

# RETHINKING HIGH SCHOOL

.....  
supporting all students  
to be college-ready in math

A study by **WestEd**  for the  
Bill & Melinda Gates Foundation



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supporting all students to be college-ready in math

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$$dx = x + c$$

$$m = \frac{y^2 - y^1}{x^2 - x^1}$$

$$(x-2)^2 + [y - (-3)]^2 = 4^2$$

*In mathematics classes across the country, many students identify themselves as being in one of two camps: those who can do math and those who can't. Such labels may be assumed by the students themselves or unconsciously assigned to them by the adults in their lives based on students' math achievement. Whatever its source, the can't label may be a costly one.*

Students who do not take and pass a rigorous math sequence in high school – generally, Algebra I, Geometry, and Algebra II – are ineligible for admission to many four-year colleges and universities.<sup>2</sup> With almost two-thirds of future jobs expected to require college-level math skills,<sup>3</sup> these students are not just missing out on important academic opportunities, they may also be closed out of significant economic opportunities.

#### HIGH SCHOOL STUDENTS FIND UNEQUAL ACCESS AND SUPPORT IN MATH

Ensuring that students can confidently perform as successful mathematicians is a process that starts on day one of the K–12 education experience. By the time students reach high school, they must be ready to jump into college-preparatory math courses. Yet many start the ninth grade unprepared to succeed in such classes. This is especially true for our nation's most underserved students, who often begin high school far behind in math.<sup>4</sup> Making up this lost ground requires intensive remediation and other support, which many schools are unable to offer.<sup>5</sup>

Yet, even when students are ready for college preparatory courses, there is no guarantee their high school will offer the full array of math courses required for college admissions. One prominent study about factors contributing to academic success found a correlation between the higher-level math courses available at a community's high school and the income level in that community. The researchers found, for example, that only 44 percent of high schools serving high-poverty communities offer Calculus. In comparison, among those schools serving the nation's wealthiest communities, 72 percent offer Calculus.<sup>6</sup>

And even when schools do offer a full range of rigorous math courses, not all students are aware of which ones are required for college admission. In some states, students can meet the math requirements for high school graduation yet still not have met the math requirement for admissions to the state's institutions of higher education. California students, for example, must take two years of math for a high school diploma,<sup>7</sup> while the state-supported university systems –

California State University (CSU) and University of California (UC) – require, *at a minimum*, that students successfully complete three years of math.<sup>8</sup>

### THE URGENT NEED TO IMPROVE MATHEMATICS EDUCATION

The lack of universally high-quality math education across the nation's K–12 schools has resulted in disappointing achievement overall. On the National Assessment of Education Progress (NAEP), which is considered the only nationally representative assessment of what students know and can do in various subjects, more than 75 percent of high school seniors taking the exam in 2005 scored below proficient in mathematics.<sup>9</sup> Such disappointing results are likely to remain the norm until we can ensure that all high school students have the opportunity – and are encouraged – to take rigorous college-preparatory math courses and that they receive the high-quality instruction and support necessary to be successful in these classes.

While research has identified some key elements of a strong mathematics program, it is helpful to understand what these elements might look like in practice. To that end, this report, the latest in the *Rethinking High School* series, introduces three of the key program elements identified in the research and three schools – all supported in part by the Bill & Melinda Gates Foundation – that show what these elements look like when taken to heart by a committed staff.

The next section of this report presents each element and provides a brief introduction to the schools. A subsequent section then profiles each school in greater depth, providing a context and more detail about how the particular element is being implemented.

### FOUNDATIONS FOR SUCCESS: ELEMENTS OF A STRONG MATH PROGRAM THAT SERVES *ALL* STUDENTS

The program elements identified by the research and explored in this report are:

- ✦ Offering high-level math courses and supports<sup>10</sup>
- ✦ Continually improving teachers' skills and math content knowledge<sup>11</sup>
- ✦ Using student information to drive instruction<sup>12</sup>

#### *Offering high-level math courses and supports*

Many states have minimal math standards, but schools and districts can choose to go beyond those standards. The math coursework a school or district offers is by far the most concrete piece of evidence of its academic plans or aspirations for its students. A recent U.S. Department of Education study found that access to academically challenging coursework in high school significantly increased the likelihood of a student successfully completing a bachelor's degree.<sup>13</sup> According to the report, access to and enrollment in challenging courses had a greater impact than any other factor, including income level and parents' level of education.<sup>14</sup>

#### *Continually improving teachers' skills and math content knowledge*

A large body of research makes clear that effectiveness in teaching mathematics requires a combination of strong teaching skills and solid knowledge of the subject matter of mathematics.<sup>15</sup> Teaching higher-level math to high-need students is uniquely

challenging because many of these students begin high school several years below grade level.<sup>16</sup> Making matters worse, the students who are the most behind often encounter the least-qualified teachers.<sup>17</sup> Schools can try to address this shortcoming by hiring more highly qualified teachers. But often schools have the most impact on teacher quality by providing those already on their staff with support and ongoing opportunities for professional learning. To effectively teach math, all teachers must develop and maintain skills that enable them to help students understand the complex concepts that underpin mathematical formulas and computation. Because content knowledge is particularly important for teaching math,<sup>18,19</sup> teachers must have opportunities throughout their careers to hone their own understanding of the subject.

### *Using student information to drive instruction*

In recent years, the attention that policymakers and the public have given to assessment has focused mostly on high-stakes assessments – those used to make high-stakes decisions, such as determining whether to sanction or reward a district or determining whether a student graduates from high school. Many of these tests are important in keeping schools, districts, and states accountable for student performance. However, another important type of assessment, receiving far less attention, is formative assessment or benchmark assessment. When used properly, this kind of assessment can provide critical and timely information about what students understand and where they need help. Armed with this knowledge, teachers are better prepared to adjust their instruction, keep students on track, and help them meet learning goals.



## THE SCHOOLS


Each of the schools featured in this report has adopted all three of the identified program elements. But a close look reveals that each school has tended to implement one particular element so carefully and fully that it could be considered a foundation of the math program's success.

**Interlake High School** in Bellevue, Washington, provides a strong example of a school embracing and implementing a rigorous curriculum and offering access to additional courses during each phase of students' academic careers, resulting in high academic achievement. In 1997, Interlake High School was considered the lowest-performing high school in the district. In a bold move to break this pattern, Interlake adopted an academically rigorous curriculum to bolster expectations, and the school began to provide the academic support students needed to meet these expectations. In addition, Interlake adopted the International Baccalaureate (IB) degree program and increased its math offerings in the Advanced Placement (AP) program. Over the past few years the percentage of students passing the state's math assessment has jumped from only 49 percent in 2003 to 73 percent in 2006 (see Table 1 for details). Interlake's collective belief that all students are able to achieve at high levels in mathematics is evidenced not only by course enrollment and test scores but also by the multiple supports in place to assist students who need extra help or would benefit from enrichment courses.

**Granby High School** in Norfolk, Virginia, is an example of a school with a deep culture of continuous learning for its entire staff. Granby offers various opportunities to learn and grow as a professional – all connected to the end goal of improved student learning. Ten years ago, fewer than one in five Granby students passed Algebra I, and only one in four passed Algebra II. By 2006–07, the pass rates for Algebra I and II had increased dramatically to 84 percent and 90 percent, respectively.<sup>20</sup> Granby High School offers a prime example of a school with a powerful approach to professional development that provides teachers with opportunities for ongoing learning. The school's purposeful teacher education is directly focused on instructional practice and supports achievement for all students.



**Fenway High School** in Boston, Massachusetts, was created as a program for at-risk students. Although the majority of its students begin high school performing below grade level, Fenway staff set their sights high, and the school has become one of the better-performing high schools in the district. The school has achieved success in large part by making good use of formative assessment and other means of pinpointing and monitoring students' needs, then adjusting instruction accordingly. Students keep portfolios and develop exhibitions that demonstrate understanding, for example, and teachers draw on continuous conversations with students to help guide math instruction. Math teachers work collaboratively to keep track of student learning and to improve instruction to ensure that all students meet the state requirement for math achievement as well as the school's higher standard of passing four years of math. In 2006, 91 percent of the school's tenth graders passed the state's math exam.<sup>21</sup> On average, approximately one-third of Fenway's seniors take college-level math classes at Emmanuel College and receive college credits.

A stack of several algebra textbooks, with the title 'ALGEBRA 2' visible on the spines. The books are stacked in a slightly irregular manner, with some pages visible at the edges.

*To effectively teach  
math, all teachers  
must develop and  
maintain skills that  
enable them to help  
students understand*

*the complex concepts  
that underpin  
mathematical formulas  
and computation.*



# Interlake High School

BELLEVUE, WASHINGTON

*Ensuring that all students reach their highest potential in math*

*Over the past few years, Washington State's Bellevue School District, serving over 16,000 students, has earned national attention for exceptional student achievement. Since 2003, the district's high schools have been recognized by Newsweek as being among the highest-ranking schools in the country.<sup>22,23</sup> The district's standards, most notably in math, have always been high, exceeding those required by the state. Recently, the Bellevue School District set its sights even higher by implementing an academic program with internationally agreed upon standards.*

Only a decade ago, Interlake High School was the lowest-performing school in the Bellevue district. As Bellevue is an open enrollment district, Interlake parents and community members knew they needed an academically rigorous program to turn the school's performance around and draw students to the school. In 1997, Interlake implemented the prestigious International Baccalaureate (IB) Degree program and in 2003 added the Advanced Placement program. Together, these two programs are having an increasingly positive influence on student achievement. Over the past four years, Interlake has improved the performance of its tenth grade students on the state's exam, the Wash-

2006-07 School Profile<sup>24</sup>

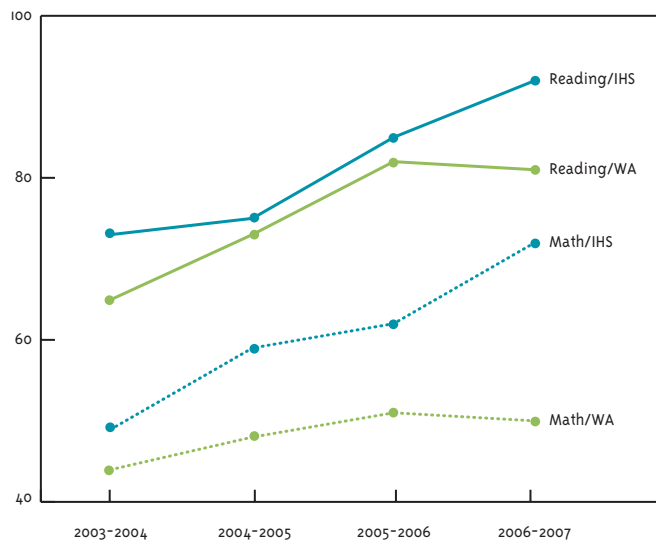
Black	4%	Enrollment	918
Asian	23%	Grades served	9-12
Hispanic	12%	Free/reduced lunch	24%
White	57%	Graduation rate	80%
		Did school make AYP?	Yes

*"At Interlake, we believe every kid is a math student."*

*- Sharon Collins, Principal  
Interlake High School*

ington Assessment of Student Learning (WASL), outperforming the state average. In 2003–04, less than half (49 percent) of Interlake’s students scored at proficient or above in math while in 2006–07, almost three fourths (73 percent) scored at proficient or above (see Table 1 for details).

**TABLE 1. STUDENTS SCORING PROFICIENT OR ADVANCED ON THE WASL\* (READING AND MATH), INTERLAKE HIGH SCHOOL (IHS) VS. WASHINGTON STATE (WA) 2003–2007<sup>25</sup>**



\* Washington Assessment of Student Learning – tenth grade level.

## COLLEGE-PREPARATORY MATH COURSES FOR ALL STUDENTS

Access to challenging high school courses has more impact on the likelihood of a student successfully completing a bachelor’s degree than any other factor.<sup>26</sup> At Interlake High, the combination of its IB and AP programs provides students with a number of rigorous course options. Equally important is that these high-level courses are available to the entire student body. What’s more, the number of students participating in these courses has steadily increased over the years, as all students at Interlake are encouraged to take high-level classes, particularly in math, regardless of their past academic performance.

While recent studies have identified Algebra II as the “gatekeeper” for college entry, Interlake has set the bar even higher, with the goal that all students will successfully complete pre-Calculus prior to graduating. And whereas Washington State requires three years of math in high school, Interlake strongly encourages students to take four. Administrators report that such high expectations increase the odds not only of college entry but of college success. While school administrators recognize that not all students may choose to go on to college, they believe it’s important to prepare all students to be “college-ready.”

For the past two years, Interlake student scores in math on the SAT college entrance exam have been higher than the state and the nation (see Table 2 for details).

**TABLE 2. SAT SCORES<sup>27</sup>**

	Class of 2006			Class of 2007		
	National	State	IHS	National	State	IHS
Math	518	532	541	518	531	550
Verbal	503	527	519	502	526	538
Writing <sup>28</sup>	497	511	498	494	510	528

### FOUNDATION FOR SUCCESS: OFFERING HIGH-LEVEL MATH COURSES AND SUPPORTS

Interlake's principal and math chair point to the following three elements as critical to students' success in math:

- ☀ Making high-level math courses available to all students
- ☀ Encouraging students to take more challenging courses
- ☀ Providing supports to help students succeed

#### *Making high-level math courses available to all students*

**Inquiry-based approach.** Staff and administrators report that math at Interlake is more than just memorizing formulas and doing countless practice problems. Rather, the math curriculum is inquiry-based, so learning math is an interactive experience for students and staff. Teachers encourage students to question answers and processes, investigate alternative possibilities, and draw from their prior experiences to build on their knowledge. Interlake staff believe math knowledge is critically important, regardless of a person's future education or career plans. As a result, the school focuses on building students' understanding of math concepts in order to apply that knowl-

edge in their future endeavors, be it higher education, the work force, or as responsible consumers.

**A variety of course options.** Recognizing that students come in with a variety of skill sets and experiences, Interlake offers a wide range of high-level course options to increase students' chances for math success. Over the past ten years, Interlake has expanded the number, levels, and variety of math courses available to students while eliminating the most basic courses. Interlake currently offers 16 different math courses—all at the honors level or above. Regardless of the course selected, each offers a high level of academic rigor.

Through the AP and IB programs, Interlake offers a range of high-level math courses to best serve each student's individual strengths as well as their future plans. In 2006–07, most Interlake seniors (74 percent) were enrolled in AP and IB coursework. An increasing number of these students are taking the AP and IB exams, from 227 in 2002 to 776 in 2007.<sup>29</sup> (See Tables 3 and 4 for details.) What's more impressive, 78 percent of students taking the AP Calculus exam received a passing score,<sup>30</sup> making them eligible for college credit.

*"We are trying to do the best that we can to get every student as high and as far in math – we enable our students. And we know students struggle in math, so we offer a variety of math courses best suited to their needs."*

*– Jami Mickelson, Interlake Math Coordinator*

**TABLE 3. STUDENTS PARTICIPATING IN AP AND IB COURSEWORK (2006–07)<sup>31</sup>**

Grade	
12th	74%
11th	61%
10th	58%
9th	12% <sup>32</sup>

**TABLE 4. NUMBER OF IB PLUS AP EXAMS TAKEN (2002–2007)<sup>33</sup>**

Year	
2002	227
2003	265
2004	666
2005	630
2006	686
2007	776

**District-defined curriculum.** Administrators and staff report that Bellevue's clearly defined math program has been critical to Interlake's math success. The district's curriculum is consistent K–12, so as soon as students enter grade school, they begin the path that will prepare them for high-level coursework in high school. The math program is the same across all 16 elementary and 6 middle schools, so when students enter Interlake in ninth grade, they are prepared for rigorous math courses that will bring them at least to the pre-Calculus level, regardless of what specific course options they choose as right for them.

### **Encouraging students to take more challenging courses**

**"Every student is a math student."** Research suggests that students who pass Calculus in high school, even if they retake Calculus in college, are more likely to graduate from college.<sup>34</sup> Interlake staff encourage *all* students – regardless of their past performance – to take advanced math courses to increase their chances of college success. When Interlake eliminated its more basic math courses, making all math classes honors level at a minimum, there was concern that some students would struggle. Historically, there



had always been a few lower-level math classes where students would often do just the minimum to get by. However, Jami Mickelson, Interlake's math coordinator, reported that when these students were combined into higher-level classes, they rose to the challenge. A majority of the students were achieving at a higher level in a more rigorous class. She believes that for many of the students, they had the skill, but needed an opportunity to experience rigorous coursework alongside their peers.

### *Providing supports to help students succeed*

For many students, success in high-level math courses requires more than just encouragement; they need support to increase their chances for success. Interlake offers a wide variety of support options—some beginning even before a student steps into the school. What makes Interlake's support unique is the number of programs and the variety of support. In addition, many of these programs not only focus on remediation but on acceleration as well.

## Student Story

In 1997, Anar immigrated to the United States from war-torn Azerbaijan as an 8-year-old who had never been to school. He received intense tutoring and support from the Bellevue school system and quickly caught up to his peers. Anar recalls that his fourth grade teacher mentioned college. Unfamiliar with the term, Anar asked his teacher what college was, and he remembers it was explained as the next step after high school. From that point on, he recalls, "There was no *if* college, it was always *when*." Once enrolled at Interlake, Anar took the necessary coursework, actively participated in sports and the community, and even assisted his family financially with a part-time job. Anar set his sights on the University of Washington, but needed help with his college application. College Corps Program volunteers assisted, including helping him write an essay that he recalls truly captured his experiences and hopes for his future. Anar used the knowledge gained from College Corps to help his mother apply to the University of Washington's nursing program. Both he and his mother were accepted and are now both proud college freshmen.

Anar Veliyev, Interlake Class of 2007

*"It prepared me mentally – I was not afraid entering my first day of high school. I was ready to go!"*

*- Josh Andreychuk, Interlake Class of 2010*

**"Starting Strong."** A program designed for incoming freshmen offers support for students who have struggled in their middle school classes. Staff work with middle school teachers to identify eighth grade students who could benefit from additional assistance and are offered the opportunity to come to Interlake the summer before their freshman year and get a head start on their classes.

**College Corps Program.** Selecting the right college and applying can be daunting tasks. To help, Interlake makes a College Corps Program available to all students and provides specially trained community volunteers to assist students with every aspect of the college process, including identifying and selecting the right school, preparing the application, and applying for available financial assistance.

**Tutorial High.** Where students can receive tutoring every day, in every subject, from 2:30–3:05 pm.

**Safe Study.** An after-school program where students can receive assistance for a variety of social or emotional issues that may have a negative impact on their school work, such as coping with stress, assistance with time management, or ideas to help them organizationally.

**Math Support.** A class that meets at the end of the school day and is required of students who are struggling academically, but also open for all who would like a little more assistance with math.



# What is the IB program?

The International Baccalaureate (IB) degree program is an academically rigorous, college preparatory program currently offered in 125 countries, including the United States.<sup>35</sup> Created in the 1960s to serve international students studying in other countries, IB has since become a challenging college preparatory program recognized by many elite universities around the world. Most U.S. high schools that offer the IB program use it to supplement their regular coursework, rather than as the only path students can take to graduation. Students can take their school's regular coursework, select some individual IB courses, or enroll in the IB diploma program, which has a rigorous set of requirements leading to an IB diploma. To earn an IB diploma, students must take classes in six subject areas (English, second language, individuals and society, sciences, math, and arts) and advanced classes in three of the fields. At the core of the program are three requirements: an extended essay, a Theory of Knowledge class, and a class entitled, Creativity, Action, and Service (CAS). CAS exposes students to activities that differ from the academic rigors of the program's other classes. For example, students participate in physical, creative, and social activities, including community service. The internationally created curriculum exposes students to a variety of perspectives, and the overall structure provides students who choose the IB program with a well-rounded education, preparing them for the rigors of postsecondary studies. Students earning an IB diploma also may qualify to earn college-level credits through IB courses.



# Granby High School

NORFOLK, VIRGINIA

*Working and learning together as a team*

*Granby High School is a large, urban, and diverse high school in Norfolk, Virginia, serving over 2,200 students. At Granby, students are enrolled in and passing high-level math classes including Calculus and Statistics. For the 2006–07 school year, 90 percent of Granby students passed Virginia's "Standards of Learning" end-of-course test in Algebra II – an impressive accomplishment for any school. However, Granby High School's math achievements were not always so promising.*

A decade earlier, few Granby students were taking advanced math courses, and of those who did, few passed. In 1998, less than 10 students were enrolled in Calculus, only 17 percent of the students enrolled in Algebra I passed the course, and only 25 percent enrolled in Algebra II passed. Granby High showed few indicators of academic excellence. At the time, the school was described as "a high school in distress with low academic achievement and a high incidence of behavioral problems."<sup>36</sup> Granby needed a change. School leaders recognized the need to push all of their students to reach higher levels in math, not only to be successful in postsecondary education, but to prepare for career opportunities as well.

2006-07 School Profile<sup>37,38</sup>

Black	49%	Enrollment	2287
White	38%	Grades served	9-12
Hispanic	4%	Graduation rate	82%
Asian/Pacific Islander	3%	Economically Disadvantaged	46%
Multiethnic	5%	Did school make AYP?	Yes

*"Everything is about professional development at Granby High School. There is no sitting on your laurels here."*

*— Beth Ellis, Math Department Chairperson, Granby High School*



Also in 1998, Norfolk Public Schools instituted a whole-system overhaul and dramatically increased the focus on professional development. Since then, Granby students have made tremendous growth, especially in higher-level math courses. More students are taking advanced math courses like Calculus and Algebra II than ever before and the pass rates for Algebra I and II increased dramatically to 84 percent and 90 percent, respectively.<sup>39</sup> Granby illustrates how a school with a culture of ongoing learning for teachers can promote learning for all students. Granby has taken significant strides to eliminate the achievement gap between white and Asian students and the increasing number of black and Hispanic students the school now serves.

#### **BUILDING STRONG MATH TEACHERS: A CHALLENGING AND IMPORTANT TASK**

The quality of the United States' math teacher workforce has gained recent attention as an area of concern, with the least qualified teachers often matched with the students who struggle the most.<sup>40</sup> Schools can impact teacher quality by giving their staff support and ongoing learning opportunities.

Granby High School offers a prime example of a school with a powerful approach to professional development that provides teachers with opportunities for ongoing learning where they can develop and maintain skills and content knowledge. The school's purposeful teacher education is directly focused on instructional practice and supports achievement for all students. Although no single action is the sole contributor to Granby's student achievement gains, the professional development systems within the school and organized by the district play a significant part in that success.

#### **FOUNDATION FOR SUCCESS: CONTINUALLY IMPROVING TEACHERS' SKILLS AND MATH CONTENT KNOWLEDGE**

Granby's principal, Ted Daughtrey, cites three critical elements as contributing to the school's success:

- ✦ Working and learning together as a team
- ✦ Providing teachers with varied and appropriate learning opportunities

*"I really like that feeling that, yes, we are all under a microscope. You have got to grow, and you have got to learn. You know you are going to stumble along the way, just as the students do, and I think that is a really healthy environment."*

*- Beth Ellis, Math Department Chairperson, Granby High School*

- ☀ Ensuring professional development impacts student achievement

### **Working and learning together as a team**

High expectations leave little room for missed teaching opportunities. Granby's teachers realized that they could no longer work as individuals but needed to work together as a team. Granby has instituted a culture of ongoing learning and support so new math staff members are not expected to learn on their own, but become part of the school's community of learners. Teachers are immersed in on-the-job learning – from their peers in collaborative teams and departments, from the analysis of student performance data, and from getting observation-based feedback from their school and district leaders.

In an ideal high school, teachers in the same academic department would come together on a regular basis to give and receive support aimed at enhancing their instructional practices. However, this is rarely the case. Instead, teachers tend to work in isolation, with little opportunity to collaborate and share or

learn new strategies. If professional change is discouraged within a department, its members can stagnate. But if change is encouraged, departments can become hotbeds of innovation and collaboration.<sup>41</sup> Such is the case in Granby's mathematics department. Here, professional learning is a constant, guided by teachers' real-world needs and, thus, targeted to their daily efforts to help all students succeed in mathematics.

### **Providing teachers with varied and appropriate learning opportunities**

Take any group of teachers in a given academic department and variety is the apt descriptor. In any group of teachers, even those working in the same academic area, one is likely to find a range of content knowledge, teaching experience, pedagogical skills, and beliefs about student learning. Add to such variables the fact that each teacher deals with a different group of students and it's clear that teachers' professional learning needs are likely to be equally varied. Granby recognizes that when it comes to professional development, one size does not fit all. So while

# Room for learning

When asked how professional development benefits veteran staff, Beth Ellis recounts her experience with one of the school's most experienced math teachers. Mrs. Taylor\* had been teaching at the school for years and had a reputation as one of the toughest math teachers. She generally spent most of her class periods writing problems on the board while students copied the problems at their desks. Her philosophy was that some students get it, others don't. Students in her classes had a high rate of failure, which supported her view.

In 2000, when Granby focused on professional development and exploring new teaching strategies, Mrs. Taylor was the school's biggest opponent. As Beth Ellis recalls, the school took the approach that "you cannot blame the student for not learning — you must look to yourself. Whenever there's a problem with a student, we ask, 'What can we do and what can the teacher do to make that child successful?'"

After several group meetings and targeted workshops focused on different approaches to teaching, Mrs. Taylor implemented some of the new ideas in her own classroom. She found that students who had struggled in the past were succeeding with some of the alternative strategies. There was more than one way to teach Algebra, and if a student didn't get it, she should try something else. Eventually, she saw her classes' grades improve and pass rates increase. Now Mrs. Taylor leads the Algebra department and is its biggest advocate for continuous improvement.

\* a pseudonym

the school emphasizes the need for all teachers, veterans and novices alike, to continue their professional growth, it takes a targeted approach to professional development, providing multiple and varied learning opportunities. While the opportunities and strategies listed below may exist in many schools, rarely do they exist at one site to create such a rich and supportive teacher learning community.

**New teacher guidance and support.** Teachers who are new to Granby participate in a range of learning opportunities designed to orient them to the school, district, the profession, and to bolster their subject matter knowledge. New teachers take part in a three-year teacher induction program that promotes their effectiveness and helps keep them in their positions — critical, since few states or districts have induction programs or requirements. They work closely with a coach who observes their teaching and gives detailed feedback and guidance.

**Subject-specific support teams.** In addition to meeting as a department, teachers meet in subject-specific teams that work together to plan units, develop lesson plans, and evaluate student data. Teams discuss student needs and develop extra academic supports as needed. Granby teachers report knowing each other's work intimately and are therefore able to hold each other accountable for teaching all of their students to a high standard.

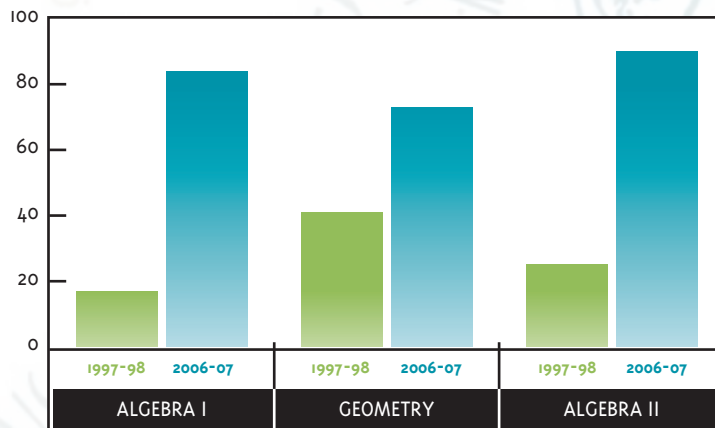
**Ongoing learning opportunities for experienced teachers.** Granby teachers also have access to a range of professional development experiences that complement what they are learning from departmental colleagues. Professional development leaders target learning opportunities to the needs of the students and to the individual staff members in need of the support.

### Ensuring professional development impacts student achievement

Student achievement is the bottom line of teacher professional development in an effective math program. Between 1998 and 2007, Granby students have made tremendous gains on Virginia's "Standards of Learning" end-of-course tests in math (see Table 6 for details). Equally impressive is the school's success in narrowing the achievement gap in math, as evidenced by a pass rate of 84 percent for black students in Algebra I versus 85 percent for white students in 2006–07.<sup>42</sup>

Granby's math department chairperson, Beth Ellis, reports, "We have so many students who, seven years ago, would have been taking general math and are now taking Algebra II." Based on what she sees in classroom observations and in student performance data, she identifies needs for increasing the math teachers' content knowledge and teaching skills. She then uses this up-close knowledge of Granby math teachers' professional learning needs to mobilize resources – within Granby and the district – to meet these needs. With her guidance, department meetings become defacto professional development sessions.

**TABLE 6. GRANBY PERFORMANCE DATA: PERCENT OF STUDENTS PASSING STANDARDS OF LEARNING END-OF-COURSE TEST<sup>43,44</sup>**







# Fenway High School

BOSTON, MASSACHUSETTS

*Helping students demonstrate their math knowledge*

*In recent years, the Boston Public School District, serving close to 58,000 students, has experienced an upward trend in student achievement. Reading and math scores for Boston's fourth and eighth grades improved at a faster rate than other large American cities on average, and faster than the national average.<sup>45</sup> In spite of these promising trends, the average district graduation rate for the 2005–06 school year was only 59 percent,<sup>46,47</sup> with one high school reporting a rate of only 27 percent. There remains an alarming disparity among Boston's high schools. Yet, learning from those that are beating the odds is of critical importance to supporting all schools to better prepare students for college, career, and life. One school to learn from is Fenway High School.*

Fenway High has a unique history. It was founded in 1983 as a program for students in at-risk situations who were failing in the more traditional high schools. Fenway became a pilot school in 1995 and is now open to all students (see sidebar for an overview of Boston's public high schools). In 2007, Fenway boasted an overall graduation rate of 83 percent and a higher graduation rate of 89 percent for both black and Hispanic students.<sup>48</sup> In addition, 91 percent of Fenway's tenth graders passed the math portion of the state's exam, the Mas-

2006-07 School Profile<sup>49</sup>

Black	44%	Enrollment	295
Hispanic	36%	Grades served	9-12
White	15%	Graduation rate (2005-06)	83%
Asian	2%	Low-income <sup>50</sup>	46%
Native American	0%	Did school make AYP?	Yes
Multi-Race, Non-Hispanic	0%		

*"Fenway is a strong advocate for assessing student performance in a variety of ways..."*

*- Fenway High School website*

*"Fenway is a strong advocate for assessing student performance in a variety of ways: classroom-based diagnostics, portfolios, exhibitions, standardized tests, work internships, integrated projects, and college acceptances (for seniors). Teachers write in-depth narrative reports on all students twice a year and give quarterly grades in-between the reports."*

*- From Fenway High School's website <sup>51</sup>*

sachusetts Comprehensive Assessment System (MCAS). Fenway has high expectations for its students and requires all *to take and pass* four years of math in order to graduate.

#### FOSTERING A DYNAMIC LEARNING ENVIRONMENT

Fenway has an innovative approach to student learning, most notably in math. Staff members work from the assumption that students who can demonstrate or explain math solutions, not just find the right answers, have a deeper understanding of math. Consequently, teachers shape instruction around multiple assessments that gauge students' understanding of critical math concepts. The school's approach helps students retain information and concepts that they can apply to other problems or scenarios they may face in other classes or later in life. It also provides the school with deeper insight into students' math understanding and achievement – information that ultimately is used to help improve learning.

#### FOUNDATION FOR SUCCESS: USING STUDENT INFORMATION TO DRIVE INSTRUCTION

Fenway's principal and math chair both agree that their continuous improvement in mathematics is supported by three key elements:

- ✦ Developing students' deep understanding of math
- ✦ Using formative assessments to gauge student performance
- ✦ Providing resources that both enhance and support students' math knowledge

#### *Developing students' deep understanding of math*

**Communicating math.** Because the ability to demonstrate or explain math knowledge is at the core of Fenway's math program, opportunities to communicate math concepts are critical. Walk into any math class and you will hear students and staff talking about math – their understanding of problems and concepts as well as their struggles. While performance on quizzes and exams

is vitally important, a student's ability to communicate mathematical understanding to others is considered equally important. Fenway's philosophy is that a student who can teach a concept to another person is more likely to truly understand that concept and therefore retain the information.

**Developing math knowledge and confidence.** Starting when students first enter Fenway as freshmen, they have opportunities to present their math ideas to an audience. Throughout their careers at Fenway, students are required to present high-level math problems – from a math fair during freshman year to exhibitions held annually. While presenting can be intimidating for some, over time, students develop a strong foundation in math and the confidence needed to be successful. Some of the opportunities to make math presentations are formal – in front of staff, parents, peers, and community members – but a majority are informal and imbedded in everyday interactions and conversations. Regardless of the setting, staff encourage students to discuss math with one another and with staff to help students develop their understanding of math as well as their skills as presenters – skills that can benefit them regardless of their future aspirations.

Staff point to the skills that this process engenders – a culture of engaged learners who can articulate their beliefs and knowledge. Students are continuously discussing and communicating their understanding and sharing their learnings with peers and teachers, creating a dynamic learning environment. Students work in groups and support and challenge each other to clearly articulate their knowledge. Jonathan Spath, Fenway's math chair, reported that when a student is struggling with a math problem,

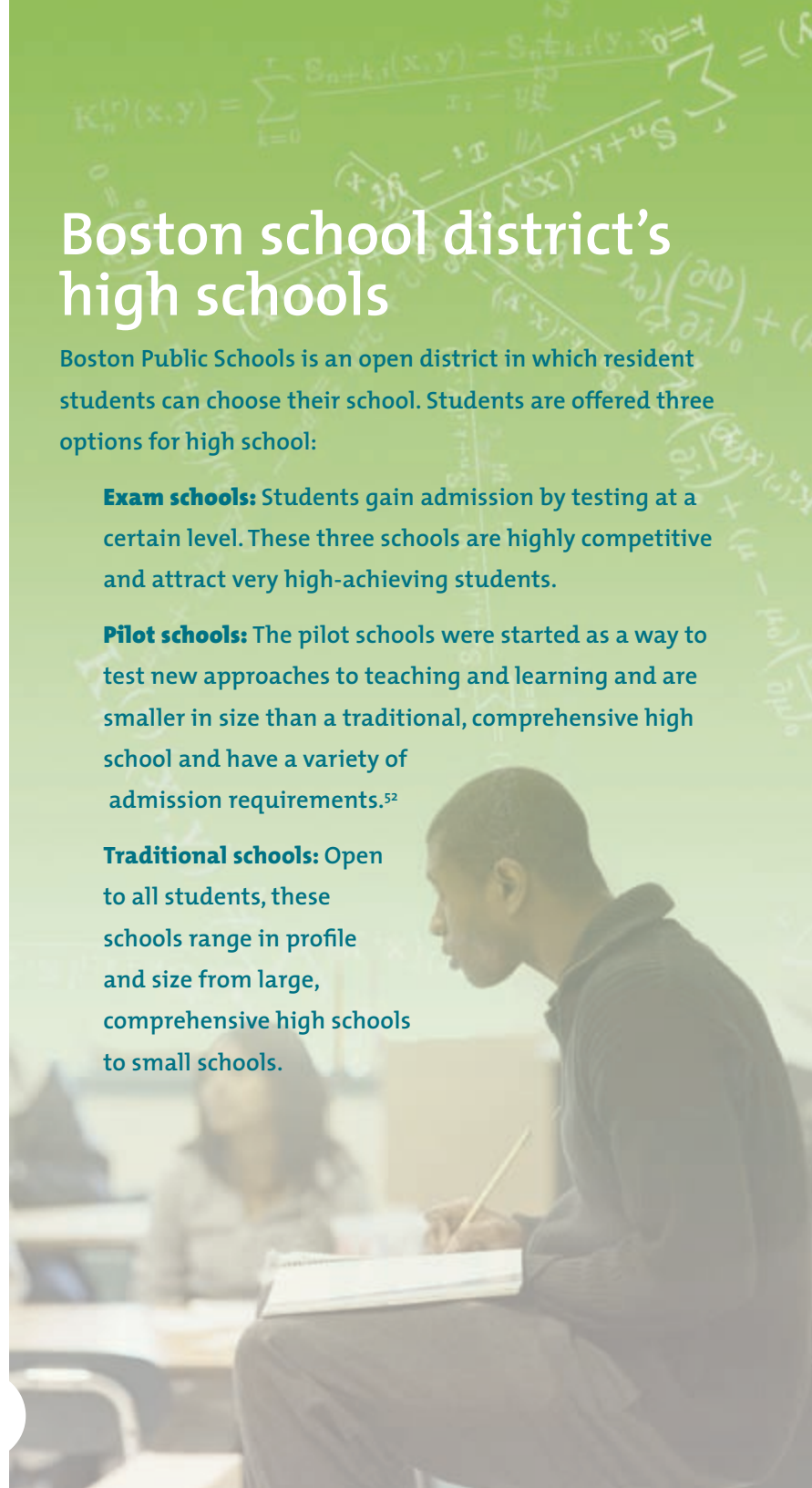
## Boston school district's high schools

Boston Public Schools is an open district in which resident students can choose their school. Students are offered three options for high school:

**Exam schools:** Students gain admission by testing at a certain level. These three schools are highly competitive and attract very high-achieving students.

**Pilot schools:** The pilot schools were started as a way to test new approaches to teaching and learning and are smaller in size than a traditional, comprehensive high school and have a variety of admission requirements.<sup>52</sup>

**Traditional schools:** Open to all students, these schools range in profile and size from large, comprehensive high schools to small schools.





classmates are just as likely as the teacher to jump in and offer assistance in the form of an alternative explanation. Each of these interactions – from discussions to presentations to group work – provide critical student information, which helps Jonathan assess student understanding and performance.

### *Using formative assessments to gauge student performance*

**Formative assessments.** Fenway math staff rely on formative assessments to inform their teaching practice. As students are always discussing and communicating their understanding of math concepts, teachers use these conversations to gather continuous and timely information about students' comprehension, gauging where they may need assistance. In addition, teachers grade students and provide feedback on more formal assessments, such as portfolios and exhibitions.

**Authentic assessments.** In addition to emphasizing presentation skills, teachers require students to keep portfolios of their math work. Portfolios provide valuable indicators of students' under-

standing and growth. After each unit, every student must submit a portfolio, which is usually a collection of the student's best work and a two- to four-page write-up addressing specific competencies. Students are required to choose at least three competencies or skills to write about, using examples from their work to demonstrate understanding. A valuable authentic assessment, these portfolios are key to building on a student's knowledge of math.

Research suggests that students whose teachers use information gleaned from these kinds of assessments (both formal and informal) to inform their instruction often fare better on high-stakes assessments as compared to students whose instruction is more aligned to "teaching to the test."<sup>53</sup> At Fenway, with the various measures the school has in place to assess student learning along the way, there has been a steady increase in students' performance on the math portion of the statewide MCAS test over the past four years.

**Student performance.** Since 2004, Fenway students' performance on the math portion of MCAS has improved considerably – more students are performing at the two highest levels ("proficient"

and “advanced”), and fewer are scoring in the bottom two levels (“needs improvement” and “failing”). In 2004, only 35 percent of students were scoring in the top two levels, whereas in 2007, 70 percent were in these two levels (see Table 7). Fenway also has other signs of student success – attendance, promotion, graduation, and college placement rates suggest Fenway’s approach is working well for students. In fact, in 2005–06, the graduation rate was 83 percent, higher than both the district (60 percent) and the state (80 percent).<sup>54</sup>

In spite of these positive signs, Fenway students still struggle to perform well on college entrance exams. Student scores on the SAT college entrance exam in 2006 ranked low in comparison to other Massachusetts schools.<sup>55,56</sup> Fenway staff members are reviewing their math coursework in hopes of better aligning it to this important measure.

**TABLE 7. GRADE 10 MATHEMATICS PERFORMANCE, 2004–2007, BY PERCENT<sup>57</sup>**

Level	2004	2005	2006	2007
Advanced	10	13	28	30
Proficient	25	42	28	40
Needs Improvement	57	39	28	21
Failing	8	6	15	9

*Providing resources that both enhance and support students’ math knowledge*

Fenway’s efforts to improve student learning depend on teachers not only assessing students in the many ways described above, but also *using* that information to target assistance for students who need it. The school provides multiple

## What does a dynamic classroom look like?

When asked to describe a typical math class at Fenway, Jonathan Spath, the math chair, uses the term “dynamic.” Students are encouraged to work together and communicate with one another on their math assignments. He says it’s common to walk over to a group’s table, where desks are pushed together, and hear students discussing concepts with one another. If a student is struggling to comprehend, others jump in to either explain or take another approach. Even though it is a group discussion, Spath is able to gauge each student’s understanding based on their comments and interjections. As a result, he can target assistance that any individual student may need.

opportunities for remediation and acceleration to increase students' math knowledge.

Fenway's innovative approach to assessment requires constant teacher observation, communication, and intervention. The school's math teachers regularly engage in detailed conversations about math during weekly two-hour meetings. In these meetings, teachers discuss the needs of individual students and determine the best supports to meet each student's goals. Some of the support available to students includes after-school, one-on-one sessions with math staff as well as access to the school's Learning Center, which provides targeted support during the school day and is open to all students after school.

In addition to remedial supports, Fenway offers resources to accelerate students' learning so they can excel in higher-level math classes. Fenway has a partnership with Emmanuel College, a liberal arts and sciences college, where students can take college-level math courses *and* earn college credit. On average, approximately one-third of Fenway's seniors have taken advantage of this opportunity to enroll in college-level math classes at Emmanuel. Access to this caliber of courses is of particular importance, especially for underserved students, given the relationship between taking rigorous math courses in high school and being successful later in college.



# Endnotes

- 1 Since there is not a standard math requirement across all four-year colleges, we use the term “rigorous math sequence” to imply a course pattern that builds on itself and is not considered remedial. Courses in this sequence generally include Algebra I, Geometry, and Algebra II.
- 2 Many colleges require applicants to have taken at least three years of math including Algebra I, Geometry, and Algebra II. See, for example, *State notes: College ready standards*, Education Commission of the States, <http://mb2.ecs.org/reports/Report.aspx?id=743>, collected November 26, 2007.
- 3 Carnevale, A.P., & Desrochers, D.M. (2003). The democratization of mathematics. In B.L. Madison & L.A. Steen (Eds.), *Quantitative literacy: Why numeracy matters for schools and colleges* (pp. 21–31). Princeton, NJ: National Council on Education and the Disciplines.
- 4 Neild, R., & Balfanz, R. (2006). An extreme degree of difficulty: The educational demographics of urban neighborhood high schools. *Journal of Education for Students Placed at Risk*, 11(2), 123–141. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- 5 Ibid.
- 6 Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Washington, DC: U.S. Department of Education.
- 7 Including Algebra I.
- 8 Including Algebra I, II, and Geometry. Data for California is taken from the UC Counselor Conference 2007 and includes both the CSU system and the UC system. Combined, both systems enrolled over 580,400 undergraduate students in 2006.
- 9 Perie, M., Grigg, W.S., & Dion, G.S. (2005). *The Nation's Report Card: Mathematics 2005* (NCES 2006–453); U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.
- 10 For examples of studies reviewing high standards in math for all students, see: Spillane, J. (2004). *State standards, assessment, and accountability instruments in practice: Where the rubber meets the road*. Evanston, IL: Northwestern University, Institute for Policy Research. For support to students to meet these high standards, see, for example: Balfanz, R., McPartland, J.M., & Shaw, A. (2002). *Re-conceptualizing extra help for high school students in a high standards era*. Baltimore, MD: Center for Social Organization of Schools, Johns Hopkins University.
- 11 See, for example: Ball, D. (2003, February 6). *What mathematical knowledge is needed for teaching mathematics?* Remarks from the Secretary's Summit on Mathematics, U.S. Department of Education; Birman, B., Desimone, L., Porter, A., & Garet, M. (2000). Designing professional development that works. *Educational Leadership*, 57(8), 28–33.
- 12 See, for example: Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, 80(2), 139–148.
- 13 Adelman (2006).
- 14 Ibid.
- 15 See, for example: Ball, D. (1991). Teaching mathematics for understanding: What do teachers need to know about subject matter? In M. Kennedy (Ed.), *Teaching academic subjects to diverse learners* (pp. 63–83). New York: Teachers College Press; Hill, H., Rowan, B., & Ball, D. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42(2), 371–406.
- 16 Neild & Balfanz (2006).
- 17 Greenberg, E., Rhodes, D., Ye, X., & Stancavage, F. (2004, April). *Prepared to teach: Teacher preparation and student achievement in eighth-grade mathematics*. Washington, DC: AIR.

- 18 Ball, D. (1988). Research on teaching mathematics: Making subject matter knowledge part of the equation. In J. Brophy (Ed.), *Advances in research on teaching: Vol. 2. Teachers' subject matter knowledge and classroom instruction*. Greenwich, CT: JAI Press.
- 19 National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics* (p. 7). Reston, VA: NCTM.
- 20 Information from Virginia Department of Education, <https://p1pe.doe.virginia.gov/reportcard/>, collected November 26, 2007.
- 21 Information from Massachusetts Department of Education, <http://profiles.doe.mass.edu>, collected November 20, 2007.
- 22 No ranking available for 2004.
- 23 Bondy, H., Brillman, D., & Kaufman, B. (2006). America's top public high schools. *Newsweek*. Collected October 8, 2007.
- 24 Information from the Office of Superintendent of Public Instruction, *Washington State Report Card*, <http://reportcard.ospi.k12.wa.us/summary.aspx?year=2006-07>, collected October 1, 2007.
- 25 Ibid., collected October 10, 2007.
- 26 Adelman (2006).
- 27 Information from Bellevue School District, <http://www.bsd405.org/Default.aspx?tabid=505>, collected October 15, 2007.
- 28 Writing section of SAT introduced in 2006.
- 29 Bellevue School District (2007).
- 30 Defined as a 3 or higher on the AP exam or "passing" on the IB exam.
- 31 Bellevue School District (2007).
- 32 School year 2006-07 is the first year of a self-contained, gifted program at Interlake High School.
- 33 Bellevue School District (2007).
- 34 Adelman (2006).
- 35 Information from International Baccalaureate, <http://www.ibo.org/who/index.cfm>, collected October 3, 2007.
- 36 Information from Northwest Regional Educational Laboratory, *Schools Making Progress* series, Granby High School, <http://www.nwrel.org/scpd/sslc/descriptions/grnby/index.asp>, collected July 2, 2007.
- 37 R. Brown (personal communication, December 3, 2007).
- 38 Ibid. Data also provided by Norfolk Public Schools, collected November 28, 2007.
- 39 Information from Virginia Department of Education, <https://p1pe.doe.virginia.gov/reportcard/>, collected November 26, 2007.
- 40 Greenberg, Rhodes, Ye, & Stancavage (2004, April).
- 41 See, for example: Darling-Hammond, L. (1994, November). *The current status of teaching and teacher development in the United States*. New York: Teachers College, Columbia University; Darling-Hammond, L. (1996, March). The quiet revolution: Rethinking teacher development. *Educational Leadership*, 53(6), 4-10; McLaughlin, M.W., & Talbert, J.E. (1993). *Contexts that matter for teaching and learning*. Stanford, CA: Center for Research on the Context of Secondary School Teaching, Stanford University.
- 42 Information from Norfolk Public Schools, [http://cf.nps.k12.va.us/perform06/performhs/pr\\_hs06.cfm?DID=001](http://cf.nps.k12.va.us/perform06/performhs/pr_hs06.cfm?DID=001), collected November 26, 2007.
- 43 Information from Norfolk Public Schools, *Division performance report executive summary: 2004-05*, <http://www.nps.k12.va.us>, collected February 9, 2006.
- 44 Information from Norfolk Public Schools, [http://cf.nps.k12.va.us/perform06/performhs/pr\\_hs06.cfm?DID=001](http://cf.nps.k12.va.us/perform06/performhs/pr_hs06.cfm?DID=001), collected November 26, 2007.
- NOTE: Data for 2003-05 school years differs from data reported in *Division performance report executive summary*.



- 45 The National Assessment of Educational Progress. (2006). *The Nation's Report Card: Trial Urban District Assessment, mathematics 2005* (NCES 2006-457rev). Washington, DC: U.S. Department of Education, National Center for Education Statistics, Institute of Education Sciences.
- 46 This four-year graduation rate applies to students who started ninth grade in September of 2002 and graduated in June 2006. Students who did not graduate in the four-year time period are identified as "still in school!"
- 47 Information from Massachusetts Department of Education, <http://profiles.doe.mass.edu/>, collected November 26, 2007.
- 48 Ibid.
- 49 Information from Massachusetts Department of Education, <http://profiles.doe.mass.edu/home.asp?mode=so&view=all&mcasyear=2007&ot=560=1>, collected November 13, 2007.
- 50 Low income is an indication of whether a student meets any one of the following criteria: eligible for free or reduced price lunch, receives Transitional Aid to Families benefits, or eligible for food stamps.
- 51 Information from <http://fenway.boston.k12.ma.us/AboutFenway/Overview/Assessment.shtml>, collected November 13, 2007.
- 52 For more information on Boston's Pilot High Schools, see: *Strong results, high demand: A four-year study of Boston's Pilot high schools, executive summary* (2007, November). Boston: Center for Collaborative Education.
- 53 Atkin, J. M., & Coffey, J. (Eds.). (2003). *Everyday assessment in the science classroom*. Arlington, VA: National Science Teachers Association.
- 54 Massachusetts Department of Education (2005).
- 55 For example, in 2006, the average math score was 422 out of a possible 800, which ranked Fenway only 285 out of 336 schools.
- 56 Information from *The Boston Globe*, "2006 SAT scores for Massachusetts High Schools," <http://www.boston.com>, collected November 20, 2007.
- 57 Information from Massachusetts Department of Education, *2007 MCAS annual comparisons*, <http://profiles.doe.mass.edu>, collected November 20, 2007.

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Public and private organizations have joined together to invest billions of dollars to help identify barriers to college-readiness and strategies that help students succeed. Since 2000, the Bill & Melinda Gates Foundation has invested more than \$1.7 billion to improve more than 1,800 schools in 47 states and the District of Columbia. The Foundation and its partners are focused on increasing graduation and college-readiness rates by supporting the creation of new high-quality high schools and the transformation of existing low-performing high schools into more focused and effective learning environments. The Foundation's investments are aimed at creating a portfolio of innovative education options that serve a full spectrum of students' needs with the goal that every student is well prepared for success in college, career, and life regardless of their background or circumstance.

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