 2, 3, 10, and  $n$ . As they work through this problem as a whole group, the teacher at times asks questions that elicit students' thinking and on which the next steps build. For example: "How did you do it?" "Why did you multiply by four?"

In a grade 7 class, students were engaged in individual presentations of student projects in which they create a product, design and carry out a survey of classmates concerning this product, and report on the survey responses using decimals and percents. There is very little conversation or discussion around the presentations.

- ◆ 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.

Source: *Classroom observations (educator day)*

#### E X A M P L E S

Students worked in small groups on problem 4.1 in *Growing, Growing, Growing* until a minute or two before the end of the class period. At this point the teacher told the students that they had not yet gotten as far as the homework problems and asked them instead to finish their graphs and to do problems b, c, d, and e. The teacher also asked if there were any questions. There were none. The bell rang.

Students sometimes worked individually and sometimes as a whole class solving exponential growth problems. They did so until about the last minute of class. At this point the teacher assigned homework and class was dismissed.

Individual student presentations to the whole class (of a non-CMP project involving decimal and percent) ran until the bell. At the bell, the teacher listed names of students she wanted to see after school.

## Findings on Mathematics Learning across the Curriculum

Action Teams were able to visit a total of ten middle school classes in which mathematics was a part of cross-curricular instruction. Observers also saw several homework assignments into which mathematics were integrated. This observational data was supplemented by interviews in which students were asked about where they used their mathematical thinking outside of specific mathematics classes.

<b>SUMMARY FINDING</b>	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 report using only the most basic calculation and measurement outside of their mathematics classes.
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- ◆ 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 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.).

*Sources: Teacher and student interviews, sample assignments*

#### E X A M P L E S

Students described creating scale models of the solar system, studying the linear relationship between altitude and air temperature (so many degrees cooler/warmer for every 1,000 feet increase/decrease in altitude), or exploring the relationship between two variables such as the distance traveled by a toy car beyond the end of a ramp and the height of the ramp.

Seventh-graders did a project involving the drawing of cartoon characters that were each variations of an original (for instance, twice the size in all dimensions, half the width, twice the height) and predicting resulting areas. This combination of mathematics and visual art was, according to one teacher, “probably my kids’ favorite project. One boy got so into it that his father, who makes countertops, used scraps to cut out a whole series of figures that I keep on display in the classroom.”

- ◆ The majority of students described basic calculation and measurement activities as the major ways in which they apply mathematics in other classes.

*Source: Student interviews*

#### E X A M P L E

“Sometimes I do math in other classes. Like, sometimes in science we are pouring liquids in and you have to watch that you get exactly the right amount. Sort of like in cooking. But that’s about all I can think of.”

- ◆ Teachers report that they would be interested in cross-curricular units and projects. They see subjects like science and social science as powerful contexts in which students work with different kinds of representations and applications. But they note that there is limited time to plan across departments or to be thoughtful about how to share responsibility for different concepts or grade-level expectations.

*Source: Educator interviews*

#### E X A M P L E S

“I have all the software and the machines that would let me be doing math and technology projects. But I am pretty much on my own. I taught myself and I am working out the projects myself. Same with English, the project you saw today is my best guess about where technology, information, and writing come together.”

“I work with the science teacher on making connections and trying to put together interdisciplinary work, but we have never had any training on that. We are making it fit. Like, right now they are doing a science fair. I am helping the kids to do all their graphs in Excel. They just learned Excel yesterday.

A lot of the kids want to do it by hand, so I was saying to them, ‘Come on and do it on the computer. You used to have a radio, now you have an iPod. So this is just the same – more advanced.’”

“CMP has investigations, but to keep the kids’ interest up, we need hands-on projects at the end of every investigation – not like games, but like a science experiment for the engagement, for sealing in the learning, and also for signaling that the math has real uses.”

## Findings on 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 make 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, for instance by:
  - asking another student or teacher to model and explain a new process or idea
  - being able to diagnose where they are having difficulty
  - being willing to use their work to demonstrate where their thinking breaks down
  - sticking with a problem or procedure over several tries
  - trying alternative solutions or representations

Sources: *Classroom observations, student interviews*

### EXAMPLES

In a sixth-grade class on dividing by fractions, a student who had been having difficulty observed out loud, “Hey, why am I dividing and getting a bigger number?” Her question allowed the teacher to lead the class in reflecting on why this would be. It also modeled the “habit” of sharing insights and questions.

A seventh-grade student was working with demographic data that described the population of students in Rhode Island. She was studying a table that displayed the ethnic composition of the student body. She reflected on the data to a peer, asking what happens to students who do not fit neatly into a specific ethnic category.

- ◆ This kind of active engagement is not equally encouraged across classrooms. It is often missing for lower-performing students or non-honors classes. Possibly as a result,

individual students vary widely in whether and how they promote their own mathematical learning, even within groups of students who are performing at similar levels.

*Source: Classroom observations*

#### E X A M P L E S

Even though she was currently a low-performing student, a seventh-grader took an active role in pushing herself to understand the part-to-whole relations involved in a complex mathematics project where she had to model the number of T-shirts a company would have to buy for the entire state, based on what three middle schools purchase. Working with a group of three other students, she watched them calculating percentages: “Wait, I don’t understand what you are doing. Let me watch you. . . . No, I didn’t get it yet. Do it again. Tell it to me again.” A second student did another example, narrating the steps. The first student said, “I get the first part, but I don’t understand what you do next.” She watched more, then flagged down the teacher and pointed to the different parts of the calculation, isolated the place where she is confused, “Okay, I understand the first part but I don’t understand the last part. John is trying to explain it to me but I still don’t get it.” The teacher then said, “Let me listen to your group discussion.”

During this same process, another struggling student watched while one of his group members filled out a table showing the percentages needed. Without asking any questions, he copied down the information they generated without noticing that he had left out an entry, so that his total is only 72 percent.

- ◆ Students are also capable of investing in their peers’ learning in ways that may increase understanding for all involved. Students depend on this peer-to-peer system in and outside of school. For instance, students:
  - ask one another for help in class
  - teach one another during class and in after-school homework settings,
  - monitor the quality of one another’s work in joint projects

*Sources: Classroom observations, student interviews*

#### E X A M P L E

In a seventh-grade class, a student realized that the percentages in a problem added up to 104 percent. He wouldn’t let the group progress, even though they argued that it was “close enough to 100 percent.” He drove the group to review their work until he located the source of the error: that each of them had rounded up their calculation, so that when all the calculations were summed, there was a cumulative effect of 4 percent. With him leading the way, they discussed a strategy for only rounding on the total.

Roughly one-third of students we interviewed said that during class they sought help from friends *first*, before asking teachers or teaching assistants for

help. Across homework and in-school settings, students identified their friends and siblings as sources of mathematics help as frequently as they identified their mathematics teacher as a source of help.

- ◆ Some teachers make excellent use of student-to-student learning; others bypass it.

*Source: Classroom observations of students*

#### E X A M P L E S

In a seventh-grade class, two students were working together on a problem. One partner was having difficulty with the calculations. The second student realized this. “Here, give me the calculator and you watch.” He turned the calculator so she could see him enter the numbers and do the operation. The teacher had observed this interaction and made a suggestion: “We have a potential teacher here. Think about this. I wouldn’t grab the calculator from her. I might say something like, ‘Show me how you got it.’ Then you would have seen that her problem was with the decimal place.”

A group of students had come up with an improbable answer. They called the teacher over. The teacher looked at the work, “You can figure this out. What strategies could you use to locate what’s going wrong? I’ll come back in a minute.” (Also, see the example on page 19 where teacher listens to the group discussion rather than providing a diagnosis.)

## Findings on Extended Learning Opportunities in Mathematics

The findings on extended learning opportunities were generated through student interviews, focus groups, and a survey administered to 227 middle school students conducted at the same time that the school visits occurred. On the survey, middle school students supplied information about the kinds of mathematics activities that they engage in outside of school, the people who help them with their mathematics, and the programs in the community that provide this kind of help.

### **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 occurs in these programs. In sum, significant numbers of students spend their after-school time in ways that support their keeping up and doing their homework but do not challenge or extend mathematical learning.

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

*Source: Extended Learning Opportunities Survey*

- ◆ 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.

*Source: Extended Learning Opportunities Survey*

- ◆ The majority of school-based programs offer tutorial and remediation support for students. There are few building-based programs that offer mathematics enrichment programs rigorous enough to support students' increased mathematics achievement.

*Source: Student learning logs*

#### E X A M P L E

“My friend is actually in math club and she said that it is really fun because she doesn't just talk about one thing, like she could go to the computer lab to play math games. And, like, half the stuff that we are learning right now she learned it in the beginning of the year in math club, so when I don't get it she helps me, too. It is seventh- and eighth-graders, my friend and her sister, and another friend and her sister. So it is basically like a younger-sister–older-sister type thing. There are boys in it too. Anybody can go, you just have to sign up for it. And you have to make sure to be there.”

*Note: This is the only school where students mentioned having these rich opportunities.*

- ◆ Off-site programs have 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 is a high level of student engagement.

*Source: Observations of off-site after-school programs*

#### E X A M P L E

During one off-site focus group and observation session at a larger after-school program, students overwhelmingly stated that they preferred attending that program because the adult interaction was more engaging than school-based support and there were various methods of getting academic support at this off-site program. They could work with a tutor, a peer, or independently with computer support.

- ◆ 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.

*Source: Student interviews*

#### E X A M P L E

In their interviews about mathematics in off-site programs, students included playing a game (Pay Day) where they have to calculate costs like rent and mortgages, Monopoly where they are accruing cash and paying fines, and computer games where they keep track of levels and point scores.

## Findings on 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. This pattern of exchange and support at home contrasted with patterns of attendance at organized events such as “family math nights.”

#### E X A M P L E

Student interviews included instances of lessons about accuracy, measuring, and precision; the importance of sharing their knowledge with younger family members; and how to negotiate the high-demand curriculum (e.g., how to show that you made an effort even if you did not get the answer, how to ask for help).

- ◆ More than two-thirds of students turn to family members and/or family friends for assistance with mathematics learning. For instance, they:
  - do homework with family members
  - ask family members to help them “practice math”
  - save up or ask for mathematics-related items (software, calculator) for birthdays and holidays

#### E X A M P L E

“I have trouble in math. I didn’t used to. But now I do. So on weekends, I ask my mom to help me. So she makes up problems for me and makes them harder and harder.”

- ◆ Students turn 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.”

#### EXAMPLES

“In sixth grade I wasn’t very good at math and (my teacher) used to always call me up [at the board] ’cause I didn’t get math so much. . . . He always helped me and he gave me problems that I didn’t know and then I figured it out. And right now my mom says I’m, like, one of the smartest kids she’s ever seen in her life because math is not my favorite subject and it is the one I really put more energy into than all my other ones, even gym, because I like math a lot more.”

“At Christmastime, actually, my mom was doing her bills, and she said that she was going to have this much for Christmas shoes. She didn’t have her calculator, so she said, ‘[Name], come here,’ ’cause she wanted to see if I could get it. So she asked me and then I got it, how much she would have to split between them.”

- ◆ But families are frustrated by the ways in which school or district infrastructure gets in the way of their children’s mathematical learning and their own interest in supporting that learning.

#### EXAMPLES

Transportation issues emerged as a major dilemma and point of concern for parents. Limited transportation options made it difficult for many students to participate in formal after-school programs or informal help sessions with teachers or peers.

Families wish that the format of mathematics-related events such as family math nights would change to make it easier for them to participate. For instance, dinner and childcare would help, as would concrete family-to-family discussions about how to help middle school students if your own mathematics education was very different.

## Findings on Professional Development for Mathematics Teachers

Over the last five years, the Pawtucket School Department has had a strong commitment to providing professional development for teachers to support the implementation of CMP. Leveraging both internal and external partner resources, the district advertises a multitude of training opportunities. Teachers at all grade levels were provided with basic training in an approach to mathematics instruction emphasizing understanding. At the elementary school level, coaches were dispatched to schools and lead teachers were trained in each building. A series of training on curricular units has been required for middle and high school teachers, but the district has been challenged in finding qualified coaches to provide direct classroom support.

**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 10–16). 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.

*Sources: Educator pre-interview questionnaires, educator interviews*

**E X A M P L E S**

“I went to URI, so those classes really have helped me with my teaching.”

“The principal posts opportunities from the local colleges, et cetera. I mean, there are a lot of opportunities.”

“I go to the classes that are offered through the district or those that are sponsored by the union. They are very effective. The last class I took – I’ve been doing this for the last thirteen years and I think it was one of the most helpful classes I’ve taken.”

“We just finished the Prime Time grant. We had a peer coach; she was wonderful.”

- ◆ However, teachers, including the most experienced and skilled individuals, want to understand how to implement CMP well with their particular student populations. For example, they want to work on adapting lessons and problems based on relevance to the student population or CMP-provided curriculum that challenges the reading abilities of the student population.

*Source: Educator interviews*

**E X A M P L E S**

“We’ve been trained in every book we teach and so we get to see how the lesson’s supposed to go.”

“The differentiation is where I need help. It’s overwhelming. And I think they – the kids – are struggling with the reading in this [curriculum].”

“It’s not so much the math that I have problems with. It’s just how far I have to back up every year, the lack of basic knowledge that the students should know when they get to eighth grade. Part of the problem is their reading levels. . . . And those are the things that I need help with – the things I need to work on, what I need to learn about.”

- ◆ Teachers acknowledged their peers as a major source of their professional learning. As a result, teachers want more common planning time in order to:
  - compare and develop assessments
  - conduct lesson study
  - practice various techniques (including the use of manipulatives)
  - observe skilled teaching of difficult concepts or diverse learners

*Source: Educator interviews*

#### E X A M P L E S

“I’m lucky, real fortunate, I have two men working with me and they tell me what they bought at the teacher’s store and they say, ‘Look at this, don’t buy it.’ You know, they’ll just share it.”

“I go to my colleagues, both in the building and even in other schools. I mean we have the math teacher of the year just down the hall.”

“Last year we did lesson study at [neighboring school] and that was really great. I wish we could do more of those.”

“I wish we had more time together to talk about how we do the lesson. To share tests or assessments. Just to share different materials or examples.”

- ◆ Teachers saw a major need for training that would allow them to work more effectively across subjects and specialties. Teachers also said they want supports in working across subject-matter boundaries, and they want to learn more about team teaching with special education teachers, ESL teachers, and classroom aides.

*Source: Educator interviews*

#### E X A M P L E S

“I work very well with the special education teacher who works with me in my classroom. But we have never had any training on team teaching or working across special education and math. I have inclusion students who can do grade-level work and kids who are way below grade level. I want to meet their needs. I know that I could get there eventually, but I’d like to get there faster.”

“I work with the science teacher on making connections and trying to put together interdisciplinary work, but we have never had any training on that. In my eighth-grade class we are making it fit. Like, right now they are doing a science fair. I am helping the kids to do all their graphs in Excel. They just learned Excel yesterday. Graphing in technology – a lot of the kids want to do it by hand, so I was saying to them, ‘Come on, do it on the computer. You used to have a radio, now you have an iPod.’ So this is just the same – more advanced.”

- ◆ 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 remain unclear and want more help understanding how the two sets of requirements fit together.

Sources: *Educator pre-interview questionnaires, educator interviews*

#### E X A M P L E S

“I just really want to know what my kids need to be able to do. I know they are working on the GLEs [grade-level expectations] and those are there, but I don’t want my students getting to the high school unprepared.”

“A lot of the background materials from CMP are useful and I’ve learned a lot just by reading that stuff, but then you have the GLEs on this side – and I’ll be honest, I’m not always sure. I’m still trying to figure out which one because variables and patterns took a long time.”

## Serving the District’s Neediest Children Well

One important overall finding regarding equitable resources for mathematical learning emerged from the rest of the findings and touches on all of them.

- ◆ Classrooms and schools serving high numbers of students with IEPs and students who are still in the process of acquiring academic English struggle most with the implementation of CMP for all students. Some teachers seriously doubt their students “can handle” the course. Many want and need help figuring out how to make the course leaner or the language simpler – without sacrificing rigor. Many in-room aides, who have little background or training in CMP, do not know how to intervene to support students in the new curriculum.

*Note: Each of Pawtucket’s middle schools serves a wide range of students, including IEP and LEP students. A number of these students are also poor and change schools frequently. However, one middle school has a high concentration of the neediest students.*

## RECOMMENDATIONS

As a district, Pawtucket has already made a substantial investment in changing 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 below 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 district’s 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.

## Recommendations on Classroom Instruction

The district has made a significant and important commitment to improving mathematics education at the middle school level by adopting and implementing CMP. But, as the findings indicate, the implementation requires multiple phases. In support of moving beyond phase one:

**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.

The Institute recommends that these ongoing teacher groups involve teachers working together on the issues raised in their own practices, working from some artifact of practice brought to the group, such as video clips chosen by the teacher him/herself as moments in which they are trying to understand something about the logic of the lesson or the student thinking, or student work samples that focus on similar issues of practice.

- ◆ 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.

These teachers should work closely with central office mathematics staff on a regular basis. The Institute recommends supporting these individuals with release time, off-site professional development opportunities (particularly those directly connected to CMP), and the help of CMP-savvy consultants for occasional on-site consultation about the problems of practice.

The focus of these on-site consultations by outside experts should be on problems of practice through classroom observations, observations of the teacher working groups, lesson study, and discussion so that local teacher-leaders can support their colleagues in focused and concrete ways.

### *Over the following two years*

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

A key element is hour-long mathematics periods that will permit full-length CMP lessons. A second element is a short (fifteen-minute) period at the end of the day designed to allow students to collect materials, ask questions, and review assignments before leaving school.

## Recommendations for Mathematics Learning across the Curriculum

<b>SUMMARY RECOMMENDATION</b>	Building cross-curricular links can extend and deepen mathematics learning if interdisciplinary units are of high quality, well planned, and well implemented. For this to be the case, cross-disciplinary teams of Pawtucket 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.
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### *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.

Focus on those with the greatest potential for reinforcing major concepts and GLEs that students have difficulty grasping. Share them. Create in-building professional development time for planning, implementation, and review.

### *Over the following two years*

- ◆ Develop a set of common cross-curricular units for the middle schools that reinforce key concepts and GLEs.

Build on the building-level work, but also consider field-tested materials from organizations like the National Science Foundation.

- ◆ Seek funding and support for this work, in collaboration with local universities, using the highly successful model of Prime Time.

## Recommendations for Engaging Students in Their Own and Others' Mathematics 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.

The discussion of strategies should include topics like how to seek help, ask questions, try multiple strategies, etc.

- ◆ Create time in professional development sessions to address the process of being a peer and cross-age tutor 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.

Consider participating in proven models such as those developed by the Breakthrough Collaborative <[www.breakthroughcollaborative.org](http://www.breakthroughcollaborative.org)> and AVID <[http://avid.panam.edu/GStarting\\_WhatIsAVID.htm](http://avid.panam.edu/GStarting_WhatIsAVID.htm)>.

## Recommendations for Extended Learning Opportunities

**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 jointly plan 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 middle schools need to market their resources so they will draw more of the students that need help.
- ◆ School-based mathematics enrichment resources (e.g., math club) must be equally available, rigorous, and engaging across the three middle schools.

In addition, they need to be more visible so that they are not perceived by students and families as solely credit recovery or tutorial services. This will help to insure heterogeneous groups of students that will facilitate high-quality peer-to-peer learning.

- ◆ 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.

One strategy would be to include after-school staff in professional development sessions.

- ◆ The district, working with after-school providers, should develop a set of mathematics-related competitions and projects that would engage students in practicing key mathematics skills and concepts.

For example, students can be involved in community census, design, and entry-level engineering projects.

## Recommendations for Family Involvement in Mathematics Learning

**SUMMARY RECOMMENDATION** The district, working with its family liaisons, should think about how to move its 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 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 the city transportation department to create additional options for students during the school year.  
PASA in Providence might be able to provide quality technical assistance in this area.

### *Over the following two years*

- ◆ Working with its family liaisons, the district should develop and seek funds for on-going forms of mathematical outreach that are likely to involve more families to acknowledge and extend the ways in which they already help their children with mathematics.  
For example, the district could build on the work of Logan Square (Chicago) with Literacy Ambassadors (home visits with small groups of families sharing information, strategies, and mathematics-related activities that involve siblings of different ages).

## Recommendations for Professional Development for Mathematics Teachers

One important question linking the findings in professional development with findings in math instruction is: If teachers report that professional development has been good, then why is implementation so varied across middle school classrooms? The need for a second phase of professional development that focuses on implementation issues for the CMP curriculum is at the core of these recommendations, building on the strong first-phase work already undertaken by the central office and school leaders and faculty.

**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.

Further training could focus on:

- conducting investigatory classes
- teacher as facilitator (versus direct instruction)
- collaborative and group work using CMP content
- reading across the content area, especially targeted to support struggling readers with text-heavy curriculum such as CMP
- making adaptations to CMP curriculum for special populations (e.g., ELLs, special education students)

### *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 mathematics.

These professional development sessions would build on work already started with the alignment of the GLEs to CMP curriculum and would allow cross-building, grade-level teams to discuss common lesson plans, units, and tasks.

- ◆ 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

The following overall recommendations address the possible uneven distribution of resources across different populations of middle school students (see finding on page 26).

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.

<b>SUMMARY RECOMMENDATION</b> 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.
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### *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.

## REFERENCES

- Carpenter, T. P., M. L. Franke, V. R. Jacobs, E. Fennema, and S. B. Empson. 1998. "A longitudinal study of invention and understanding in children's multidigit addition and subtraction," *Journal for Research in Mathematics Education* 29, no. 1:3–20.
- Fuson, K. C., W. Carroll, and J. Drucek. 2000. "Achievement results for second- and third-graders using the standards-based curriculum," *Everyday Mathematics, Journal for Research in Mathematics Education* 31, no. 3:277–295.
- Gordon, E., B. Bridglall, and A. Meroe. 2005. *Supplementary education: The hidden curriculum of high academic achievement*. Lanham, MD: Rowman & Littlefield.
- Harvard Family Research Project. 2006. "Complementary learning." HFRP Web site, Harvard University Graduate School of Education.  
<[www.gse.harvard.edu/hfrp/projects/complementary-learning.html](http://www.gse.harvard.edu/hfrp/projects/complementary-learning.html)>
- Kilpatrick, J., J. Swafford, and B. Findell, eds. 2001. *Adding it up: Helping children learn mathematics*. Washington DC: National Academy Press.
- Lubienski, S. T., E. Camburn, and M. C. Shelley. 2004. *Reform-oriented mathematics instruction, achievement, and equity: Examinations of race and SES in 2000 main NAEP data*. Urbana-Champaign, IL: College of Education at the University of Illinois at Urbana-Champaign, NAEP.
- Noble, T., R. Nemirovsky, T. Wright, and C. Tierney. 2001. "Experiencing change: The mathematics of change in multiple environments," *Journal for Research in Mathematics Education* 32, no. 1:85–108.
- Rhode Island Information Works! 2006.  
<[www.infoworks.ride.uri.edu/2006/default.asp](http://www.infoworks.ride.uri.edu/2006/default.asp)>.
- Rothman, R., ed. 2007. *City schools: How districts and communities can create smart education systems*. Cambridge, MA: Harvard Education Press.
- Time, Learning, and Afterschool Task Force. 2007. A new day for learning. Flint, MI: Charles Stewart. Mott Foundation. Available for download at  
<[www.edutopia.org/node/4342](http://www.edutopia.org/node/4342)>.
- U. S. Bureau of the Census. 2007. <[www.census.gov](http://www.census.gov)>.

## APPENDIX A

### Student-Achievement Data

Figures 5–8 in this appendix contain student-achievement data from a regional standardized test, the New England Comprehensive Assessment System (NECAP), in which Rhode Island participates. NECAP defines levels 3 or 4 as proficient scores; students scoring at levels 1 or 2 are considered below proficient. NECAP has been in place since 2005; these graphs represent the first two years of available data.

Figure 5. Fall 2005 NECAP mathematics test: percentage of students not meeting proficiency standards, by grade level

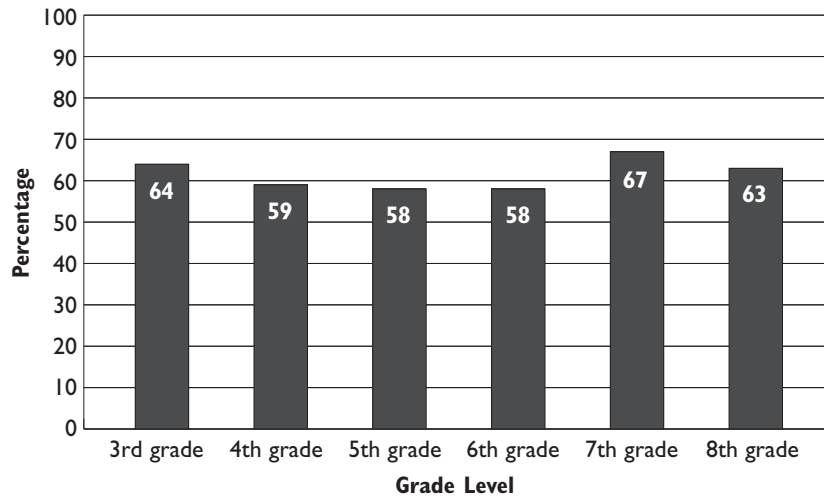


Figure 6. Fall 2006 NECAP mathematics test: percentage of students not meeting proficiency standards, by grade level

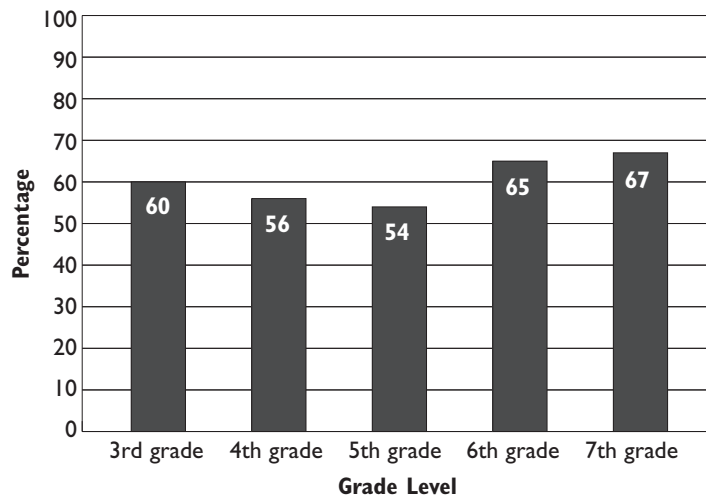


Figure 7. Fifth-grade 2006 NECAP mathematics test: percentage of students not meeting proficiency standards, by race/ethnicity

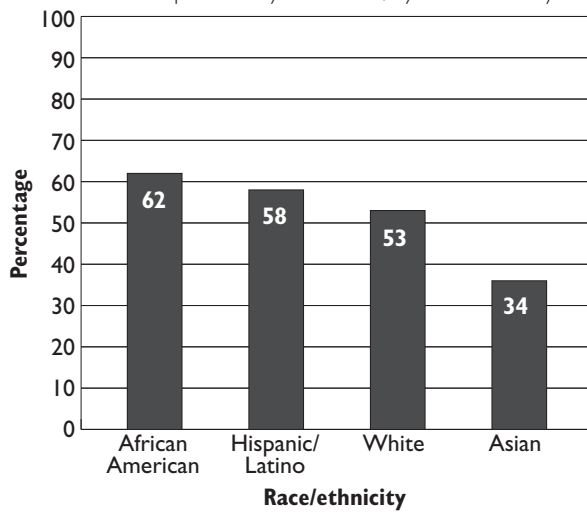
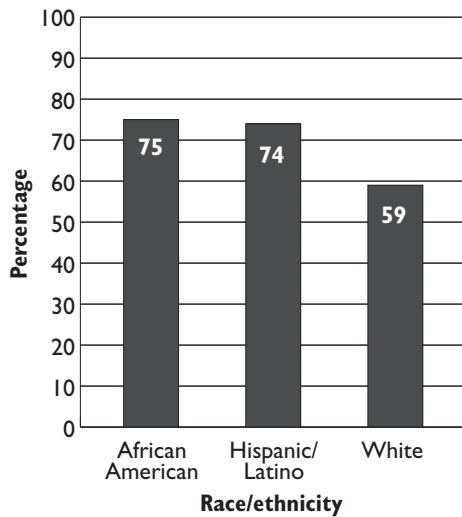


Figure 8. Eighth-grade 2006 NECAP mathematics test: percentage of students not meeting proficiency standards, by race/ethnicity



*Note: Asian students do not appear in this figure because of their small numbers. A few students transferring out can cause the total to fall below the Pawtucket School Department's cutoff point (fewer than ten students in a category) for tracking data.*

## APPENDIX B

### The Teaching and Learning Review: Process, Tools, and Methodology

The Teaching and Learning Review, developed by the Annenberg Institute, consists of a broadly defined process and a set of research, observation, and interview tools that enable community stakeholders – district and school staff, students, community organizations, and families – to closely examine teaching and learning in their schools. The Review intentionally builds the capacity of these stakeholders to engage in inclusive and honest discussion about how effectively their public schools serve all their children and youth and about what is needed to make public education a source of development and opportunity. The Review is customized to reflect the context and needs of the community in which it is being conducted. A detailed description of how the Review was conducted in Pawtucket appears in Appendix C.

#### Process

The Review comprises three broad phases: collaborative planning and preparation, collection and analysis of data from schools and classrooms, and development of findings and recommendations for action.

#### *Planning and Preparation*

- Institute staff meet with the superintendent, other district personnel, and community leaders to collaboratively tailor the Review to their community's needs. The group identifies the schools to be visited during the Review.
- The district/community planning group identifies a team of educators from the district's schools and central office, leaders of key partner organizations, and family and community members who will gather data during school and classroom visits and develop findings and recommendations.
- Institute staff train the team members in the data-collection process, introducing them to the Teaching and Learning Review tools for observations and interviews and working with the team to adapt the tools to the context of the community.
- Data and background materials about the district, the community, and students are gathered and compiled to provide context for the Review.

#### *Data Collection and Analysis*

- Team members spend two full days in the selected schools, gathering data on teaching and learning through classroom observations, individual interviews, and focus groups. One day is focused on educators; the other day is focused on students.

- Institute staff compile the data from all the observations and interviews. Following an analysis of the data, the staff draft a set of preliminary findings for review by the school-visit team.

### *Findings and Recommendations*

- The school-visit team meets, facilitated by Institute staff, to discuss and complete the findings and to develop a set of recommendations emphasizing strengths that the district and its partners should build on, as well as identifying work that remains to be done.
- The findings and recommendations are shared with district and community leaders.

## Tools

The Review features a set of tools designed to gather data consistently across multiple classroom observations, individual interviews, and focus groups by each of the school-visit team members.

### *Observation Tools*

- Classroom observations of both educators and students are recorded on “running record” forms. Every two minutes during the class period, the observer notes in writing the actions (who is talking, listening, etc.), language, interactions between educator and students or colleagues, and materials being used.
- Following each observation session, the observer reviews the running record and notes instances of key themes for use in data analysis.

### *Interview Tools*

- Individual and focus group interviews with educators and students follow a set of scripted questions to ensure consistency in data collection.

### *Extended Learning Opportunities and Supports Tools*

Gathering data from sources outside the classroom is a natural extension of the investigation guided by the Teaching and Learning Review. A separate suite of tools focuses on extended learning opportunities and supports (ELOS) and accompany the core set of Teaching and Learning tools. They are:

- *Principal interviews* focusing on the major challenges for enhancing instruction. Protocols are particularly concerned with problem areas that require additional supports (e.g., target populations, specific content areas) and the communities of student population.

- A *student survey* to gather individual information regarding time on task and supports in and out of school, as well as to identify additional sites for inquiry.
- *Student focus groups* to allow for more in-depth discussion regarding the teaching and learning struggles of students and to further understand how students and families address these struggles.
- *Community service provider interviews* to gather descriptive data of programs offered to students, assess capacity of organizations that offer supplemental services, and probe the level of partnership with schools and central office.
- *ELOS observations*, using ethnographic logs that track the overall activities, levels of student engagement, relationships between adults and students, and materials utilized.

## APPENDIX C

### The Teaching and Learning Review in Pawtucket

The Pawtucket School Department (PSD), in partnership with the Rhode Island Department of Education (RIDE), undertook a Teaching and Learning Review from fall 2006 to spring 2007. Staff from the Annenberg Institute facilitated the Review. A detailed timeline of the Review process in Pawtucket appears in Appendix D.

#### Initial Phase: Review of PSD Data

The Review began with a comprehensive examination of districtwide student-achievement data in mathematics from the past several years, as well as state standards, summaries of curricula taught in different middle schools across the city, emerging plans for professional development, etc.

This initial review helped the district and Institute staff to select a focus for the Review: mathematics achievement in the middle schools. In addition, since a growing number of students use district- and community-based after-school programs, the school frame was widened to include these programs. Finally, a decision was made to use tools developed by the Institute to examine the many different settings in which students are working on mathematics and where mathematics learning might be taking place, including students' time with peers and at home.

#### *Planning and Preparation*

During the fall and winter of 2006–2007, nearly thirty individuals from PSD, Institute staff, and a number of community members (retired teachers, university faculty members, and parent liaisons) came together to form three Teaching and Learning Review Action Teams (see the inside front cover for a list of the Action Team members).

Facilitated by staff from the Institute, the teams trained together in the observation and interview processes and tools (see Appendix B), which they would be using during the school visits to examine both the opportunities to learn and the outcomes for Pawtucket educators and students. Part of the training sessions included a critique of the tools and processes, which were subsequently refined and adapted for use in the Pawtucket Review.

## The School Visits

In January and February of 2007, each of the three Action Teams (comprising approximately ten people) visited one of the three middle schools for two full days and spent a third day visiting classrooms in the transition grades: fourth and fifth grade at feeder elementary schools and ninth and tenth grade at high schools.

Over the two days, team members each observed two educators and two students in mathematics classrooms; conducted individual interviews with the educators and students they observed; and led focus groups with other students, teachers, and school staff. Team members completed a running record form for each educator and student observed and took detailed notes on responses to each of the interview and focus group questions (see Appendix B).

At the end of the visit, team members participated in debriefing discussions with principals and interested staff members at the school site.

The structure of the two-day school visit is detailed in Figure 9.

**Figure 9.** Structure of the two-day school visits in Pawtucket by the Teaching and Learning Review Action Teams

<b>Day 1: Educators at Work</b>	PRE-OBSERVATION MEETING WITH EDUCATORS
	OBSERVATION 1: 5 Settings, 2 Action Team members in each setting <div style="display: flex; justify-content: space-around; width: 100%;"> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="border: 1px solid black; padding: 2px 5px;">OTHER</span> </div>
	OBSERVATION 2: 5 Settings, 2 Action Team members in each setting <div style="display: flex; justify-content: space-around; width: 100%;"> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="border: 1px solid black; padding: 2px 5px;">OTHER</span> </div>
	INDIVIDUAL INTERVIEWS 1: the 5 educators from Observation 1
	INDIVIDUAL INTERVIEWS 2: the 5 educators from Observation 2
	FOCUS GROUPS (e.g., parents, school counselors)
	ACTION TEAM DEBRIEF & PREP FOR DAY 2
<b>Day 2: Students' Learning</b>	PRE-OBSERVATION MEETING WITH EDUCATORS
	OBSERVATION 1: 5 Settings, 2 Action Team members observing 1 student each <div style="display: flex; justify-content: space-around; width: 100%;"> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="border: 1px solid black; padding: 2px 5px;">OTHER</span> </div>
	OBSERVATION 2: 5 Settings, 2 Action Team members observing 1 student each <div style="display: flex; justify-content: space-around; width: 100%;"> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="background-color: black; color: white; padding: 2px 5px;">MATH</span> <span style="border: 1px solid black; padding: 2px 5px;">OTHER</span> </div>
	INDIVIDUAL INTERVIEWS 1: the 10 students from Observation 1
	INDIVIDUAL INTERVIEWS 2: the 10 students from Observation 2
	DEBRIEF WITH PRINCIPAL AND SCHOOL STAFF
	ACTION TEAM DEBRIEF

During the six school visits, the Action Teams, in total:

- observed and individually interviewed 34 educators
- observed and individually interviewed 51 students (a range of high- and low-achieving students)
- facilitated 6 focus groups (participants included additional students, educators, administrators, and support staff who were not otherwise interviewed or observed)
- held structured debrief sessions at the three middle school sites with the principal; debriefs were open to all staff

The type and quantity of data collected is summarized in Figure 10.

The data collected during the school visits offer a detailed snapshot of mathematics teaching and learning at the middle school level in Pawtucket. However, for the reasons outlined below, it is important to bear in mind that these data constitute a slice of secondary teaching and learning in Pawtucket, not a comprehensive research or statistically valid study:

- Teams visited all of the district’s middle schools. Teams also observed and interviewed for a half day in three elementary schools and the two high schools to gather context for understanding the issues at the middle level.
- Teams observed two consecutive days of instruction, at one particular time of the year.
- Teams saw less of teachers’ professional lives (e.g., grade-level meetings, IEP meetings, planning periods) than anticipated.
- Schools, classrooms, teachers, and students were largely volunteers.
- All teachers were informed of the visits ahead of time. There were no random or surprise visits.

**Figure 10.** Data collected at Pawtucket middle schools on mathematics learning

Data Collected	Quantity
<b>In-school learning</b>	
Mathematics classes observed	44
Mathematics-related classes observed	10
Teachers observed and interviewed	34
Students observed and interviewed	51
<b>Out-of-school learning</b>	
Student surveys on out-of-school mathematics learning (homework, after-school programs, sources of help, etc.)	227
Focus groups with students	5
Focus group, parents and other family members	1
Student learning logs (24-hour accounts of mathematics thinking and activity)	7

## Data Analysis and Preliminary Findings

Working in pairs at the end of their school visit, Action Team members began the data-coding process by identifying instances of the key areas in their running records on their educator and student observations and comparing the experiences of the two students they observed in the same classroom. In addition, they listed what they saw as areas of strength and areas in need of investment from their school visit.

Institute staff compiled the data from the Action Teams' observations and interviews and combined them with the initial background research from the first phase of the Review to produce a preliminary set of findings.

In broad outline, the Institute (research staff and consultants) completed the following steps:

1. Reviewed the handwritten data from the school visits, aligned materials from multiple observers, double-checked coding, and verified confusing or missing information with school sites.
2. Listened to the tape-recorded interviews with students and teachers.
3. Classified the data for its relevance to each of the settings in which students learned mathematics (e.g., mathematics classrooms, family interactions).
4. Completed two readings of each data type to double-check the Action Teams' coding of the data.
5. Compiled a preliminary list of major findings (to be considered a finding, a point had to occur across two or more sources of data – such as student observations, focus groups, Action Team debriefs – or across schools).

## Final Findings and Recommendations

The draft findings from the analysis by Institute staff were reviewed by the Action Team members, PSD central office staff, and community education partners at a meeting in late April. Institute staff then expanded and clarified the findings, which were again reviewed by the Action Team members at a meeting in April 2007.

Based on the Action Team findings, Institute staff developed a series of immediate and near-term (within two years) recommendations for action by the district and its partners.

## APPENDIX D

### Timeline for the Teaching and Learning Review in Pawtucket

Fall 2006: Planning with District and RIDE

- Planning sessions with RIDE and central office staff to identify the goals and structure of the Review
- Review protocols modified to meet Pawtucket's goals
- Selection of school sites
- Selection of Action Team members

January 2007: Joint Planning with Sites

- Meeting with school principals to plan school visits (January 5)
- Training sessions for Action Team members (January 23 and 25)
- Final revisions to the Review tools based on feedback from the Action Team members

Late January–Early February 2007: Data Collection

- School visits (January 31 to February 1)
- Extended learning observations and interviews (first week of February)

April–May 2007: Review of Findings and Implications: Action Phase

- Draft findings sent to Action Team members for review (April 20)
- Action Team meeting to refine findings and further develop implications (April 26)
- Meeting with district staff to develop implications
- Capstone meeting with RIDE, middle school principals, and district to translate recommendations into action

## APPENDIX E

### Two Cultures: Two Teachers' Approaches to Mathematics Instruction

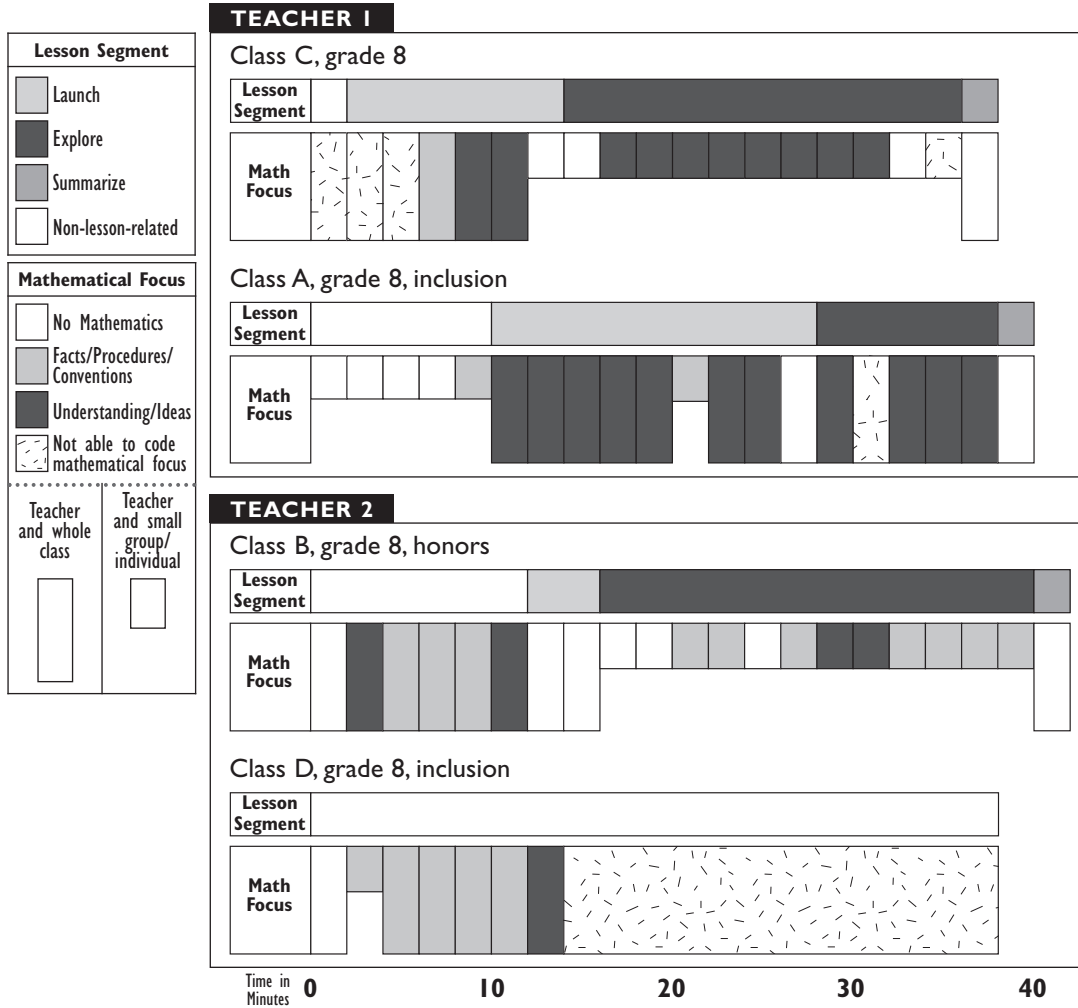
The Review's findings in the key area of classroom instruction described two distinct cultures of mathematics instruction in the district: one focused chiefly on mathematical procedures and skills and the other on mathematical understanding and the big ideas of the curriculum, using these to drive computational procedures. Each of these two mathematical cultures produces distinctive patterns of instruction and opportunities for student learning that hold across different levels (inclusion, regular classes, honors), through different stages of the class, and in both whole-class and small-group work with students.

This finding was derived in part by the detailed records Action Team members kept of classroom observations during the two days of school visits. For each class, the time allotted to the major segments of the lesson was noted: launch, explore, summarize, and any other lesson parts (e.g., quiz, journaling, assigning homework) that were observed in that lesson. Further, for each class, a running record was kept at two-minute intervals and coded for its mathematical focus: no mathematics; a focus on procedure, fact, and/or conventions; a focus primarily on the mathematical concepts; or not possible to code the focus. If a given segment was working on issues of procedure or fact but engaging students in discussion of the underlying ideas, this was coded as a segment that focused on concepts/ideas.

Figure 11 depicts the coding for two classes each given by two teachers: Teacher 1, who focuses on understanding the underlying mathematical ideas, and Teacher 2, whose observed practice and interview indicate a focus on procedures.

Following Figure 11 is a transcript of interviews with these two teachers, illustrating their differing approaches to various aspects of instruction, and with each teacher's students.

Figure 11. Two cultures: two teachers' approaches to mathematics instruction (detail)



TEACHER 1	TEACHER 2
Enacted lessons stay close to CMP lessons as written	Enacted lessons involve significant mathematical and pedagogical adjustments from CMP
<p><b>Teacher expresses belief that content of the material is sound</b></p> <p>Changes/adjustments to today's lesson</p> <p><i>Interview, Teacher 1</i></p> <p>“Everything is pretty much the same except that they [CMP] have the students cutting out what I know they can do visually now. So I'm going to have a few extras on the side just in case they need to cut things out, but I think they already have the concept so they're not going to need to cut.”</p> <p><b>Fit of curriculum materials to students</b></p> <p><i>Interview, Teacher 1</i></p> <p>“I think that CMP is a very good math program to be using. I think that they have interesting investigations. A lot of the activities the kids do like. However you do need a personality to teach this. If you can't change the words into a visual display for the children, they're not going to be able to understand it. There's a lot of words. Their reading skills are not as high as they should be for most of them. They're at least a grade or two below. So now we have to use the reading skills and put it to math too. So unless you know a good way to make it fun for them, they're not going to like CMP.”</p>	<p><b>Teacher expresses fundamental differences with the pedagogical choices of CMP</b></p> <p>Describing the focus of the class observed</p> <p><i>Interview, Teacher 2</i></p> <p>“What I do with CMP, I look at the book. And then I say, OK, they're going to this section of the book, but they haven't talked about the negative exponent, but they want to do a decay problem. Say, ooh, that could be a problem because they might not know how to do it. And they haven't done a division exponent. So I differentiate. So this [today's class] was kind of like the prerequisite before I got into chapter 2 of <i>Growing, Growing, Growing</i>.”</p> <p><b>Fit of curriculum materials to students</b></p> <p><i>Interview, Teacher 2</i></p> <p>“I think there needs to be more differentiating with the curriculum that we have. We actually have a program – the CMP program. And I think the reading level for eighth grade for those programs is on an eighth-grade reading level. And most of our students here do not read at an eighth-grade reading level. So not only do I have to be the math teacher but now I have to become their English teacher and you know tell them what these words mean. Because some of them can do the problem, they just can't read the problem. So that's the big gap, I think. So you need a lot of differentiated materials to make sure they can bridge it. And that's what I did, with this one, with that rubric, I made that one myself, instead of doing the traditional you know this is <math>y = mx + b</math>, I did that so it's kind of a step by step on how to do it. And then in my other class we're doing <i>Growing, Growing, Growing</i> which is all on exponential equations, and the book goes right into the growth and decay, but they don't talk about the negative rule, the division rule, the multiplication rule so I kind of have to differentiate or teach that first out of the book before I can get into the book.”</p> <p>Interviewer: “So you find yourself supplementing?”</p> <p>T: “A lot. Yeah.”</p>
<p><b>Observed lessons focus on mathematical ideas, understanding and derive/build computational procedures from these</b> (See Figure 11)</p>	<p><b>Observed lessons focus primarily on mathematical facts, procedures, and/or conventions of notation</b> (See Figure 11)</p>

TEACHER 1	TEACHER 2
<p>Enacted lessons stay close to CMP lessons as written</p>	<p>Enacted lessons involve significant mathematical and pedagogical adjustments from CMP</p>
<p><b>Teacher demonstrates strong inclination to notice and analyze students' mathematical thinking</b></p> <p>Observed examples of T's skill/inclination to notice and analyze student mathematical thinking  <i>Running Record, Teacher 1, Class A (inclusion class)</i></p> <p>During class notices that some students are struggling with the decay functions. T described to observer that as the values approached zero some students began to subtract rather than to multiply by one-half. T is interested both in this shift in operation and in the resulting negative values for area. [This observation and T's reflection on it, is itself a strong index of T's skill and inclination in working with students' mathematical understanding. We might further wonder if this T will use this observation to push T's own thinking about the mathematics underlying the students' difficulty with algebraic equations a little deeper.]</p> <p><i>In interview prior to class T said the following: Predictions re: what will struggling kids struggle the most with</i></p> <p>T: "My challenges with the lesson today is many of the kids are still having a hard time finding the equation. They look at the table. They can tell it by words. They can say: Oh yeah, it's doing this, it's going by half. They can't make it into an equation. So that's the toughest part for them."</p> <p>Interviewer: "Do you have any sense of why? What's the hurdle there?"</p> <p>T: "They say that algebra is hard and as soon as they see algebraic equations they think it's going to be tough for them. Even if they know how to put it into words, if they've done it before. In their heads it's been put in that algebra's going to be hard, that numbers and letters don't mix together. And I'm trying to teach them that in actuality they do. And it can be easy and fun.</p>	<p><b>Teacher demonstrates some inclination to notice and analyze students' mathematical thinking</b></p> <p>Observed examples of T's skill/inclination to notice and analyze student mathematical thinking  <i>Running Record, Teacher 2, Class B (inclusion class)</i></p> <p>Notices that in <math>(x \text{ squared}) (x) (x \text{ cubed}) = (x \text{ to the sixth})</math>, the unwritten exponent in <math>x</math> to the first power can be problematic.</p>

TEACHER 1	TEACHER 2
Enacted lessons stay close to CMP lessons as written	Enacted lessons involve significant mathematical and pedagogical adjustments from CMP
<p><b>Student’s focus on mathematical understanding</b></p> <p>Describe today’s assignment – how you were thinking about it and how you were doing it?</p> <p><i>Student interview, student of Teacher 1</i></p> <p>“4.1. We were doing powers and exponential and we were, this was earlier, and we were doing tables, and. At first for problem c for doing the equation I had problems. At first I thought it was to multiply but we’re doing decay and I had to learn that we have to divide it. Because at first I was doing negative 2, negative 4, negative 6, but then I knew that we just had to keep dividing by 2. To 0.5, .025.”</p> <p><b>What did teacher want you to understand?</b></p> <p>“I think she wanted us to learn different ways to be doing things. Like to know that there’s not just like one thing to do. That there’s like multiple ways to figure out problems. That’s why we do like charts and graphs and tables and charts.”</p>	<p><b>Student’s focus on mathematical procedures</b></p> <p>Explain today’s assignment and what do you think T wanted you to understand?</p> <p><i>Student interview, student of Teacher 2</i></p> <p>“[T] taught us a new rule called “product of power.” And he combined 2 rules together, power of power and power of product. So [T] wanted us to, um, combine exponents and bases, if bases were the same you combine them, and distribute the exponents if the base didn’t have one. So that was pretty much what we did.”</p> <p><b>How did you solve it – especially number 9</b></p> <p>“First you . . . I wrote the thing on my paper, like, over again. And I did the basic steps like, um, first we distribute the exponents to the base and if one of the base already had an exponent you combined it and you add it to it so it made it into one. And then we, if we – some of the bases didn’t have a value – it was just like a letter like <math>x</math> or <math>y</math> . . . and then I just simplified it, and I solved it, but if it didn’t have a value to the base, I couldn’t solve it.”</p> <p><b>Today [your teacher] asked a question: rather get \$10,000 right now or a penny doubled each day for 30 days. What did you think of that question?</b></p> <p>Student: “Doubled it. . . . (with some enthusiasm in his voice) Cause I watched something, it was a story about, it was like a, they explained, like he would rather get \$100 or doubled it? So the little kid told him a story, in China there was this king. He was really greedy. And all the poor people wanted food. So the little kid took a checkerboard, so each square he put a rice and every time he would double it, so it came out to be, um, he always doubled it every day, so it came out to be like tons and tons of rice. And there was enough rice to cover the earth, so he’d rather get doubled it.”</p> <p>Interviewer: “Do you see any connection between that problem that [T] posed to your class and the work that you did today?”</p> <p>Student: “Mmmm . . . (pause) . . . No. . . . Oh yeah, just when the exponent, the base, like powers, you doubled it.”</p>

TEACHER 1	TEACHER 2
<p>Enacted lessons stay close to CMP lessons as written</p>	<p>Enacted lessons involve significant mathematical and pedagogical adjustments from CMP</p>
<p><b>Student’s interesting math example comes from school day</b></p> <p>Learned something interesting in math</p> <p>“That would have to be today. I never heard of this before. It’s um ... 4 digit ... (looks at paper) 4 number cycle. That’s like if you look at a pattern and it has a certain pattern like this one right here, it’s like 2, 4, 8, 6 in like an exponential.”</p>	<p><b>Student’s interesting math example comes from outside of school</b></p> <p>Learned something new and exciting in math</p> <p>“When my mom went to a restaurant, and the waitress, my mom wanted to give her a tip, and so that day I learned how to do the tip, like the tax ... so my mom didn’t know how to do it, so I taught her, and she gave her the right amount of money.”</p>
<p><b>Student enjoys math</b></p> <p>How interesting is the math you have in school?</p> <p>“It’s really interesting. I love math. I’m not always good at it, but I like to learn different things.”</p> <p>Do you ever make it more challenging?</p> <p>“Yesterday, I thought I had the right answer but then it turns out my friend did so we kind of debated.”</p>	<p><b>Student enjoys math</b></p> <p>How interesting is math in school?</p> <p>“I like how I have to think really hard and I have to figure it out.”</p>
	<p><b>Student describes “hands-on” math that student would like more of</b></p> <p>Anything you’d like to tell the team about how mathematics could be more interesting or easier to understand</p> <p>(S answers immediately and with some enthusiasm)          “If we did like more hands-on things.”</p> <p>Interviewer: “More hands-on? Do you ever use manipulatives or materials to solve problems?”</p> <p>Interviewer: “No” (by tone of voice it sounds like the student answers with shake of head or other inaudible signal of “no,” not like the interviewer is feeding answer.)</p> <p>S: “We did an experiment like before Christmas.”</p> <p>Interviewer: “Mm hmm. And what materials did you use?”</p> <p>S: “We used pennies. We used books. And we used the paper to make a bridge. We made a bridge. How much pennies could it go and so every time it collapsed, we like doubled it, the paper.”</p> <p>Interviewer: “And that was a project you did in groups? You worked in groups?”</p> <p>S: “Mm hmm.”</p>

TEACHER 1	TEACHER 2
Enacted lessons stay close to CMP lessons as written	Enacted lessons involve significant mathematical and pedagogical adjustments from CMP
	<p><b>Student offers story that makes clear that this year’s teacher has offered him access to mathematics in important ways</b></p> <p>Have you ever needed additional help [in] other years?</p> <p>S: “Yeah.”</p> <p>Interviewer: “Like did you need it in 7th grade?”</p> <p>S: “Mm hmm. A lot.”</p> <p>Interviewer: “A lot in 7th grade?”</p> <p>S: “I didn’t understand nothin’.”</p> <p>Interviewer: “You didn’t understand anything?”</p> <p>S: “He didn’t explain it, like, . . . he just gave us the work, that we didn’t even do. . . . We hadn’t even seen before and we had to do it. And I like almost failed. I had like a 70 for the year.”</p> <p>Interviewer: “So what did you do? If you didn’t understand, what did you do to catch up?”</p> <p>S: “Yeah, nothing.”</p> <p><b>Last year (7th grade) when struggling, did you have access to enough help outside of class to help you catch up?</b></p> <p>S: “My sister didn’t even know what was . . . ’cause she forgot most of the stuff what we did last year, and she, she forgot. And my dad didn’t know how to do it too, so I had to guess most of the time.”</p> <p>Interviewer: “Tell me. I asked you this question in class. I said ‘do you like math’ and you told me ‘this is my favorite class’. Was math your favorite class last year?”</p> <p>S: (quietly) “No.”</p>



### **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.

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