FALL 2008

OPPORTUNITY TO LEARN AUDIT: High School Science

RENNIE CENTER
for Education Research & Policy

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About Rennie Center for Education Research & Policy

The Rennie Center's mission is to develop a public agenda that informs and promotes significant improvement of public education in Massachusetts. Our work is motivated by a vision of an education system that creates the opportunity to educate every child to be successful in life, citizenship, employment and life-long learning. Applying nonpartisan, independent research, journalism and civic engagement, the Rennie Center is creating a civil space to foster thoughtful public discourse to inform and shape effective policy. For more information about the Rennie Center and our current work, visit www.renniecenter.org, or call 617.354.0002.

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INTRODUCTION

The Massachusetts economy is increasingly dependent on science, technology, engineering and math (STEM) related industries and occupations. As a result, a robust pipeline of students interested in and prepared for work in STEM fields is required to fill these positions. Yet, recent years have seen relatively flat student performance in STEM, a persistent achievement gap, high remediation rates at colleges and universities, and too few students majoring in STEM at the college level, given the Commonwealth's workforce needs.

As a result, Massachusetts has begun to invest significant effort in improving science education. The Board of Education's requirement that students pass one of the high school MCAS science assessments (biology, chemistry, introductory physics, or technology/engineering) to earn their high school diploma is spurring increased attention to science instruction. In addition, the Board of Education's adoption of a rigorous Massachusetts Core Curriculum with a recommended three units of lab-based high school science, and Governor Patrick's life sciences initiative, aimed at enhancing the fields of medicine and science, are all indications of renewed attention to and support for improvements in science education.

Yet, there is still much to be done to determine the state's role in better preparing students in science. If the state is to require that all students reach a minimum level of proficiency in science, then uncovering gaps in opportunities to learn and understanding how some schools succeed where others fail is crucial to formulating sound policy for improving science achievement.

This study represents a first step in examining whether students in high- and low-performing high schools receive equitable opportunities to learn science. Findings presented here are from a small sample of high schools (25 high-performing and 31 low-performing schools) and are based on interviews with science coordinators. Additional research is needed to provide a more complete picture of the disparities that exist in science instruction and how these disparities relate to student outcomes. However, the study findings suggest that there are gaps in the opportunities to learn science between high- and low-performing schools. Building on these findings, policy considerations for school and district leaders and state policymakers to consider are presented.

This report is the second in a two-part series that the Rennie Center for Education Research and Policy has produced on students' opportunities to learn science. This report examines opportunities at the high school level. The first report, issued in Spring 2008, highlighted opportunities at the elementary (K-5) level.

BACKGROUND AND CONTEXT

It is clear that citizens in today's society require deeper levels of scientific knowledge than ever before. Recent policy debates about global warming, stem cell research and renewable energy have brought into stark relief the need for all citizens to have sufficient knowledge of science. In addition, the current knowledge-based global economy is critically dependent on the availability of a workforce with strong scientific and technical knowledge. Many of the fastest growing jobs fueling the global economy require high levels of knowledge and skills in science, engineering, and technology. Yet, many of today's students lack the opportunities in science that will help them to become the robust workforce that the current economy needs. The 2007 National Academies of Science report, *Rising Above the Gathering Storm*, explained this in sobering terms: "The danger exists that Americans may not know enough about science, technology, or mathematics to significantly contribute to, or fully benefit from, the knowledge-based society that is already taking shape around us." Among the Academies' recommendations to federal policymakers was to increase America's talent pool by improving K-12 science education.

Seventy-six percent of Americans indicated that presidential candidates in the 2008 election should make improving science education a national priority, according to a Spring 2008 Harris Interactive survey of 1,304 U.S. adults. But only 26% believe that they themselves have a good understanding of science.[i] In 2007, the National Science Board issued a report that called attention to the state of science, technology, engineering, and mathematics (STEM) education in the United States. Although the United States has been a leader in innovation in science and technology, the report found that "the education system is failing to ensure that *all* American students receive the skills and knowledge for success in the 21st century workforce."[ii]

Indeed, results on the Trends in International Mathematics and Science Study (TIMSS) from 2003 demonstrated that 8th and 12th graders in the United States did comparatively worse than their counterparts in other industrialized countries.[iii] Between 2000 and 2006, American high school students dropped from 14th to 21st place among industrialized countries in science.[iv]

Despite these national deficits in the STEM disciplines, Massachusetts has emerged as a leader in science education. In 2005, Massachusetts tied seven other states in the nation for second place in eighth grade science on the National Assessment of Educational Progress (NAEP).[v] Massachusetts science standards have been rated an "A" by the Fordham Foundation in a 2006 survey[vi] of state standards, and the Commonwealth was the first to include technology and engineering in its rigorous standards.

However, there are serious concerns in Massachusetts regarding student mastery of a rigorous science sequence, disparities in student achievement among student sub-groups, and lack of student interest in pursuing STEM careers. The following are some of Massachusetts' primary challenges.

- **Few high school students demonstrate grade-level proficiency in the sciences.** Nearly half (45%) of the students in the class of 2010 did **not** take the high school MCAS science exam in 2008 which suggests they were unprepared for the assessment. Among those who took the test, the percent scoring at the proficient or advanced levels was high in some subject areas (82% in biology) and low in others (55% in chemistry, 68% in physics, 72% in technology/engineering).[vii]
- **Wide disparities exist in science achievement.** While 83% of students in the class of 2010 who took the high school MCAS science exam passed, only 67% of low-income students passed. Similarly, 89% of white students and 88% of Asian students scored proficient and above compared to only 64% of African American and 60% of Hispanic students.
- **High school students lack interest in pursuing STEM careers.** Thirty-six percent of high school juniors expressed an interest in STEM careers in 2006–07, but that estimate is well below the national average and percentages in competitive states. The number of students from Massachusetts colleges and universities studying science, technology, engineering and mathematics declined from 1993 to 2007, while the number rose nationally.[viii] This lack of interest is particularly worrisome given that STEM occu-

pations account for about 13% of the state's jobs and are expected to grow by over 18% in the next six years, totaling 80,000 new positions in STEM fields.[ix]

Data such as these have made it clear that the Commonwealth must do more to promote science learning among students at all grade levels. Recent developments such as the requirement that students pass one of the high school MCAS science assessments (biology, chemistry, introductory physics, or technology/engineering),[1] the adoption of a more rigorous Massachusetts Core Curriculum, with a recommended three units of lab-based high school science, and Governor Patrick's life sciences initiative, are indications of renewed attention to and support for improvements in science education. In addition, the state regularly collects and reports data on STEM education and achievement through the Massachusetts Statewide STEM Indicators Project. And most recently, the Patrick Administration's Readiness Report (released in June 2008) *Ready for 21st Century Success: The New Promise of Public Education*, includes establishing the *Readiness Science and Math Teaching Fellowship Program* to increase the Commonwealth's supply of qualified science and math teachers and a new program of differentiated pay for teachers in high demand disciplines, including science.

Even with these promising initiatives, there is still much work needed to ensure that all students are better prepared in science for the 21st century. The Commonwealth must do more to promote science learning among students at all grade levels. Prior research on science in Massachusetts focuses exclusively on state-level indicators, so it is not possible to explore the variation that exists between schools and districts in their approach to science instruction. The necessary next step for research on science education in Massachusetts, which this study seeks to address, involves collecting new data at the school and classroom levels.

1 Starting with the class of 2010, school districts must develop an Educational Proficiency Plan (EPP) for a student who does not score at 240 or above on the grade 10 ELA and Mathematics MCAS tests. The EPP requirement does not apply to students who do not score at least at the proficient level in Science and Technology/Engineering. However, students do have to score at least 220 (needs improvement) on a discipline-specific high school Science and Technology/Engineering MCAS test to earn a Competency Determination.

METHODOLOGY

This study is the second in a two-part project that examines students' opportunities to learn science. The first report (published in Spring 2008) focused on science education in elementary schools (K-5) across Massachusetts. This report focuses on opportunities to learn science at the high school level.

Two main questions lie at the foundation of this research:

- Do students in a diverse set of Massachusetts high schools receive equitable opportunities to learn and succeed at science?
- What strategies and practices are used in high-performing schools with large populations of low-income, minority and special education students?

Sample

A total of 164 high schools (out of 366 Massachusetts high schools) were selected for this study, of which 34% participated (n=56). Schools were selected based on two criteria: (1) the percent of low-income students and (2) performance on the high school MCAS science assessment. Schools were first grouped into the following three categories by the proportion of students eligible for free or reduced price lunch.

- *Predominantly low-income:* Two-thirds or more of students eligible
- *Partial low-income:* More than one-third but less than two-thirds of students eligible
- *Minimal low-income:* One-third or fewer of students eligible

Within each income group, schools were classified[2] as high- or low-performing based on results of the 2006-2007 high school MCAS science assessment. The Composite Performance Index (CPI),[3] a 100-point index, was used for the classification. CPIs are generated separately for biology, chemistry, physics and technology/engineering so the CPI associated with the science test that had the greatest number of test takers at each participating high school was used, which in our sample accounted for about 73% of test takers, on average. The following criteria were used to determine performance level:

- Low-performing: CPI less than 70
- High-performing: CPI of 80 or greater[4]

A total of 25 high-performing and 31 low-performing schools participated in the study. As shown in Table 1, schools from each income group are represented in each performance category. However, it is important to note that a majority of participating schools in the low-performing category are predominantly low-income schools and a majority of the schools in the high-performing category are minimal low-income schools.

Of the 25 participating high-performing schools, three schools were selected as case study schools. Schools were selected based on two criteria: (1) 60% or more of students eligible for free or reduced price lunch and (2) CPI of 70 or greater on the high school MCAS science assessment taken by the most students.[5]

2 Classifications were based on the six performance rating categories used by the Massachusetts Department of Elementary and Secondary Education. The categories Very High (CPI of 90 to 100) and High (CPI of 80 to 89.9) were combined to create the High-performing group. The categories Low (CPI of 60 to 69.9), Very Low (CPI of 40 to 59.9) and Critically Low (CPI of 0 to 39.9) were combined to create the Low-performing group. The Moderate performing group (CPI of 70 to 79.9) was excluded from the study with the exception noted below.

3 Massachusetts uses the Composite Performance Index (CPI), a 100-point index that assigns 100, 75, 50, 25, or 0 points to each student participating in MCAS and MCAS-Alternative tests based on their performance. The total points assigned to each student are added together and the sum is divided by the total number of students assessed. The result is a number between 0 and 100, which constitutes a district, school or group's CPI for that subject and student group. CPIs are generated separately for ELA, mathematics, biology, chemistry, physics and technology/engineering, and at all levels–state, district, school, and student group.

4 Only one predominantly low-income school achieved a CPI of 80 or greater. As a result, two of the top performing predominantly low-income schools were included in this category even though their CPIs were in the moderate (70 to 79.9) range.

5 CPIs are generated separately for biology, chemistry, physics and technology/engineering, so the CPI associated with the science test that had the greatest number of test takers in each high school in our sample was used.

Table 1. Number of schools in each group

Performance	Income	# of schools in sample	# of completed interviews
High	Predominantly low-income	3	3
	Partial low-income	3	3
	Minimal low-income	52	19
	Total	58	25
Low	Predominantly low-income	33	14
	Partial low-income	54	9
	Minimal low-income	19	8
	Total	106	31

All fifty-six schools, including the three case study schools, were included in the analysis and the findings are presented in this report.

Data Collection

Each school's science coordinator was interviewed for the study by telephone. The areas covered during the interview and some of the specific interview questions are shown below. The frame of reference for the interview was the 2007-2008 school year. *See Appendix A for the complete interview guide.*

- **Staffing.** How many 9th and 10th grade science teachers are in the school? How many are categorized as highly qualified? Were there any courses taught by teachers who are not certified in that science discipline?
- **Resources.** What types of resources/equipment are available for use by students? What is the school's annual budget for science materials?
- **School Policies.** What are the school's graduation requirements in science? What factors are taken into consideration when making decisions about where to place 9th graders in science courses?
- **Courses.** What science courses are offered? How many students are taking each course? How many elective courses in science are offered?
- **Student Support.** What support is available for students who need extra help in science?
- **Enrichment Opportunities.** What science clubs or extracurricular science activities does the school offer? With which science organizations does the school partner?

This section provides descriptive information about the schools that participated in this study. While schools from across the Commonwealth are represented, a majority of the high-performing schools (n=16) and slightly less than half (n=14) of the low-performing schools are located in greater Boston. All three of the case study schools are located in the greater Boston area.

In addition to traditional high schools (n=34), alternative (n=3), vocational/technical (n=7), charter (n=5), pilot[6] (n=5) and redesigned[7] (n=2) high schools are represented in this study.

6 Pilot Schools are public schools that have autonomy over budget, staffing, governance, curriculum/assessment, and the school calendar.

7 Redesigned schools are public schools that have reorganized into academies or smaller learning communities; they are sometimes described as a school-within-a-school.

DESCRIPTION OF PARTICIPATING SCHOOLS

Demographic Information

Table 2 shows the average percentage of students in low-performing, high-performing and case study schools that fall into each racial/ethnic group and other subgroups. On average, low-performing schools are more diverse with much higher percentages of African American and Hispanic students, special education students and students whose first language is not English. Low-performing schools also have an average percentage of low-income students more than 4 times that of high-performing schools.

Student Performance and Engagement Indicators

Table 3 shows the average high school science CPI, attendance rate, in-school suspension rate, graduation rate and dropout rate for low-performing, high-performing and case study schools. On average, low-performing schools have a lower rate of attendance and lower graduation rates; they also have higher rates of in-school suspension and students dropping out.

As shown in Tables 2 and 3, large disparities exist in the level of student engagement and the demographic make-up of high- and low-performing schools. Yet, there are some low-income schools with diverse populations that are doing well in science relative to their peers. Three of these schools are highlighted in the case studies presented on pages 15 through 21 of this report.

Table 2. Demographic information

	Race/Ethnicity					Other Subgroups		
	African American	Asian	Hispanic	White	Other/ Multi Racial	First Language Not English	Special Education	Low Income
Low-performing (n=31)	25%	3%	29%	41%	2%	23%	25%	54%
High-performing Non Case Study Schools (n=22)	8%	8%	6%	77%	2%	10%	13%	13%
High-performing Case Study Schools (n=3)	37%	9%	44%	9%	1%	44%	8%	71%
State Average (2006-07)	8%	5%	13%	72%	2%	15%	17%	29%

Table 3. Performance and engagement indicators

	CPI[8]	Attendance	In-School Suspension Rate	Graduation Rate	Grade 9-12 Drop Out Rate
Low-performing (n=31)	44.8	89%	5%	66%	18%
High-performing Non Case Study Schools (n=22)	90.8	94%	2%	93%	2%
High-performing Case Study Schools (n=3)	79.6	94%	6%	70%	16%
State Average (2006-07)	68.2	95%	3%	81%	4%

8 CPIs are generated separately for biology, chemistry, physics and technology/engineering so the average CPI is based on the school CPI associated with the science test that had the greatest number of test takers. The state average is based on the 2006-2007 MCAS biology assessment as it was the test taken by the most high school students statewide.

THEMES ACROSS THE SCHOOLS

The purpose of this study is to examine whether students in high- and low-performing high schools receive equitable opportunities to learn science. Findings are based on interviews with science coordinators from a small sample of Massachusetts high schools (25 high-performing[9] and 31 low-performing) that may not be representative of all schools in the Commonwealth.

The study findings suggest that there are greater opportunities to learn science in high-performing schools. While the study did not show many sizable gaps, it revealed that low-performing schools consistently lag behind in several areas. It may be that when taken together, the cumulative effect of these many small disadvantages make it harder for students to achieve success in science. This study does not provide a complete picture of the disparities that exist in science instruction nor how these disparities relate to student outcomes; rather, it provides a glimpse into some of the areas where inequities may exist.

Findings in six areas are presented: (1) staffing, (2) resources, (3) school policies, (4) courses, (5) enrichment opportunities and (6) student support.

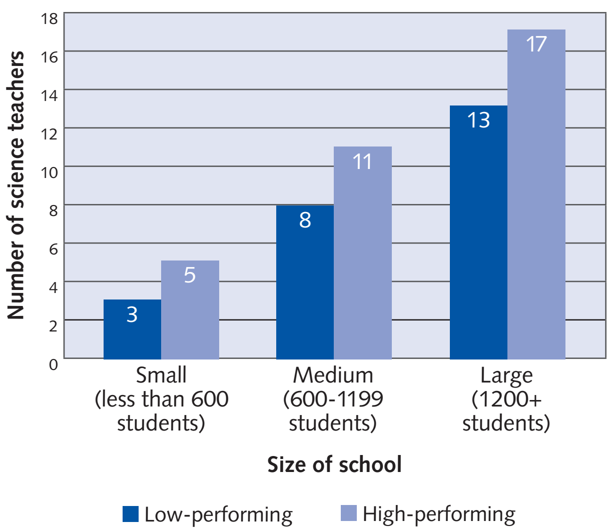
1. Staffing

High-performing schools have more science teachers than low-performing schools of comparable size (see Chart 1). On average, high-performing schools have 84 students per science teacher and low-performing schools have 95 students per science teacher.[10]

Science teachers in low-performing schools are more likely to be under-prepared. On average, low-performing schools have fewer 9th and 10th grade science teachers who are highly qualified[11] (74% of teachers compared to 85% at high-performing schools). Furthermore, more low-performing schools have 9th and 10th grade science classes that are taught by teachers who are not certified in the science discipline in which they are teaching (61% compared to 44% of high-performing schools). At both high- and low-performing schools, biology, chemistry and physics are the subjects most frequently mentioned as being taught by teachers not certified in that discipline.

First-year science teachers in high-performing schools are more likely to receive science-focused mentoring. Among the schools that had first-year science teachers in 2007-2008, 79% of high-performing schools and 67% of low-performing schools provided them with science-focused mentoring. While most of this mentoring is from other teachers, equal numbers of high- and low-performing schools (11% percent of each) mentioned mentoring and support through the science department and its chair.

Chart 1. Average number of science teachers



9 Only one predominantly low-income school achieved a CPI in the high-performing range (80 or above). As a result, two of the top performing predominantly low-income schools were included in this category even though their CPIs were in the moderate (70 to 79.9) range.

10 The student to teacher ratio was calculated by dividing the total number of 9th through 12th grade students by the number of science teachers. Therefore, it may not represent the actual number of students with whom each science teacher interacts.

11 A highly qualified teacher was defined during the interview as a teacher who has passed the Massachusetts Tests for Educator Licensure (MTEL) in the course he/she is teaching. However, some science coordinators may have included teachers who were determined to be highly qualified before the MTEL requirement was added (July, 2007).

Science teachers in high-performing schools have considerably more preparation time during the school day. Science coordinators in low-performing schools reported that science teachers have, on average, 4.9 hours of planning and preparation time per week whereas teachers in high-performing schools average an additional 84 minutes (6.3 hours per week).

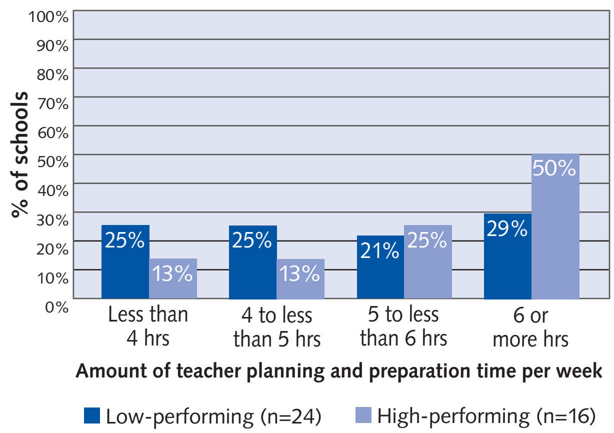
- Teachers in low-performing schools have as few as 1.4 hours of planning time per week to as many as 10 hours per week.
- Teachers in high-performing schools have as few as 3.3 hours of planning time per week to as many as 15 hours per week.

Science coordinators in high- and low-performing schools differ in their opinion of how much teacher preparation time is sufficient. Science coordinators in low-performing schools were more likely to report that science teachers have sufficient planning and preparation time (77% compared to 64% of science coordinators in high-performing schools). Among those who reported that teachers do not have a sufficient amount of time, teachers in low-performing schools typically have 4.2 hours per week and teachers in high-performing schools typically have an additional 20 minutes (4.5 hours).

The disparity between high- and low-performing schools is even greater in schools where teachers do have a sufficient amount of planning time. As shown in Chart 2, half of high-performing schools said their teachers have 6 hours or more of planning time per week compared to only 29% of teachers in low-performing schools. On average, teachers in low-performing schools (who report having sufficient planning time) have 4.8 hours per week and teachers in high-performing schools (who report having sufficient planning time) have an additional hour (a total of 5.9 hours per week).

Science teachers in high- and low-performing schools spend comparable amounts of time interacting with their peers. Ninth and tenth grade science teachers in high-performing schools spent 3.2 hours per month in formal meetings with other science teachers (in 2007-2008) and teachers in low-performing schools spent about 30 minutes less (2.7 hours per month). The percentage of meeting time spent on issues related to science teaching and learning is equivalent.

Chart 2. Planning and preparation time in schools that reported having a sufficient amount of time



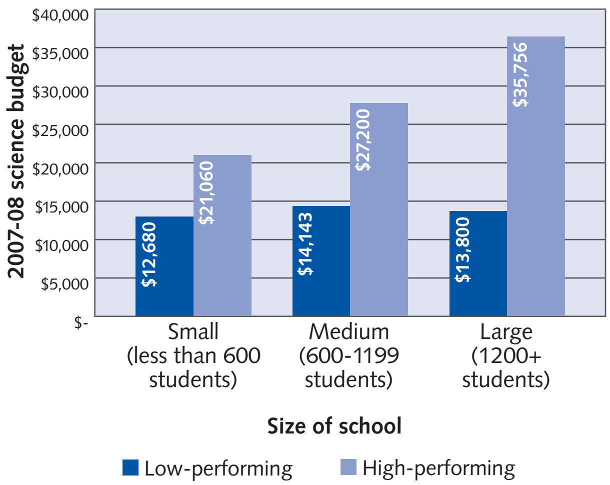
Teachers in both high- and low-performing schools spent on average about two-thirds of their time in formal meetings on issues related to science teaching and learning and the remaining one-third on administrative issues.

Ninth and tenth grade science teachers in high- and low-performing schools also spent comparable amounts of time meeting informally with other science teachers (in 2007-2008). Teachers in high-performing schools spent 7.4 hours per month on average whereas teachers in low-performing schools spent about one hour less (6.4 hours). Information from science coordinators suggests that teachers in high-performing schools may spend slightly more of their informal meeting time discussing science. Science coordinators in high-performing schools estimated that their teachers spend, on average, 84% of informal meeting time on issues related to science teaching and learning whereas it was estimated that teachers in low-performing schools spend, on average, 75% of their time.

2. Resources

The total school budget for science (excluding salaries), reported by science coordinators, ranged from as little as $600 to as much as $70,000 for the 2007-2008 school year. On average, high-performing schools have larger science budgets than low-performing schools. As shown in Chart 3, the discrepancy is greatest among large schools (schools enrolling 1200 or more students) where the average low-performing school budget is 40% of the budget for the average

Chart 3. Average 2007-2008 science budget by school size



high-performing school. Among medium size schools (schools enrolling 600 to 1199 students), the average low-performing school budget is about half that of the average high-performing school. Among small schools (those enrolling less than 600 students), the average low-performing school is operating on a budget that is 60% of the budget for the average high-performing school.

High-performing schools also have more material resources. As described below, high-performing schools reported having more safety equipment, audio and video equipment, and other laboratory equipment available for students in science courses.

Safety equipment. Sixty percent of high-performing schools compared to only 40% of low-performing schools reported having all four types of safety equipment referenced in the survey: fire extinguishers, fume hoods, emergency showers and eye wash stations. More high-performing schools reported having each type of safety equipment available for students in science courses.

When asked about the safety equipment that is available, more high-performing schools indicate that they have a sufficient supply (84% compared to 68% of low-performing schools). However, more low-performing schools report that all of their safety equipment is in good condition (77% compared to 64% of high-performing schools).

Audio and video (AV) equipment. More high-performing schools (76%) than low-performing schools (61%) reported having most (five or six) of the six types of audio and video equipment asked about in the survey: computers with internet access; overhead projectors; VCRs and monitors; DVD players; Smart Boards; video or digital cameras. Fewer low-performing schools reported having Smart Boards available for students in science courses.

While a majority of high- and low-performing schools have AV equipment available for science students, a minority (32% of high-performing schools and 42% of low-performing schools) indicate that they have a sufficient supply. On the other hand, most report that all of their AV equipment is in good condition (65% of low-performing schools and 68% of high-performing schools).

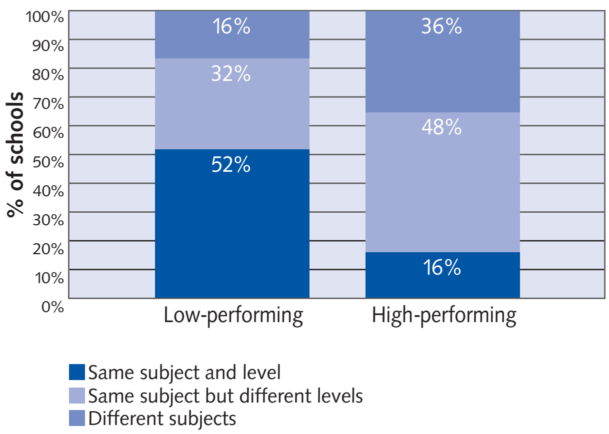
Other laboratory equipment. More high-performing schools (80%) than low-performing schools (58%) reported having most (six or seven) of the other types of laboratory equipment asked about in the survey: gas; electrical outlets; running water and sinks; storage for laboratory materials and supplies; textbooks, manuals and reference materials; laboratory equipment; and laboratory aides. Fewer low-performing schools reported having gas and textbooks, manuals, and reference materials available for students in science courses.

When asked about the laboratory equipment that is available, more high-performing schools indicate that they have a sufficient supply (52% compared to 39% of low-performing schools) and that all of the equipment they have is in good condition (64% compared to 48% of low-performing schools).

3. School Policies

Most high- and low-performing schools place students in the same science subject (such as biology). As shown in Chart 4, only 16% of low-performing schools and 36% of high-performing schools offer different science subjects to 9th graders. Most low-performing schools place all 9th grade students in the same subject and level (52% compared to only 16% of high-performing schools). High-performing schools are more likely to place students in different levels of the same subject (48% compared to 32% of low-performing); for example, they may place some students in a level 1 biology course while others will be placed in a level 2 biology course.[12]

Chart 4. Placement of 9th grade students in science courses[13]



High- and low-performing schools take similar factors into consideration when making decisions about which science course students will take when they enter high school. When making decisions about what level course in which to place students, most (78% of low-performing schools and 92% of high-performing schools) rely on recommendations from middle school teachers and/or guidance counselors. In some schools, recommendations are only accepted to determine if the student will be placed in an honors-level course.

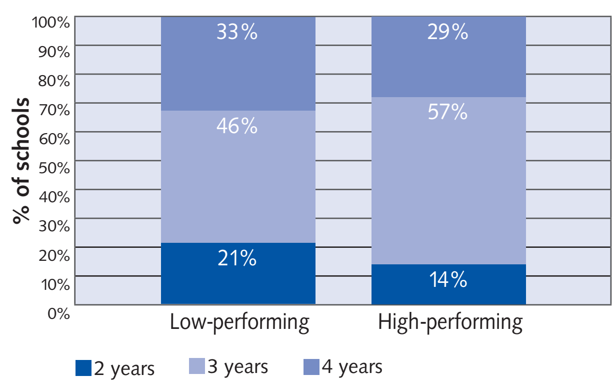
Student performance is also taken into consideration when making decisions about course level. Placement based on math and science grades appears to be slightly more common in high-performing schools (50% compared to 44% of low-performing schools). Only one-third of high-performing (33%) and low-performing (33%) schools use MCAS scores or other assessments such as entrance exams and readiness tests as part of the decision-making process.

For some high- and low-performing schools, parents are involved in decisions about what level course students will take; for others, parental involvement usually only occurs in the form of an override when the parent disagrees with the school's recommendation. More than half of schools mentioned receiving parental input about student placement (56% of low-performing and 58% of high-performing schools). Few mentioned student preference (22% of low-performing and 25% of high-performing) as a factor in determining placement.

In schools that place students in different subjects, more low-performing schools rely on recommendations from middle school teachers and/or guidance counselors to determine the course in which students are placed (75% compared to 38% of high-performing schools). On the other hand, more high-performing schools rely on students' math and science grades (50% compared to 25% of low-performing schools who place students in different subjects).

High- and low-performing schools also have similar graduation requirements (see Chart 5). Most high- (86%) and low-performing (79%) schools require 3 to 4 years of science.

Chart 5. Graduation requirements: percent of schools requiring 2, 3 and 4 years of science



4. Courses

Sequence of 9th and 10th grade science courses. The traditional American high school science curricula start off with one year of biology or earth science, followed by a year of chemistry then a year of physics. However, in recent years, education reformers have begun to explore re-sequencing the science curricu-

12 Science coordinators were asked to indicate level 1 (highest), level 2 and level 3 (lowest) science course offerings in 2007-2008.

13 Courses specified as ELL and SPED courses are not included in this analysis.

lum. An organized movement among educators in the early 1990s began to advocate for teaching physics first followed by chemistry then biology; the most prominent movement championing physics first is ARISE (American Renaissance in Science Education). Many proponents argue that physics lays the foundations for better understanding of chemistry, which in turn will lead to greater comprehension of biology.

Most of the Massachusetts high schools participating in this study enroll a majority of their 9th graders in biology. In fact, 56% of high-performing schools and 48% of low-performing schools have most of their 9th graders taking biology. Only 40% of high-performing schools and 13% of low-performing schools seem to follow the traditional sequence of biology then chemistry.

Twenty-eight percent of high-performing schools and 29% of low-performing schools enroll most of their 9th graders in physics. However, only 16% of high-performing schools and 7% of low-performing schools seem to follow the "physics first" sequence (physics in 9th grade followed by chemistry in 10th grade).

Course offerings. While 9th grade biology is most common, other 9th grade course offerings vary at high- and low-performing schools (see Table 4). Biology is the course offered by most low-performing schools (61%), followed by physics (42%), chemistry (10%), earth science (6%) and general science (6%). None of the low-performing schools offer technology/engineering courses to 9th grade students.

The 9th grade course offered by most high-performing schools is biology (72%), followed by physics (36%) and technology/engineering (13%). None of the high-performing schools offer chemistry, earth science or general science courses to 9th grade students.

Table 4 also shows the average percentage of 9th grade students enrolled in each type of science course. The percentage of students in high- and low-performing schools taking biology and physics, the two courses most commonly offered to 9th graders, is comparable. It is interesting to note that while chemistry, earth science and general science are offered by only a few low-performing schools, a considerable percentage of students enroll or are placed in these

Table 4. Percent of schools offering each type of 9th grade science course & average percentage of students enrolled

	Low-Performing		High-Performing	
	% of schools offering course	Average % of students enrolled	% of schools offering course	Average % of students enrolled
Biology	61%	43%	72%	41%
Physics	42%	47%	36%	43%
Technology/Engineering	0	NA	16%	6%
Chemistry	10%	35%	0	NA
Earth Science	6%	43%	0	NA
General Science	6%	56%	0	NA

Table 5. Percent of schools offering each type of 10th grade science course & average percentage of students enrolled

	Low-Performing		High-Performing	
	% of schools offering course	Average % of students enrolled	% of schools offering course	Average % of students enrolled
Chemistry	39%	47%	76%	38%
Biology	74%	41%	40%	27%
Physics	23%	45%	20%	50%
Technology/Engineering	6%	15%	8%	8%
General Science	0	NA	4%	4%
Earth Science	0	NA	0	NA

courses–especially general science with 56% of 9th grade students on average enrolling in this course.

In both high- and low-performing schools, the 9th grade course with the highest enrollment typically meets 5 days per week and averages about the same number of students per course section (23 students in high-performing schools and 21 students in low-performing schools).

The 10th grade science course offered by most high-performing schools differs from that offered by most low-performing schools (see Table 5.) A majority (74%) of low-performing schools offer 10th grade biology courses whereas far fewer (40%) high-performing schools offer this course. On the other hand, a majority (76%) of high-performing schools offer 10th grade chemistry whereas far fewer (39%) low-performing schools offer this course. The percentage of high- and low-performing schools offering 10th grade physics (20% and 23% respectively) and technology/engineering (8% and 6% respectively) is comparable.

Table 5 also shows the average percentage of 10th grade students enrolled in each type of science course. The percentage of 10th grade students in high- and low-performing schools taking physics is comparable. Chemistry, the course offered by most high-performing schools, enrolls 38% of 10th grade students, on average. Biology, the course offered by most low-performing schools, enrolls 41% of 10th grade students, on average.

Elective courses can extend and deepen students' foundational science understanding and motivate students to become interested in science. Yet, a majority of the schools in this study do not offer science electives to 9th and 10th grade students. Only 32% of high-performing schools and 29% of low-performing schools offer science electives to 9th and 10th graders. On average, 2 elective courses were offered by both high- and low-performing schools.

Upper classman at high-performing schools are more likely to take advanced science and science courses that are not required. On average, a higher percentage of juniors and seniors from high-performing schools take science courses beyond what is required (40% of juniors compared to 30% in low-performing schools, 60% of seniors compared to 40% in low-performing schools). Similarly, a higher percentage of seniors from high-performing schools take Advanced Placement (AP) science courses (30% compared to 20% in low-performing schools).

Most educators agree that connecting classroom learning to real world experiences motivates students and improves learning. Findings from this study suggest that real world application of science skills varies by discipline. Almost all high- (88%) and low-performing (97%) schools reported that their 9th and 10th grade science courses include real world application when asked if their science courses "include the application of science content and skills to topics or events outside the classroom."[14] However, there appear to be some differences in the extent to which real world application is used in specific courses. Real world application in chemistry courses appears to be more common in high-performing schools (73% compared with 50% of low-performing schools). Slightly more of the high-performing schools also reported using real world application in physics courses (77% compared with 67% of low-performing schools). There was no difference in biology courses with nearly three-quarters of high- (74%) and low-performing (73%) schools using real world application in these courses.

Many educators believe that effective teaching of science requires extended, uninterrupted blocks of time for working on content-rich units and hands-on investigation. This study found that more low-performing schools (42%) than high-performing schools (28%) use block scheduling which allows for periods of an hour or more.

In schools that use block scheduling, the amount of time students in high- and low-performing schools spend in science class is comparable. On average, the 9th grade course with the highest enrollment meets for 68 minutes in low-performing schools and 64 minutes in high-performing schools. The amount of class time students spend engaged in hands-on investigation is also comparable. With the exception of one low-performing school that indicated 100% of

14 Science coordinators were asked, "Do any of the science courses include the (real-world) application of science content and skills to topics/events outside the classroom? Are you connecting the science they're learning to the world outside?"

class time is spent on hands-on activities, both high- and low-performing schools that use block scheduling report spending, on average, 35% of class time doing hands-on investigation.

In schools that do not use block scheduling, the amount of time students in high- and low-performing schools spend in science class is comparable. On average, the 9th grade course with the highest enrollment meets for 55 minutes in low-performing schools and 52 minutes in high-performing schools. The amount of class time students spend doing hands-on investigation is also comparable. Students in high-performing schools spend, on average, about one-third (32%) of class time engaging in hands-on investigation and students in low-performing schools spend about one-quarter (26%) of their time.

5. Student Support

Almost all schools have support for students who have difficulties in science and this support is primarily offered by teachers either before or after school. Support provided by teachers is slightly more common among low-performing schools (93% compared to 84% of high-performing schools). Some schools said teachers are required to stay after school one or two days a week while others indicated that teachers make themselves available regularly or whenever students need help.

Far more high-performing schools offer peer tutoring; 44% compared to only 7% of low-performing schools. In these schools, peer tutoring is generally provided through the National Honor Society or peer tutoring programs organized by the school.

More high-performing schools also offer tutoring to prepare for MCAS (20% compared to 7% of low-performing schools). These schools offer MCAS review courses or other targeted support during school hours as well as after school.

6. Enrichment Opportunities

Some disparities exist in the extent to which enrichment opportunities are available to students in high- and low-performing schools. Fifty-eight percent of the low-performing schools in this study offer extra-curricular science activities whereas 96% of the high-performing schools offer them. Among the schools that offer them, some offer as many as 7 different clubs and activities while others offer only one.

High-performing schools are more likely to offer competitive academic activities specific to science such as Science Olympiad, Academic Decathlon, Brain Bowl and Physics Olympics (63% compared to 17% of low-performing schools).

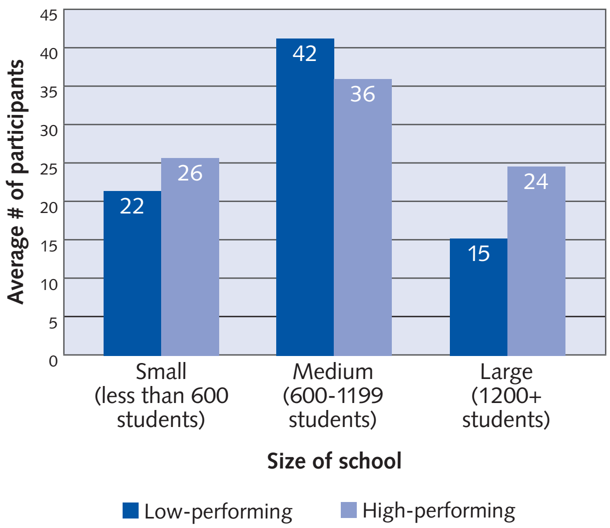
High-performing schools are also more likely to have clubs and activities related to the environment or environmental science such as recycling programs, gardening clubs and environmental clubs (46% compared to 28% of low-performing schools).

More high-performing schools (13% compared to 0 low-performing schools) also mentioned programs that foster science learning through creative and imaginative activities such as Destination ImagiNation which involves competing in various challenges that require complex thinking, problem solving, teamwork and creativity, and Rube Goldberg contests, which challenge students make a complex machine to perform a simple task.

There are some differences, albeit small, in the number of extracurricular activities available to students in high- and low-performing schools and the number of students participating in them. The number of extracurricular activities varies based on the size of the school; as a result, schools with fewer than 600 students and those with 600 or more students were examined separately. Small high-performing schools offer, on average, 2.2 extracurricular activities whereas small low-performing schools offer one less (1.4). Participation rates also differ. On average, 22 students participate in each extracurricular activity at small low-performing schools whereas high-performing schools average 26 students per activity.

Both high- and low-performing schools with student enrollments in excess of 600 offer the same number of science clubs and extracurricular activities, on average (2.6 and 2.7 respectively). However, participation rates vary. On average, medium size schools (600 to less than 1200 students) have higher participation rates than large schools (1200 or more students). As shown in Chart 6, the average number of students participating in each extracurricular science activity at medium size low-performing schools is higher than the number of participants in high-performing schools of a comparable size (42 students compared to 36 in high-performing schools). The opposite is true for large schools where the high-performing schools have a higher average participation rate than the low-performing schools (24 and 15, respectively).

Chart 6. Average number of students participating in each extracurricular science activity



Roughly half of high-performing (52%) and low-performing (48%) schools reported having partnerships with science organizations. Far more high-performing schools (77%) than low-performing schools (33%) have partnerships with a university. High-performing schools mentioned loose affiliations as well as formal partnerships with universities. Through these partnerships, high-performing schools have access to:

- **Equipment.** One school uses telescopes and another uses laboratories at area universities.
- **Special programs for students.** One school mentioned participating in a laptop program through a local college.
- **Teaching fellows.** One school mentioned a physics fellow from an area college helping out in the high school physics class.
- **Professional development courses for teachers.** One school mentioned externships for teachers through a local university. Another mentioned receiving mentoring in robotics from a neighboring university.

More high-performing schools (23%) than low-performing schools (7%) have partnerships with museums or aquariums. These partnerships are most commonly with the Museum of Science and the New England Aquarium. Partnerships involve special student programs, field trips, and specific targeted professional development courses for teachers, generally for specific courses offered in the school.

Partnerships with companies in the high tech industry are uncommon, with only 20% of high-performing and 15% of low-performing schools reporting them. Partnerships with hospitals and medical centers are also uncommon; only 20% of high-performing and 15% of low-performing schools reported having them. These partnerships typically involve field trips or tours for students in specific classes such as anatomy and physiology. One low-performing school reported that a local hospital offers tutoring and labs for students on Saturdays and a handful provide professional development for teachers.

CASE STUDIES

This section describes three schools with large populations of low-income students whose students are achieving proficiency on the science MCAS.

CASE STUDY 1:

Chelsea High School

Chelsea has long been an immigrant gateway city, and students enrolled at Chelsea High School represent a range of cultures. In the Chelsea school district, 82.5% of the students come from homes where the primary language is other than English. Students also enter and leave the system throughout the year in large numbers. The 2007-2008 mobility rate[15] was 27.2%.

From 1989 to 2008, Boston University managed the Chelsea Public Schools under a unique partnership agreement. This contract between the School Committee and Boston University gave the university a mandate to transform the Chelsea schools while the city worked to emerge from state-declared bankruptcy and receivership.

Chelsea High School is home to 1,477 students in grades nine through twelve and boasts a well-appointed building that was completed in 1996, with a 500-student addition that opened in September 2002.

Chelsea's students are in the middle-performing category with a CPI of 71.1. Seventy-eight percent of Chelsea High's students passed the 2008 high school Biology (science/technology) MCAS. While this pass rate does not place Chelsea among the highest-performing schools in the state, Chelsea High is outperforming most other schools with similar student demographics.

Table 6. 2008 Student demographic information

African American	8%
Asian	4%
Hispanic	77%
White	11%
Other/Multi-Racial	1%
First Language Not English	81%
Special Education	14%
Low-Income	82%

School Policies

Students are required to take a minimum of three years of science in order to graduate. Chelsea High uses a rotating schedule with six of seven classes meeting daily. Every seventh day of the rotation, each class meets for an extended 80-minute period.

Courses

The science curriculum at Chelsea High is tightly aligned to the Massachusetts curriculum frameworks. According to Lead Teacher Catherine Erickson, Chelsea science core courses are "all frameworks all the time." Science teacher Irene Mahoney explained that for the past four summers the district has provided stipends for the some of the science faculty to spend 30 hours over the summer aligning their curriculum to the frameworks.

Chelsea also implemented formative assessments in the form of quarterly exams at different levels for general science, biology, chemistry, and physics. Some of the teachers' time over the summer is dedicated to developing and refining these exams. The district grades the exams and returns the results to the

15 The mobility rate is the percentage of the school population transferring into or out of the school district during the ten months of the school year.

Chelsea High faculty. Faculty members can use these results to gauge how their students are doing and to alter their instruction accordingly.

There are three levels of science courses at Chelsea High: College Prep, Honors, and Advanced Placement (AP). Biology, chemistry and physics are all offered at the AP level. Most students, upon enrolling in Chelsea High School, participate in the General Science offering in their freshmen year, but some are invited to enroll in biology, based on their middle school grades and teacher recommendations. General science students progress to biology in their sophomore year and then chemistry in their junior year. After completing chemistry, students are free to choose from elective courses including environmental science, anatomy/physiology, forensic science, and earth/space. Students who take biology their freshman year proceed to chemistry and are encouraged to enroll in physics to meet most college admissions requirements. This course sequence also opens up the possibility of taking one or more AP course offerings prior to graduation.

According to the Chelsea High web site, "The honors offerings are reserved for those students who have demonstrated both a desire to challenge themselves and an ability to be successful in a rigorous course of study." Admission into these courses is competitive. Students who enter into honors level courses are likely to pursue one or more of the AP offerings.

Chelsea High is a recipient of an Advanced Placement Initiative grant through the Massachusetts Math and Science Initiative (MMSI). The program includes financial incentives for scores of 3, 4, and 5 on the AP exam for both students and teachers. As part of its participation in the Initiative, Chelsea High has allotted double blocks to AP biology, chemistry and physics.

Staffing and Professional Development

Several Chelsea High teachers have advanced degrees in science and/or backgrounds in science-related fields like engineering, neuro-science and bio-technology.

The Science Department at Chelsea High experiences fairly regular turnover. As new teachers come in they are matched with mentor teachers by subject area and have formal monthly meetings as well as regular informal meetings.

Several options for professional development in science are provided by the district, and teachers decide individually whether or not to participate in these professional development opportunities.

Student Support

Chelsea High teachers work to identify students who are falling behind in their classrooms and encourage them to stay after school. It is the norm for most of the science faculty to stay after school to provide individual support to students. However, ESL science teacher Miguel Hernando acknowledges that many of his students have after-school jobs that prevent them from staying after school. This makes it difficult for students and teachers to find the time to support students who are falling behind.

Enrichment

Chelsea High received a BioTeach grant from the Massachusetts Biotech Council to support bringing more Biotech into science classrooms. The BioTeach program is designed to outfit school science labs with lab equipment and supplies to teach biotechnology, provide professional development for biology teachers in biotech science, help teachers to access and use engaging biotech curricula, and provide sustainable plans for replenishing supplies and ongoing professional development. Over the summer, teachers received professional training on the BioTeach labs and curriculum. The interactive labs, designed by MassBioEd to pique student interest with activities such as: exploring DNA fingerprinting, the potential of bacteria, and the mystery surrounding the crooked cell–sickle cell anemia.

Chelsea High students have the opportunity to participate in the Boston University Upward Bound Math/Science program. This program targets students at Chelsea, Charlestown and Brighton High Schools. It is a federally funded TRIO program that provides academic support to low-income and/or first-generation college bound students. All program services are based on the BU campus. During the school year, students come for tutoring and academic instruction in math and science after school and one Saturday/month.

During the summer, students live on the BU campus for a six week academically intensive program.

Some Chelsea High students also participate in the North Shore Science League, which was designed to stimulate interest and achievement in science, provide recognition for scientifically talented students, and to foster communication among the students and staff of the North Shore high schools. The League holds contests between member schools and awards competitors (individuals and schools) at League competitions and at a general gathering at the end of the League season.

CASE STUDY 2:

MATCH Charter Public High School

At 5:00 p.m., students are just wrapping up their formal school day at MATCH Charter Public High School and moving on to after school clubs, sports, or extra academic help, where many will stay until 7:30 p.m. Located on a busy throughway near Boston University, MATCH serves a diverse population of 222 students from grades nine through twelve.

Most students come to MATCH performing well below their grade level. Yet, on the 2008 10th grade biology test, 93% of students scored at the Proficient or Advanced level and not a single student failed. MATCH has one of the highest Composite Performance Index (CPI) scores in science of any high school in Massachusetts at 97.6.[16]

Table 7. 2008 Student demographic information

African American	62%
Asian	2%
Hispanic	30%
White	4%
Other/Multi-Racial	2%
First Language Not English	14%
Special Education	11%
Low-Income	71%

School Policies and Culture

MATCH students attend school from 8:30 a.m. to 5:00 p.m. everyday. Many students (and most teachers) stay after school for other activities, including to get extra help on academics and some students come in for additional academic help on weekends. The MATCH School requires that all students take four years of science as well as five years of math (students double-up math in the sophomore year) in order to graduate.

“No excuses” is a formal school policy at the MATCH School. According to Chris Dupuis, Director of Curriculum, Instruction and Assessment, “we won’t let kids off the hook,” but the “fuel that keeps this engine running is relationships.” MATCH teachers work with students and their families and build trust and it is this trust that allows teachers to push students to achieve to higher and higher academic levels.

The policies at MATCH foster and reinforce an environment of accountability to the MATCH community. At MATCH, there are consequences including detention and calls home for students who do not complete their work. MATCH students are also required to attend summer school if they fail a class and/or a final exam. If they fail two classes, students are required to repeat the grade and attend summer school. Students feel accountable to each other and to themselves for reaching the high expectations set for them.

16 There has been some controversy about the graduation rate at MATCH. Graduation rates for MATCH and other schools can be found at: http://profiles.doe.mass.edu. Information about this issue can be found on the MATCH web site: www.matchschool.org.

Dupuis explains, "Teachers can push kids hard in the classroom and then can assign kids more work when they go home–other schools have to rely on more drills and memorization. MATCH can go deeper" because there is more time, additional support and unyieldingly high expectations. The high expectations result in students reaching to a higher level, but they also require teachers teach to a higher level. According to Dupuis, "Teachers see how kids can rise to the occasion and so keep pushing them. The chemistry exams that I give my students now are just as hard as the exams I had in my college chemistry courses." The ultimate focus at MATCH is college success and the school's policy of requiring each student to take at least two courses at Boston University is another tool to help prepare students for that end goal.

Courses

Prior to starting at MATCH, every 9th grader is required to participate in a five week summer program where s/he receives tutoring to bring up her/his skill levels and during which MATCH faculty can assess each student's areas of weakness and strength. All 9th graders take an integrated science course which covers the scientific method and provides a foundation for later work in biology and chemistry. In school year 2008-2009, MATCH has also added a foundational course in physics for freshmen. All 10th graders take biology and then take the 10th grade biology MCAS. All 11th graders take chemistry and 12th graders can choose to take AP Biology II or AP Physics. In addition, all seniors select one or two Advanced Placement courses and also must pass two Boston University courses.

The science curriculum is mandated, that is, there are no science electives from which students can select. Though, in their senior year, students do have the choice between taking AP Physics and AP Biology. All science courses at MATCH are standards-based and college preparatory. The entire science curriculum is designed by the MATCH faculty. MATCH uses no pre-packaged curriculum and only supplements their coursework with textbooks. According to Dupuis, "Students know that the curriculum has been designed especially for them and tailored to their needs and interests, without losing the level of rigor necessary for students to compete and succeed at the next level."

Because MATCH has a longer school day and students have additional support, teachers can integrate more real-world experiences. For example, 11th grade Chemistry students engaged in a consumer product research experiment. They designed experiments to test different brands of paper towels. They tested them for durability and recorded their findings. Students also make slime when they are learning about polymers and then experiment with the slime, testing it and collecting data on its characteristics. Further, when students learn nuclear chemistry, they engage in discussion of the implications and risks of nuclear energy and the political conversations happening nationally and globally. The goal of MATCH teachers is to develop students who are not only knowledgeable about formulas and scientific processes, but are also prepared to be responsible global citizens.

Staffing and Professional Development

MATCH has 77 students per science teacher, lower than the average for high-performing schools (84 students per science teacher) and low-performing schools (95 students per science teacher). Ninety-four percent of MATCH teachers are considered highly qualified, slightly lower than the state average of 95.7.

MATCH uses a medical model of rounds, which provides faculty with intense and job-embedded professional development opportunities. At weekly staff meetings, teachers discuss areas in which they are struggling or things that are working particularly well. Teachers can then determine whose class they might want to observe, or they can request that a colleague come in and observe them and offer assistance. As the Director of Curriculum, Instruction and Assessment, Dupuis gets into three to five classrooms every week to observe and provide teachers with feedback.

Student Support

MATCH offers students extensive support in the forms of tutoring, homework lab, after school help, and staff availability during out-of-school time. Every MATCH School freshman, sophomore, and junior receives two hours of individualized, one-on-one tutoring everyday. This support is largely centered on math and ELA, but does include some support for science as it is targeted to the areas of need for each student.

MATCH delivers this tutoring through its own residential tutoring program, which provides more than 300 hours of tutoring yearly to each student. Called the MATCH Corps, this program is a one-year fellowship program that places approximately 40 recent college graduates from elite universities at MATCH. Tutors receive a modest living stipend and housing in a dorm on the top floor of the school.

CASE STUDY 3:

John D. O'Bryant School of Math and Science

John D. O'Bryant School of Math and Science in Roxbury has an illustrious history dating back over 100 years. The school was founded as Mechanic Arts High School in 1893, became Boston Technical High in 1944, and merged with Mario Umana Technical High School in 1989. The school was renamed after Boston native and education leader John D. O'Bryant in 1992.

John D. O'Bryant was known as a tireless advocate for Boston's youth, who he always encouraged to set high goals and pursue a college education. Today, the school carries on that tradition with a college-preparatory curriculum and high expectations for all of its students. O'Bryant is the most diverse of Boston's three public examination schools[17] and serves a population of 1,308 students in grades 7 through 12.

Ninety-nine percent of O'Bryant students passed the 2008 high school biology MCAS test. The 2008 CPIs for high school biology and technology/engineering are high, 88.0 and 82.4 respectively.

Table 8. 2008 Student demographic information

African American	41%
Asian	22%
Hispanic	24%
White	12%
Other/Multi-Racial	1%
First Language Not English	43%
Special Education	1%
Low-Income	63%

School Policies and Culture

The school mission is to provide students with a rigorous and comprehensive science, technology, engineering and mathematics program integrated with humanities. The school expects its students to become skillful readers, researchers, users of technology, problem solvers and communicators who demonstrate respect for themselves and others, and who participate in their communities as responsible citizens.

The school has high expectations for its students and strives to provide as much support as possible to help students be successful. As described below, O'Bryant supports student success by building ample time into the class schedule for science, offering an expanded AP science program and providing after school and Saturday enrichment opportunities. The school's science program is also strengthened by its many partnerships with area institutions.

Courses

As a school that serves 7th through 12th graders, O'Bryant requires 6 years of science coursework. Students typically take biology in 9th grade, chemistry in 10th grade and physics in 11th grade. In their senior year, students can choose to take an AP course or an elective. Electives include second level courses in biology and chemistry, a biotechnology course, marine science and a pre-engineering course.

O'Bryant has recently expanded its Advanced Placement (AP) science program due in part to the body of research that suggests completion of AP

17 Students are admitted to exam schools based on results of the Independent School Entrance Examination (ISEE) and grade point average. Boston Latin Academy and Boston Latin School are the other BPS exam schools.

courses in high school has a positive impact on college persistence.[18] O'Bryant currently offers AP courses in biology, chemistry, physics and environmental science. AP physics and chemistry are double periods to enable more time for instruction and hands-on learning.

This year, 120 students are taking AP Science courses, an increase of 40 students from last year. Michael Sullivan, Director of Science and Technology, explained, "We challenge our students to take more rigorous courses and we try hard to provide them with the extra support they need–as much support as possible. Our students are responding to the challenge and our faculty is dedicated to insuring that the students succeed." Support for students enrolling in AP courses comes in the form of a summer bridge program.

As part of the *Bridge to AP Science Program*, juniors planning to take AP science courses during their senior year are taken off-site for 8 to 10 days of intensive preparation. Students spend the last 4-5 days of their junior year and 4-5 days before the start of their senior year on a neighboring college campus. During the 7-hour sessions, students focus on the AP course content without having to worry about other classes. An added benefit to the program is that students get to know and develop relationships with their teachers and classmates. During this time, students become comfortable asking questions and form study groups with classmates. Sullivan explains that this as a way for the students to develop the social groups and support systems that will help them overcome their initial fears and stress they may feel about taking a rigorous course. Due to the Bridge program and other support systems, O'Bryant is able to retain almost 100% of the students in their AP Science courses.

The O'Bryant science department is dedicated to fostering and engaging students in inquiry, investigation and analytical problem solving. As a result, a lot of time is dedicated to hands-on science activities both inside and outside of the classroom. While hands on learning and real world application of science are incorporated into most classes, O'Bryant offers several courses that are project-based. One such course is a 9th grade engineering design course (offered as a special program for students interested in engineering). The course combines physics and engineering into a double period course where 75% of class time is spent doing hands-on activities. Throughout the course, students work both in groups and independently to complete fifteen different projects. In addition to learning a lot, Sullivan says the project-based courses foster students' ability to work as part of a team and create interest and enthusiasm for science.

Staffing and Professional Development

Sullivan attributes the success the school has achieved thus far in science to the school's ethnically diverse, experienced and extremely dedicated teachers. All of the O'Bryant School's science teachers are licensed in both the subject and grade level that they have been assigned to teach.

Faculty who teach AP courses receive professional development through CollegeBoard workshops, Mass Insight Education and Research Institute's Math & Science Initiative, and monthly AP science teacher meetings.

Student Support

It is the norm for the science faculty to stay after school to provide individual support to students who require it. Students in AP chemistry and physics receive in-class support and out-of-class tutoring from Northeastern University graduate students who are placed in the school through the *NSF Graduate Teaching Fellows in K-12 Education (GK-12) Program.* O'Bryant also has a retired science teacher who provides support to students in AP classes twice a week.

Enrichment

O'Bryant fosters university, business and community partnerships that support student learning. The O'Bryant has developed partnerships with MIT, Wentworth Institute of Technology, Northeastern University, UMass-Boston, Harvard Medical School, Shawmut Construction, the Timothy Smith Network, and Burns & Levinson. The school also benefits greatly from funding provided from local foundations. This funding supports the development of new

18 See Adelman,1999; Camara, 2003; Dougherty, Mellor, & Jian, 2005; Klofstein, 2005; Morgan & Maneckshana, 2002.

program areas, the majority of the school's student support efforts, and after school activities. Higher education partners provide access to equipment as well as special programs. Physics, chemistry and biology classes use laboratories at neighboring universities frequently throughout the year. One such partnership is with Boston University's CityLab, a fully equipped biotechnology laboratory. O'Bryant students in biology and biotechnology classes use the CityLab to explore topics in health, disease, and industry through an inquiry-based approach.

O'Bryant is developing pathways to medical and health careers through a partnership with Longwood Medical Center called *Gateway to the LMA* (Longwood Medical/Academic Area). Students in *Gateway to the LMA* participate regularly in extended day programs that involve tutoring, counseling, college planning, academic enrichment, and career exposure events. Professionals in medical and health careers from the hospital and universities in the Longwood area come to the school to speak with the students about their fields. The partnership also includes field trips to the Longwood facilities. An upcoming field trip includes a visit to the Shapiro Simulation and Skills Center at Beth Israel Deaconess Medical Center to learn about the technology used to train surgeons in leading medical centers.

O'Bryant is also home to the Community Science Workshop (CSW), through a partnership with UMASS Boston and NSF. The CSW is a space for students to complete school assignments or other projects of interest to them. Currently students are making stained glass pieces of art while others are using the CSW space to build robots for an upcoming robot competition. There is a full-time person who oversees the workshop and provides support to students. Sullivan explains, "In a space like this, students can try things out, be innovative, maybe fail while trying, and not feel bad about failing. They have an opportunity to learn from their mistakes and then try again. There are limited places where this happens in a normal school day."

In addition to the partnerships mentioned above, the school has partnerships with the Urban Ecology Institute, to support students interested in environmental science, and a non-profit organization called Machine Science that provides programs for students interested in engineering.

These partnerships expose O'Bryant students to content that is not offered through school courses and provide opportunities for students to develop skills that cannot be taught in the school facilities. Sullivan explains that in addition to being eye-opening experiences, they give students the opportunity to learn for learning's sake. "We strongly encourage students to participate in internships, summer programs, and out-of-school time activities so they can make better decisions about what they may want to do in the future. We also encourage students to design projects around something that they are passionate about and that can benefit the local/global community." For example, one group of students is currently working with a physician in Guatemala to renovate and provision an abandoned medical clinic in a remote area of that country. They are planning the project this year, have received some grant money to support their efforts, and will be traveling to Guatemala this summer to help rebuild the clinic.

SUMMARY OF THEMES

This study represents a first step in examining whether students in high- and low-performing high schools across the Commonwealth receive equitable opportunities to learn science. The findings are based on interviews with science coordinators, who may have varying degrees of knowledge about the type of science instruction that takes place in individual high school science classrooms. Findings presented here are from a small sample of high schools (25 high-performing and 31 low-performing schools) that may not be representative of all Massachusetts high schools.

The study findings suggest that there are greater opportunities to learn science in high-performing schools. While the study did not show many sizable gaps, it revealed that low-performing schools consistently lag behind in several areas. It is possible that the cumulative effect of the many small disadvantages make it harder for students to achieve success in science, especially for students who are predominantly low-income and may already lag behind their higher income peers. This study does not provide a complete picture of the disparities that exist in science instruction nor how these disparities relate to student outcomes; rather, it provides a glimpse into some of the areas where inequities may exist.

The following is a summary of the greater opportunities to learn science that were found in high-performing schools that participated in this study.

- **More science teachers.** This study revealed that high-performing schools have more science teachers than low-performing schools. On average, high-performing schools have one science teacher for every 84 students and low-performing schools have one science teacher for every 95 students.
- **Well-prepared teachers.** In addition to having more science teachers, high-performing schools are more likely to have all of their science classes taught by teachers who are certified in the science disciplines in which they are teaching (56% of high-performing schools compared to 39% of low-performing schools). The study findings also suggest science-focused mentoring is more likely to be provided to first-year teachers in high-performing schools (79% of high-performing schools compared to 67% of low-performing schools).
- **More teacher preparation time.** Science teachers in high-performing schools have more time to plan and prepare for their classes. On average, they have 6.3 hours of preparation time each week which is 84 minutes more than their peers in low-performing schools. The study also revealed that high- and low-performing schools may have different notions of how much preparation time is sufficient.
- **Financial resources.** High-performing schools typically have larger budgets for science. The discrepancy is greatest among large schools (schools enrolling 1200 or more students) where the average low-performing school budget is 40% of the average high-performing school. Among medium sized schools (schools enrolling 600 to 1199 students) the average low-performing school budget is about half that of the average high-performing school. Among small schools (those enrolling less than 600 students) the average low-performing school operates on a budget that is 60% of the average high-performing school budget.
- **Material resources.** High-performing schools are more likely to have various types of equipment available to students in science courses. More high-performing schools reported that science students have access to textbooks, manuals and reference materials; gas; Smart Boards; and safety equipment such as fire extinguishers, fume hoods, emergency showers and eye wash stations.
- **Options for placement in science courses.** High-performing schools are more likely to offer students the option of being placed in an advanced level course (48% compared to 32% of low-performing schools) and the option to choose or be placed in different science subjects (36% offer different science subjects to 9th graders compared to 16% of low-performing schools). Only 16% of high-performing schools place all 9th grade students in the same science subject and level, whereas half (52%) of low-performing schools place their students this way.
- **Real-world application.** The study findings suggest that high-performing schools are more likely to connect classroom learning to real world experiences in chemistry (73% of high-performing schools compared to 50% of low-performing schools) and

physics (77% of high-performing schools compared to 67% of low-performing schools) courses.

- **Enrichment opportunities.** High-performing schools are more likely to offer extracurricular science activities (96% compared to 58% of low-performing schools). The activities more commonly offered in high-performing schools include competitive academic activities related to science, clubs and activities related to environmental science, and programs that foster science learning through creative and imaginative activities.
- **Science related partnerships with universities.** This study revealed that more high-performing schools have science related partnerships with universities (77% compared to only 33% of low-performing schools). Through these partnerships, high-performing schools have access to equipment, special programs for students, teaching fellows to aid with instruction, and professional development courses for teachers.
- **Peer tutoring.** High-performing schools are more likely to offer peer tutoring to students who are having difficulties in science (44% offer it compared to only 7% of low-performing schools).

POLICY CONSIDERATIONS

While this study does not provide a complete picture of the disparities that exist in science instruction nor how these disparities relate to student outcomes, the study does highlight areas where disparities may exist. Based on the findings presented in this report, we offer the following options for practitioners and policymakers to consider.

For School and District Leaders

- **Encourage and support science-related professional development.** An established body of research suggests that the single most important factor in improving any student's performance is the quality of that student's teacher. Yet, despite the vital role teachers are known to play in improving student achievement, 61% of the low-performing schools that participated in this study have science teachers who are not prepared to teach in the discipline in which they are assigned. To better support science-related professional development, consider assessing how current professional development resources are being used and develop strategies for reallocating them or securing additional resources as needed. Consider meeting with businesses, community groups, and parent organizations to determine if there are opportunities to establish collaborations that will provide and support professional development.

- **Provide incentives for highly qualified science teachers to teach in your schools.** Leaders might consider non-financial incentives such as early, streamlined hiring practices, reduced teaching loads, comprehensive mentoring and induction programs and smaller class sizes.

- **Structure the school day to enable more teacher preparation time.** Consider putting two planning periods together to create a longer block, putting a planning period next to the lunch period for the same purpose, or scheduling teams of teachers for planning periods at the same time.

- **Develop partnerships with neighboring universities.** This study revealed that low-performing schools have not developed as many partnerships with universities as high-performing schools. Because low-performing schools are less likely to have material resources for science, they may need to seek out other ways to provide students with access to laboratory equipment and other science related materials. Furthermore, students in low-performing schools could benefit from partnerships with universities that provide enriching and engaging science-related activities for students. Schools may also draw upon the university for college students who could serve as science tutors or lead extracurricular science activities, and faculty members who could serve as mentors to science teachers or lead extracurricular science activities.

- **Institute peer tutoring programs.** Peer tutoring may offer several advantages to low-performing schools. First, struggling students may more easily identify with a student relatively close in age, particularly one of the same ethnic or social background, than with an adult. Second, peer tutors can effectively model study skills that students may be lacking. Third, peer tutoring may reduce the number of students requiring help from teachers outside of regular school hours. Finally, peer tutoring solidifies the skills of the tutors and may increase their interest in a career in science or science teaching.

- **Institute formal remediation and academic support programs for students struggling in science.** Consider implementing remediation and academic support programs such as after school, Saturday, and in-school instruction similar to those currently offered for students having difficulty in English language arts and mathematics.

- **Look outside the school for people to lead extracurricular activities.** The lack of extracurricular activities in low-performing schools may be due to a variety of factors such as insufficient funds, student interest or a priority placed on other school initiatives or foci. Study findings suggest that teachers in low-performing schools may be spending after school time providing direct support to students and as a result may have less time to devote to leading extracurricular science enrichment activities. As a result, schools may wish to consider recruiting parents, college students, retired science professionals or other volunteers to organize and lead extracurricular science activities.

- **Make well-equipped science classrooms a priority.** Consider assessing how resources are being used and develop strategies for reallocating them or securing additional resources for science. Working with up-to-date, well-functioning equipment and adequate materials conveys to students that science is a priority in the school.

For State Policymakers

Providing additional resources and ensuring that all high school students in Massachusetts have opportunities to learn science and to achieve at high levels will require coordinated efforts by both state legislators and the Department of Elementary and Secondary Education. The following are recommendations for both legislators and the Department.

- **Provide incentives for highly qualified science teachers to teach in low-performing schools.** As previously stated, 61% of the low-performing schools that participated in this study have science teachers who are not prepared to teach in the discipline in which they are assigned. Furthermore, when asked at the close of the interview whether there was anything they wished to add, science coordinators in both high- and low-performing schools consistently mentioned having trouble finding teachers certified in multiple science disciplines. Given the body of research that suggests the single most important factor in improving any student's performance is the quality of that student's teacher, the state can't afford not to invest in enhancing the teacher work force. State policymakers might consider financial incentives such as multi-year bonuses, differentiated compensation, housing subsidies, relocation reimbursement, loan forgiveness, tuition-free advanced degrees at state universities, tuition assistance for children of teachers, and state income tax credits. State policymakers may also consider recruiting a critical mass of accomplished teachers, such as cohorts of National Board Certified Teachers (NBCTs), to teach in high-need schools and continue to support comprehensive mentoring and induction programs.
- **Provide incentives for science professionals to enter the teaching profession.** In addition to the incentives above, policymakers could support teacher preparation programs for career-changers. For many potential teaching candidates, the prospect of returning to school to earn a special degree in teacher education is unworkable. State policymakers could remove barriers to entering the teaching profession by providing a tailored program for career changers from science-related fields that places them in the classroom quickly so they can earn a living while taking part-time course work that emphasizes pedagogy and classroom management.
- **Continue to support expanded learning time initiatives.** The study findings revealed that 42% of low-performing schools do not offer science-related extracurricular activities. The study also suggests that teachers in low-performing schools have less preparation time; on average, eighty-four minutes less per week than their peers in high-performing schools. All children deserve to be taught by teachers with well-thought out lesson plans and the opportunity to experience enrichment activities. Expanded learning time offers opportunities for teachers to engage in collaborative planning and focus on improving instruction, and offers greater opportunities for students to participate in enrichment programs and engage in experiential learning.
- **Support enrichment opportunities for low-performing schools.** State policymakers could help to link science rich institutions, companies, organizations and volunteers to low-performing and high-need schools, perhaps through a clearinghouse or a series of matchmaking meetings.
- **Broaden current state-level science initiatives to encompass all grades from kindergarten through higher education.** The Commonwealth is fortunate to have several programs and initiatives focused on improving the STEM pipeline. Yet, the lack of alignment among these programs and between K-12, higher education and the business community means that these initiatives are not impacting students as they might. One example of such an initiative is the Robert H. Goddard Council, created as part the 2006 Economic Stimulus Package, which advises both the Department of Higher Education and the state legislature on matters relative to STEM and related workforce development issues. This initiative could be expanded to also advise the Department of Elementary and Secondary Education, as many of the Goddard Council discussions are also relevant at the K-12 level. The Council currently provides funding to regional PreK-16 networks for innovative programs that often bridge K-12 and higher education. Situating the Goddard STEM Council in the Executive Office of Education, as opposed to its current position in the Department of Higher

Education, would be one step toward encouraging greater coordination and alignment of statewide science-related initiatives.

- **Provide a supplementary materials budget to under-resourced schools.** Low-performing schools in this study had substantially smaller science budgets and less material resources than high-performing schools. The state may wish to consider making competitive grants available to low-performing schools that present a comprehensive plan for improving their science program including a clear rationale for how the funds will be used to support science instruction.

- **Provide support for formal remediation and academic support programs for students struggling in science.** Expand the current remediation and academic support programs focused on English language arts and mathematics to include science.

POTENTIAL AREAS FOR FUTURE RESEARCH

Additional research is needed to provide a more complete picture of the disparities that exist in science instruction and how these disparities relate to student outcomes. This study was based on interviews with science coordinators in 56 Massachusetts high schools and captured information at the school level. In order to fully understand the differences in students' opportunities to learn science, additional research is needed to understand what happens in the classroom. Research involving interviews with teachers, a review of classroom materials, and classroom observations would provide insight into classroom-level factors that may impact students' opportunities to learn science. Student surveys would also provide important information about their interest in science and other factors that may impact their interest and ability to engage in science-related opportunities (such as holding a job, caring for younger siblings or other after school and weekend commitments).

Endnotes

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APPENDIX A: High School Audit Survey Questions

I. SCHOOL CONTEXT

1. Number of science teachers in 2007-08:

II. COURSES AND STUDENT ENROLLMENT

2. a. Did you have block scheduling in 2007-08? Y/N

   b. 2007-08 Science course offerings:

	9th Grade		10th Grade	
	# of students taking this course	Size of dedicated lab space	# of students taking this course	Size of dedicated lab space
BIOLOGY				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				
CHEMISTRY				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				
PHYSICS				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				
EARTH & SPACE				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				

	9th Grade		10th Grade	
	# of students taking this course	Size of dedicated lab space	# of students taking this course	Size of dedicated lab space
TECH/ENGINEERING				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				
GENERAL SCIENCE				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				
OTHER SCIENCES–core courses, not electives (fill in):				
AP				
Level 1 (highest)				
Level 2				
Level 3 (lowest)				
ELL				
SPED				

3. What factors are considered when making decisions about where to place 9th graders in science courses?

4. a. Do any of the science courses listed above include the (real-world) application of science content and skills to topics/events outside the classroom? Are you connecting the science they're learning to the world outside? Y/N

   b. If yes, which ones? (refer to course list above)

5. How many elective courses in science, if any, did your school offer in 2007-08 that 9th or 10th grade students could take?

6. What are your school's graduation requirements in science?

7. a. How many juniors in 2007-08 took science specifically to pass the MCAS?

   b. How many juniors in 2007-08 took AP science courses?

   c. How many juniors in 2007-08 took science above and beyond what's required? E.g., a core course and an elective.

8. a. How many seniors in 2007-08 took science specifically to pass the MCAS?

   b. How many seniors in 2007-08 took AP science courses?

   c. How many seniors in 2007-08 took science above and beyond what's required?

9. For the 9th grade course that had the highest enrollment in 2007-08 <confirm course and level here>:

   a. How many times per week does the class meet?:

b. Number of minutes per class:

c. % of class time per week freshman spend, on average, doing hands-on investigations:

d. Average number of students per course section:

III. TEACHERS

10. a. How many 9th and 10th grade science teachers were there in your school in 2007-08?

    b. How many of them could be categorized as highly qualified? (passed the MTEL in the course(s) they are teaching)

11. a. Were there any 9th or 10th grade course sections that were taught by teachers who were not certified in that science discipline in 2007-08? Y/N

    b. If yes, which courses?

12. a. Was science-focused mentoring provided for first-year 9th and 10th grade teachers in 2007-08? Y/N

    b. If yes, what type?

IV. RESOURCES

13. What was your total school budget for science for school year 2007-08?

14. For the 9th grade course that had the highest enrollment in 2007-08 <confirm course and level here>: (add reference to NSTA here)

    a. Which of the following resources/equipment were available for use by students?

    b. Of those available, was there a sufficient supply?

    c. Of those available, were they in good condition?

Resources/equipment	Available (Yes/No)	Sufficient (Yes/No)	Good Condition (Yes/No)
Gas			
Electrical outlets			
Running water and sinks			
Computers with Internet access (must have both for a yes)			
Storage for laboratory materials and supplies			
Textbooks, manuals, reference materials for each student			
Laboratory equipment			
Laboratory aides			
Safety equipment			
Fire extinguisher			
Fume hood			
Emergency showers			
Eye wash stations			
AV equipment			
Overhead projectors			
VCRs and monitors			
DVD players			
Smart Boards			
Video or digital cameras			

V. ENRICHMENT OPPORTUNITIES

15. What science clubs or extra-curricular science activities were offered in your school in 2007-08?

Name	# Students Participating

16. a. Did your school partner with science organizations (e.g., Boston Nature Center)? Y/N
    b. If yes, which ones?

VI. STUDENT SUPPORT

17. What support was available in 2007-08 for 9th or 10th grade students who needed extra help in science?

VII. OTHER

18. a. How many minutes per month did 9th and 10th grade science teachers meet formally together or with other science teachers in 2007-08?
    b. How many minutes were spent on administrative issues?
    c. How many minutes were spent on issues related to science teaching and learning? (estimate)

19 a. How many minutes per month did 9th and 10th grade science teachers meet informally together or with other science teachers in 2007-08?
    b. How many minutes were spent on issues related to science teaching and learning? (estimate)?

20. a. Did science teachers have sufficient planning and prep time in 2007-08? Y/N
    b. How many minutes per week?

21. Anything else you'd like to add?

APPENDIX B: Profile of a High-Performing High School, Wayland High School

Introduction

Located in a demographically advantaged suburb about twenty miles west of Boston, Wayland High School is one of the highest performing high schools in the state in science with a CPI of 96.3. Eighty-seven percent of Wayland High students pass the high school science MCAS at the advanced or proficient level. With adequate funding, support and resources, as well as a highly qualified teaching staff, Wayland provides an example of an exemplary science program. While this profile of Wayland High is not meant to advocate for other high schools to replicate every aspect of Wayland High's science program (indeed, that may be impossible), it is intended to highlight the level of support for and emphasis on high quality science learning to which, ideally, all of the Commonwealth's students would have access.

School Policies

Wayland High School students are required to take a minimum of two years (eight credits) of science in order to graduate. However, the school's policy handbook stipulates that "for college admission, the admissions standards for the Massachusetts four-year college system are a good general guideline" and these standards require three years of science courses (including two courses with laboratory work). About 90% of Wayland High's students take at least four years of science.

Wayland High school students (starting in the second semester of their freshman year) have free blocks, or unstructured study halls, throughout their schedule. These are intended to help students learn to use their free time wisely, in preparation for the less structured environment of college. According to school staff, there has been, "strong, positive feedback from our graduates that the 'open campus' helped them in the transition to college."

The high school schedule spans from Monday through Friday from 7:30 a.m. until 2:15 p.m. with an early dismissal day every Wednesday at 1:05 p.m. to allow for professional development time for teachers. The school operates on an 8-day, 8-period cycle with 6 of the 8 periods meeting each day.

Table 9. 2008 Student demographic information

African American	2%
Asian	9%
Hispanic	4%
White	83%
Other/Multi-Racial	1%
First Language Not English	5%
Special Education	16%
Low-Income	4%

Courses

There are three levels of courses at Wayland High: Introductory, College and Honors/AP. The majority of the ninth grade class enrolls in either College Physical Science (approximately 48% of students) or Honors Biology (approximately 49% of students), with a small minority (about 3% of students) enrolling in the Introductory Physical Science course. Students who stay in the Introductory strand advance to Introductory College Biology in 10th grade; College Chemistry (environmental) in 11th grade; and Principles of Technology in 12th grade. Students who stay in the College strand advance to College Biology in 10th grade; College Chemistry (either environmental or quantitative) in 11th grade; and College Physics in 12th grade. Students who stay in the Honors strand advance to Honors Chemistry in 10th grade; Honors Physics in 11th grade; and one or more AP courses in Biology, Chemistry or Physics. Though the majority of students pursue the strand that they selected or were placed into in 9th grade, there is some movement of students into both more advanced and less advanced strands.

Teachers in Wayland High's science department function in subject-area teams: Physical Science, Biology, Chemistry and Physics. Each team works together to develop the curriculum for its subject and teachers take turns acting as the lead for each unit. This approach enables subject-area teams to align and sequence their curriculum to ensure that all students, no matter which teacher they have, cover the same content at the same time. It also fosters collaboration–because the entire team develops the course jointly. Each teacher can take the lead on a particular area of the course that is of interest to them and their colleagues will do the same. It allows all students to benefit from the expertise and strengths of all the teachers.

In addition, none of the science teachers have their own classrooms. Instead, there are rooms that are designated for Biology, Chemistry, Physics, and other subjects and teachers rotate to these rooms depending on the subject they are teaching. The home base for science teachers is the science department office, which is shared by the entire science faculty. This arrangement has the result of fostering constant collaboration between faculty members with and across science subject areas. As Biology teacher Imbornone describes, “You can’t hide in your room and do your own thing; there is built-in accountability to the other teachers on your team.”

Staffing and Professional Development

One hundred percent of Wayland High’s core academic teachers are highly qualified, as compared with the state’s average of 95.8. The science department is extraordinarily credentialed. All teachers are certified in the science subject they teach and two teachers are dual certified in both chemistry and physics. All of the teachers have undergraduate degrees in science. Of the 12 teachers in the science department, two have Ph.D.s in science and 10 have Masters degrees in science-related fields.

Teacher turnover at Wayland High is rare and usually occurs due to retirements. As new teachers are hired, they are paired with mentor teachers by subject area as part of a year-long mentor program. Mentors and mentees have formal meetings once every cycle (every 8 days) as well as constant informal meetings. Biology teacher Jessica Imbornone explained that mentoring really occurs as teachers team teach.

Each Wednesday, Wayland High students are dismissed early to allow faculty to spend the afternoon engaged in professional development. Once or twice a month the Wednesday afternoon time is used for school-based professional development. Once each month the science department holds a department meeting during this time and once or twice each month individual subject-area teams work together to develop and enhance their curricula.

Student Support

Wayland High science teachers post the times of their prep periods on the door of the science department office. Similar to college professors posting office hours, this makes it possible for students who are having trouble in science to come to the science office during a free period and receive one-on-one support from any of the teachers. Since all of the science courses are in synch, a student with a question about her/his Biology course may meet with her/his own teacher or with another of the teachers who teach that subject. It is mandatory for all freshmen to attend study halls during first semester. This time is designed for freshmen to work on assignments, prepare for upcoming quizzes and tests, and develop good study habits.

Wayland High recently received a grant from the Department of Elementary and Secondary Education to provide stipends for teachers to support the small number of students who are struggling to pass the high school science MCAS. This tutoring will be delivered by the science faculty and will take place during the school day.

Wayland High also has an Academic Center, which is staffed by one full-time resource teacher, one full-time teaching assistant, volunteer tutors, and National Honor Society (peer) tutors, all of whom provide assistance to students who are struggling. Students can drop in for occasional academic assistance, set up a regular tutorial schedule in any subject, get help with a particular assignment, borrow class materials, do research, use a lap top computer, study with a group, study individually, and/or learn study skills. Tutoring in the Academic Center is completely free and voluntary and occurs during the school day.

Enrichment

Wayland High has a diverse menu of science-related clubs available from which students can choose. The clubs are student-led and driven by students’ interests. Science-related clubs include: the Environmental Club, the Science Olympiad, Roots and Shoots, and Robotics. The school schedule allows for clubs to meet during the school day once a month. This allows students who participate in athletics after school to participate in clubs at least monthly.