

REPORT OF THE K-12 MATHEMATICS PROGRAM REVIEW

WESTON PUBLIC SCHOOLS
WESTON, MA

March 2007

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Executive Summary

The mathematics program in the Weston Public School System continues a venerable tradition of excellence.

During its two day visit, the Program Review Committee visited one-third of all Weston mathematics classes. The classroom environment was relaxed and well managed. Students were actively engaged in significant problem-solving, and noticeably at ease in explaining their strategies and presenting their solutions. Teachers employed a wide variety of pedagogies to support and motivate all learners. They enriched mathematics lessons with real-world applications. We saw teachers using technology thoughtfully and well at all levels, with clear content goals and pedagogical reasons in mind. The mathematics teachers are talented and dedicated professionals. They acknowledge and value the wealth of professional development opportunities afforded by Weston. They all pursue continuous professional development.

Teachers and administrators give high praise to the K-5 Mathematics Curriculum Specialist and the Secondary Mathematics Department Head, not only for their expert knowledge of Weston's K-12 mathematics curriculum, but also for their positive and supportive leadership. The curriculum leaders are credited with building teachers' sense of shared purpose and providing the mathematics program with cohesion and direction. The Committee concurs with the teachers' opinion of their program leaders.

The mathematics teachers credit the administration of the Weston Schools for creating a climate which promotes excellence in teaching. The Committee consistently heard comments such as Weston schools are "set up to let people teach" and to "help good teachers become better teachers." Trust is high. Collegiality is evident.

The Weston Mathematics Standards and BIG IDEAS make explicit what teachers believe Weston students should know and be able to do. For each grade level, the core mathematical concepts are specified, along with the skills which students need to acquire in order to understand the concepts. The BIG IDEAS vision energizes all conversations about mathematics. It informs all planning. Since traditional textbooks seldom fit this curriculum, Weston mathematics teachers courageously set about to design their own. This has been a tremendous undertaking which has engaged them for several years. What has emerged is a curriculum that draws upon the "best of the best" published curricula, and materials created by the Weston teachers.

The Weston Mathematics Standards align with the national standards of the mathematics education profession as well as the state standards articulated in the Massachusetts Mathematics Curriculum Framework. There are several supports in place for at-risk students, including Mathematics Interventions for students in Grade 1, tutoring for Grades 4 and 5, and Topics courses to supplement level II mathematics courses in the middle school. Very important, in summer 2007, the mathematics program will pilot a program for rising ninth graders that aims to help close the achievement gap, and to prepare and encourage weaker students to enroll in accelerated mathematics courses.

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In recent years, the Weston Public Schools have transitioned from homogeneous to heterogeneous classes. The elementary schools no longer have leveling; the secondary schools have moved from three course levels in mathematics to two: Honors (level I) and College Prep (level II). The effect of these changes has been to make each teacher responsible for differentiated instruction. Weston mathematics teachers strongly desire to strengthen their differentiation practices. They are grappling with differentiation and making appropriate progress.

As perhaps may be expected, these changes have met with some initial parental misgivings. Some elementary parents feel that that differentiation practices are inadequate, leaving some children insufficiently challenged; others, who perceive that insufficient time is being spent on developing number facts, have enrolled their children in after school programs (e.g., the Russian School of Mathematics and Kumon schools) to build number fluency. Also, some secondary parents voiced concern that the higher ability College Prep students are caught in the cracks between College Prep, which they feel is too slow, and Honors, where they feel the pace is too fast. In all, the Committee heard comments, either at a parent forum or by email, from a dozen elementary parents and a dozen secondary parents. The small sample sizes make it difficult to draw general conclusions; and, there is potential bias in the parent sample, as these were the parents who had a strong enough opinion to come to a meeting or to send an email. However, the extent and reasons underlying these parental concerns may warrant further investigation. Opportunities for increased dialogue with parents might include Family Math Nights or workshops for parents on the elementary mathematics curriculum.

In summary, the Weston mathematics program appears to be an outstanding program, and the mathematics teachers and curriculum leaders aspire to continue to make it better. Does the Weston mathematics curriculum align with Weston standards? Does it help all students to make progress? Is there a balance between computation and concepts? Do teachers have adequate technology resources and do they use technology effectively in their teaching? Do Weston hiring practices and professional development programs assure quality instruction in mathematics? On the basis of classroom visits, empirical data, review of written documents, and interviews with important constituencies (students, teachers, parents, administrators, and instructional and technology support staffs), the Program Review Committee thinks the answer to each of these questions is, overwhelmingly, yes.

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Introduction

Purpose

The Weston Assistant Superintendent for Curriculum and Instruction, Cheryl Maloney, invited a committee of outside consultants to visit the Weston Public Schools on March 8-9, 2007 to review the K-12 mathematics program in the Weston Public Schools. The Committee was comprised of college mathematics faculty; K-12 faculty, mathematics curriculum coordinators and specialists; teacher educators; and curriculum developers. The Committee was charged to address five questions that emerged from a self-study of the Weston Mathematics K-12 program carried out by Weston curriculum leaders and district administrators. The present report provides the Committee's responses to the questions it was charged to address, as well as commendations and recommendations.

Composition of Program Review Committee and the Charge

The Mathematics Program Review Committee was made up of nine members who represent a cross-section of expertise across K-12 mathematics. Committee members included elementary school teachers, secondary mathematics teachers, college mathematics faculty, mathematics curriculum specialists, authors of mathematics curriculum materials and textbooks, teacher educators, and an alumnus of Weston High School (Class of 2002).

The Mathematics Program Review Committee members were as follows:

Donna Beers (Chair), Ph.D., Professor of Mathematics, Simmons College

Kathleen Bodie, K-12 Mathematics Coordinator, Arlington Public Schools

Edward Burger, Ph.D., Professor of Mathematics, Williams College

E. Paul Goldenberg, Ed. D., Distinguished Scholar, Education Development Center, Newton, MA

Roberta Maguire, K-1 Teacher, Wellesley Public Schools

June Patton, Mathematics Teacher, Concord-Carlisle Regional High School

Robert Rand, Retired Mathematics Teacher, Lawrence Academy

Patricia Rourke, K-8 Mathematics Specialist, Holliston Public Schools

Alex Wolfe, Alumnus, Weston High School (2002), Cornell (2006)

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The Committee was charged with responding to the following questions:

1. Does the K-12 Mathematics Program, based on the Weston Mathematics Standards and Big Ideas, provide students with the necessary content and skills to be successful students and users of mathematics beyond high school?
2. Does our program assist students in making effective progress in attaining our learning standards?
3. Does our core mathematics program provide an appropriate balance of computation and problem solving experiences as well as concepts and skills?
4. Do we have sufficient technology and do we use it effectively?
5. Do our hiring practices and professional development programs assure quality instruction in mathematics?

The following are questions that delve into more specific areas and as such are subordinate to the four questions above:

- a. Do our efforts to differentiate instruction in the elementary and secondary schools through intervention programs, pedagogical practices, and course offerings allow teachers to meet the needs of all students?
- b. Do teachers have the necessary and appropriate materials to provide instruction for all children?
- c. How effective in supporting students are the coordination and articulation in place across grades and schools?
- d. Are children regularly problem solving and communicating their thinking?

Methodology

The conclusions in this report are based on classroom observations, review of written reports including test scores for Weston students on normed and local national mathematics exams, review of reports written by the elementary and secondary mathematics curriculum leaders, review of K-12 curriculum materials, and meetings with teachers, students, parents, instructional support staff, and school principals.

Committee Site Visit Activities

In summer 2006, Cheryl Maloney, the Assistant Superintendent for Curriculum and Instruction for the Weston Public Schools, contacted committee members to invite them to participate in a review of the Mathematics Program in the Weston Public School System. She discussed with the chair the process that Weston proposed to use, and the final charge and list of Program Review Committee members were sent to the Committee in mid-December.

On Monday evening, March 5, 2007, the chair met with Cheryl Maloney, Debra Shein-Gerson, the K-5 Mathematics Curriculum Specialist, and Dennis McCowan, the Secondary Mathematics Department Head to finalize plans and to discuss the schedule of activities for the site visit. The Committee visited the Weston Public Schools on Thursday and Friday, March 8 and 9, 2007. The visit began with an organizational

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meeting attended by the full Program Review Committee with Cheryl Maloney, Debra Shein-Gerson, and Dennis McCowan. Cheryl Maloney gave an overview of the two-day visit and reviewed the charge to the Committee; the chair went over the Committee's activities and responsibilities. Committee members then pursued individual schedules.

We visited classes across grades and schools and met with all constituencies. In all, we observed a total of 35 mathematics classes: 16 elementary, 8 middle school, and 11 high school classes. Debriefings with teachers followed each class. The Committee also attended a forum with teachers from the three elementary schools, and a secondary mathematics teacher department meeting.

In addition to meeting with regular classroom teachers, the Committee met with members of the instructional support staff. These members included the elementary and secondary technology staffs, the Metropolitan Council for Educational Opportunity (METCO) support staff, the elementary school Special Education (SPED) teachers, the middle school SPED teachers, the high school SPED skills staff, and the high school guidance chair.

The Committee met with students and parents. Two committee members met informally over lunch with thirteen high school students, nine females and four males who came from both College Prep and Honors courses. The chair attended an elementary school forum of ten parents, and a secondary school forum of six parents.

The chair met with Weston School administrators, including the Assistant Superintendent for Curriculum and Instruction, the principals of the five schools, the K-5 Mathematics Curriculum Specialist, and the Secondary Mathematics Department Head.

During the site visit, the Committee reviewed several mathematics program documents. These materials included: The Weston Public Schools Mathematics Standards Grades K-12, an Elementary and Secondary Mathematics Progress Report, an Overview of Secondary Mathematics document, curriculum guides, mathematics classroom materials provided in the committee's conference room, and secondary school mathematics curriculum materials (including materials available on the Web). It also reviewed Weston assessment metrics (SAT, MCAS, ERB).

The Committee also reviewed messages that had been emailed from a half-dozen parents who were unable to attend the parent forums but who responded to a request for feedback on the mathematics program.

The Committee convened at the beginning and end of the site visit and had a working dinner on Thursday evening hosted by Alan Oliff, Superintendent of the Weston Public Schools, at Henderson House. We determined whether we were gathering the data we needed to respond to the questions in the charge. At our meeting on Friday afternoon, we discussed our findings and identified commendations and recommendations. During the following week individual committee members wrote up their notes and detailed responses to questions in the charge and e-mailed them to the chair. The chair, in turn, emailed drafts of the report to the committee members for their review to ensure that this report accurately represents their findings and conclusions. This is the final report of the Program Review Committee.

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Caveats

The Program Review Committee notes the difficulty of generalizing and drawing conclusions from the small samples of Weston students and parents with whom we met. As well, a two-day visit can provide only a snapshot of the year-long mathematics teaching and learning that transpire in Weston.

On the other hand, we are confident that what the Committee observed in the classrooms we visited was normal, and that the overall positive atmosphere and high morale had to be the result of continuous behaviors in mathematics classrooms in the Weston Public School System.

Background

The State of U.S. Mathematics Education

The Weston program review of mathematics takes place at a moment when U.S. mathematics education is under intense scrutiny. One reason is the linkage of mathematics to the economy:

“Mathematics is at the heart of technological innovation, advances in engineering, physics, medicine, [and] biology Mathematical models can forecast environmental change and monitor energy supply and demand. Without mathematics we wouldn’t have MRIs or maps of the human genome.”¹

Less than 50% of Ph.D.s in mathematics are presently earned by U.S. citizens.² Less than 1% of U.S. undergraduates major in mathematics.³ These figures correlate with course-taking patterns of high school students: “The number of students taking mathematics in 11th grade is half those taking mathematics in 10th and so on until the PhD.”⁴

For further insight into the present state of U.S. mathematics education, we look at first year course-taking patterns in high school, AP course-taking patterns, private school course-taking patterns, and elementary and secondary mathematics assessment scores.

High School First Year Course-taking Patterns

The National Assessment of Educational Progress (NAEP) has recently published a report, *2005 NAEP High School Transcript Study (HSTS)*, on students who graduated from high school in 2005. Important findings of this study include:

- “The pattern for mathematics course-taking is set in the freshman year. ... Among those graduates who had completed algebra I in the ninth grade, 34% completed calculus or another advanced mathematics course prior to graduation. ...
- The overwhelming majority (83%) of those who had completed geometry in the ninth grade went on to complete calculus or another advanced mathematics course.”⁵

High schools that require every ninth grader to take geometry are enhancing the likelihood that their students will enroll in advanced mathematics courses during their high school career. These high schools are helping to educate students who may ultimately develop the mathematical talent necessary to drive a robust economy.

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AP Course-taking Patterns

Research studies on AP course takers show that high school students who "... take AP Exams in mathematics and science are more likely to take at least one course in the discipline of their exam while in college, compared to students who did not take any AP Exams in the same areas. In addition, many AP students who took AP Exams in biology, physics, and calculus subsequently majored or minored in the subject area of their exams or a closely related field."⁶

"Over 40 percent of our nation's high schools do not offer any AP courses. Many of these schools serve predominantly low-income and minority students."⁷ At present, only 30 percent of high school students take any AP course.⁸ Students who take two or more Advanced Placement classes are twice as likely to graduate from college in four years or less than students who do not take any AP classes.⁹

According to Bill Fitzsimmons, dean of Admissions and Financial Aid, Harvard University: "One of the best standard predictors of academic success at Harvard is performance on Advanced Placement examinations."¹⁰

High schools that offer AP mathematics courses are enhancing the likelihood that their students will succeed in college, enroll in mathematics courses in college, and perhaps major in mathematics or a closely related field.

Private School Course-taking Patterns

According to an NAEP report on private schools, *Special Analysis 2002 Private Schools: A Brief Portrait*, students in private schools are required to take more mathematics and science courses than students in public high schools and they score higher on standardized achievement tests in mathematics.

"Compared with public schools, private schools required more coursework (in 4-year high school programs) in 1999–2000 in social studies, mathematics, science, foreign language, and computer science Private schools required on average 3.1 years of mathematics, while public schools required 2.7 years, for example."¹¹

"Students who had attended private school in 8th grade were twice as likely as those who had attended public school to have completed a bachelor's or higher degree by their mid-20s, and far less likely to have had no postsecondary education."¹²

High schools that have strong mathematics graduation requirement are enhancing the likelihood that their students will be successful in college and successfully complete an undergraduate degree or higher.

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Elementary and Secondary Mathematics Assessment Scores

1. NAEP Mathematics Scores for Grades 4, 8, 12

“The Nation’s Report Card™ is an annual report of the NAEP, which is a congressionally mandated project of the National Center for Education Statistics. The NAEP measures the achievement in mathematics and other subjects, over time, of 4th, 8th, and 12th graders. The NAEP has three achievement levels. From lowest to highest they are:

- *BASIC*, which denotes partial mastery of the knowledge and skills that are fundamental for proficient work at a given grade
- *PROFICIENT*, which represents solid academic performance. Students reaching this level have demonstrated competency over challenging subject matter
- *ADVANCED*, which signifies superior performance.¹³

The Grade 12 National NAEP mathematics scores for 2005:

- 61% of high school seniors performed at or above the *Basic* level
- 23% performed at or above *Proficient*
- 2% performed at or above *Advanced* level¹⁴

Asian/Pacific Islander students scored higher than students from other racial/ethnic groups, while white students scored higher than their Black and Hispanic counterparts across 4th, 8th, and 12th grades.¹⁵ Also, data from the *2005 NAEP High School Transcript Study* show that mathematics scores on NAEP increase, on average, as graduates complete more advanced mathematics courses.¹⁶

The NAEP data underscore the continuing challenges of strengthening K-12 mathematics programs and graduation requirements, and of closing the achievement gap, in order to improve the likelihood that high school graduates will pursue careers where they will contribute to a robust economy.

2. Mathematics SAT Scores: National and State of Massachusetts

For students who graduated from high school in 2006, the national mean SAT score in mathematics was 518. Similar to the NAEP scores in mathematics, Asian/Pacific Islander students scored higher than students from other racial/ethnic groups, and White students scored higher than their Black and Hispanic counterparts. The mean SAT scores in mathematics by racial/ethnic groups were as follows: Asian students, 578; Black students, 429; Mexican American students, 465, Puerto Rican students, 456, Other Hispanic students, 463; White students, 536.¹⁷

Massachusetts students had the highest mathematics SAT score of any state. In all, 85% of Massachusetts’ public and private high school seniors participated in the 2006 SAT. For Massachusetts students, the 2006 mean SAT score in mathematics was 524. Statewide, scores mirrored the national achievement gap. The mean SAT scores by racial/ethnic groups were as follows: Asian students, 577; Black students, 430; Hispanic students, 447; White students, 534.¹⁸

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Virtually all college-bound seniors take the Mathematics SAT. It is one among a set of undergraduate admissions criteria used by most colleges and universities. There is continuing controversy and research over the validity of the SAT (verbal and mathematics) as a predictor of the grade point average (GPA) for college students. At present it is generally believed that SAT scores are not valid for predicting the college freshman GPAs for African American students or for non-traditional students (students who attend college later in life). "For traditional, Caucasian college students, there seems to be a strong correlation between SAT scores and high school grades and between SAT scores and college freshman grades. High school grades are actually a stronger predictor of college freshman grades than the SAT alone, but the combination of high school grades and SAT are a stronger predictor of college freshman grades than either alone."¹⁹

The State of Weston Mathematics Education

Standard & Poor's has identified 30 school districts, or 14.7 percent of the 204 districts in Massachusetts with sufficient data for analysis, that have outperformed demographically similar school districts in reading and mathematics proficiency (RaMP) for two consecutive years (2003-04 and 2004-05).²⁰

Particularly noteworthy, Weston is among 23 districts which have outperformed for *four* consecutive years. Other districts include Belmont, Brookline, Lexington, Newton, Wellesley, and Wayland.

Standard & Poor's believes that highlighting Massachusetts's 30 outperforming school districts is important because "... it may help shed light on effective strategies and "best practices" that assist lower-performing 'peers' in making needed improvements to positively impact student achievement."²¹

To be an "outperforming school district," the district must have met the following criteria:

- **"School districts must achieve higher levels of student proficiency than peers.**
Outperformers must report higher percentages of students that score at or above state standards on reading and tests than other school districts that serve similar proportions of economically disadvantaged students.
- **School districts must perform at a level that significantly exceeds statistical expectation.**
Outperformers must achieve proficiency levels that fall above the threshold for the expected performance zone, as simply beating peers is not sufficient.
- **School districts must outperform consistently.** Outperformers must repeat this performance for at least two consecutive years."²²

We look at the same factors discussed in the previous section, The State of U.S. Mathematics Education, for insight into the state of Weston mathematics education.

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Weston High School First Year Course-taking Patterns

The *2005 NAEP High School Transcript Study* finds that the mathematics course a student takes in the freshman year is predictive of whether they will take advanced mathematics courses. In fact, 83% of the students who graduated in 2005 who took geometry in 9th grade subsequently took an advanced mathematics class.

At Weston High School, all students take geometry in ninth grade.

AP Course-taking Patterns at Weston High School

Only 30 percent of American students take any AP course at all. Forty percent of schools offer no AP courses. Yet, as was noted earlier, research shows that taking AP mathematics and science courses correlates with taking college courses in the same fields, and even with majoring or minoring in these fields.

In the Class of 2006 at Weston High School, 16% of students took Calculus AB; 11% took Calculus BC; 30% took AP Statistics. Weston High School offers a total of 19 AP courses across subjects.

Private School Course-taking Patterns

As mentioned previously, private high schools require on average 3.1 years of mathematics, while public high schools require on average 2.7 years. Weston High School is similar to private high schools in that it requires 3 years of mathematics, including Algebra 2.

Weston Elementary and Secondary Mathematics Assessment Scores

1. ERB and MCAS Scores

The Weston Public Schools use the Comprehensive Testing Program (CTP) of the Educational Records Bureau (ERB) and the Massachusetts Comprehensive Assessment System (MCAS) to measure student progress and achievement in mathematics. The ERB's standardized achievement test is used by over 1500 independent school and suburban public school members. Member schools receive ERB reports and interpretations of individual and group test results.

Weston students have scored very favorably on the ERB and MCAS tests compared with surrounding, comparable neighborhoods. The specific data is included in a later section of this report under the answer to Question 1.

2. Weston High School SAT Mathematics Scores

The Weston High School Class of 2006 (155 students) averaged 632 on the SAT in Mathematics. This compares with the national mean of 518. (Weston High School ranked 6th out of 336 Massachusetts high schools when schools were ranked for mean SAT scores in mathematics.²³)

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Weston High School consistently scores among the top public schools in Massachusetts. The Class of 2006 averaged 632 in Mathematics, with 95% of the members of the class taking the test. Weston High School ranked 6th out of 336 Massachusetts high schools when schools were ranked for mean SAT scores in mathematics. It compared favorably with surrounding, comparable communities including Wayland (7th), Wellesley (2nd), Concord-Carlisle (10th), and Lexington (5th).²⁴

Weston High School's mean SAT score in mathematics is similar to the mean SAT score in mathematics for National Association of Independent School (NAIS) students which was 600.²⁵

By normative national and state measures and course-taking patterns, it is the Committee's opinion that the Weston mathematics program is effectively preparing Weston students in mathematics.

Also, by requiring every student to take three years of mathematics, including geometry in the ninth grade, and by offering AP courses in mathematics, Weston High School is providing an environment that is favorable to developing the mathematical talent that drives a robust economy.

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Findings

Common Themes

The Program Review Committee identified several themes that emerged across elementary, middle, and high school mathematics. These included:

- Under the leadership of the K-5 Mathematics Curriculum Specialist and Secondary Mathematics Department Head, teachers have designed a BIG IDEAS curriculum that stresses depth of understanding of fundamental concepts and the skills needed to understand them, over rote memorization and wide coverage. The BIG IDEAS curriculum supports a set of Weston Mathematics Standards for K-12 that was developed by Weston mathematics teachers. These standards align with the Massachusetts Framework standards as well as with the standards for school mathematics of the National Council of Teachers of Mathematics (NCTM), the largest professional organization of mathematics educators.
- The BIG IDEAS approach has been widely publicized and is highly visible (posted in classes, noted on homework assignments, etc.). It serves to provide direction and cohesion to all mathematics-related instruction, academic support, and planning. It energizes all conversations about mathematics at Weston.
- The mathematics teachers feel a sense of ownership in the curriculum; they are passionate about it. It has brought them together to collaborate in designing a uniquely Weston curriculum, one that aims to support all students in meeting Weston Mathematics Standards.
- The curriculum isn't text-bound. Instead, teachers select the "best of the best" class activities and homework assignments from existing, published curricula (e.g., TERC's *Investigations* and Scott Foreman-Addison Wesley Elementary Mathematics curriculum) or design their own. Some classes use a textbook; others do not. All classes have a textbook available as a reference. Teachers have organized the mathematics curriculum across grades and developed common assessments across courses.
- Teachers have high regard for the K-5 Mathematics Curriculum Specialist and the Secondary Mathematics Department Head whom they credit for leading them in developing the Weston Mathematics Standards and new curriculum, supplying them with the instructional resources they need to teach effectively, and providing them with a wealth of opportunities for professional development.
- SPED instructors are very positive about the mathematics teachers. They note mathematics teachers' concern for the progress of each student, their efforts to make themselves available for giving extra help to students, and their openness to learning and using new pedagogies.

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- The technology staff is enthusiastic about training the teachers and about helping to enhance mathematics instruction.
- The climate of mathematics classes is positive, relaxed and well managed. Classes focus on problem-solving and explaining one's thinking. Teachers give attention to developing computational fluency. Communication is a feature of every class. Mathematics is visible and spoken at all Weston schools.
- In the elementary grades, there no longer is leveling. The goal is to have every child at level. In the secondary grades, there has been a transition over the last seven years from three levels per course to two: College Preparatory and Honors. Teachers say that they talk about differentiation all the time. They practice differentiation in their classes. They desire to learn more differentiation strategies.

Moving from common themes across grades and school levels, this report next looks at the elementary, middle, and secondary schools individually, and provides commendations and recommendations.

Commendations: K-12

It is the Committee's opinion that the Weston K-12 mathematics program is very strong.

1. The Teachers

The Committee affirms the high quality of the teachers' content knowledge and pedagogy, and acknowledges their evident enthusiasm for mathematics and students' learning. Teachers used many kinds of active learning strategies and used them confidently and effectively.

2. The Classroom Environment

Mathematics classes we observed were relaxed but well-managed. The atmosphere was positive and supportive. The less knowledgeable students did not seem fearful of asking questions. The more secure students were willing to help others. Students appreciate that mathematics classes intersperse lectures, small group work, and other activities instead of just lecturing. Students like working in groups during class; some said explaining their solutions to other students helped cement their understanding.

3. Problem-solving and Communication

Problem-solving was a dominant feature of every class we visited. Also, across grades and levels, students seemed very comfortable explaining their strategies and presenting their solutions.

4. Progress in Differentiation

The Committee believes that the mathematics faculty is thoughtfully and carefully working to address the needs of individual learners. Several important differentiation initiatives have already been undertaken, including: a successful Mathematics Intervention program for Grade One; flexible grouping practices in the elementary grades; Topics courses for all level II, middle school mathematics courses; and differentiated homework assignments and assessments for middle

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and high school students.

5. **Special Education Support for Students**

The SPED instructors were very enthusiastic about the mathematics teachers and their desire to help all students learn mathematics. They said that mathematics teachers regularly attend SPED meetings and are willing to help all students, including those who are in other mathematics classes. The instructors reported that the mathematics program does a good job of transitioning special education students from the middle school to the high school. The special education instructors reported that their students make great strides between freshman and senior year. This level of collaboration between SPED and mathematics is commendable.

6. **The Students**

Given the outstanding performance of Weston students on standardized tests from MCAS, SAT, SAT2, ERB, and the American Mathematics Competition, we expected to meet bright, articulate, highly motivated students. Our expectations were more than met.

7. **The Weston Public Schools K-12 Mathematics Standards and BIG IDEAS**

The Weston Standards strongly mesh with national and state standards for elementary and secondary school mathematics. The Weston BIG IDEAS are as bold as their name. They embody the concepts that teachers believe Weston students should know, as well the skills and understandings that students should acquire at each grade level. The BIG IDEAS vision guides and integrates all mathematics curriculum development, instruction, and assessment at Weston.

8. **The Curriculum Leaders**

The Committee affirms the high quality of the leadership in mathematics. The K-5 Curriculum Specialist and Secondary Mathematics Department Head have brought teachers together to shape a curriculum that fits the Weston BIG IDEAS vision. They support teachers in continually rethinking their teaching, and obtaining any materials or software they need to enhance their teaching. The leaders have instilled openness and trust.

9. **Financial Support and Faculty Development**

The Committee recognizes the level of support of the Weston community in providing teaching resources for the classroom and professional development resources for faculty. For example, teachers can be reimbursed up to \$1,200 each year for courses/workshops. Also, there is a \$280,000 fund that supports teacher proposals for professional development activities (e.g., for taking online courses, for organizing workshops, and so forth). Teachers appreciate and use the generous faculty development provided by Weston. All teachers are engaged in ongoing professional development.

10. **Technology and Other Resources**

The classrooms we observed seemed very well equipped, and teachers seemed very confident about requesting materials needed for instruction. Each elementary classroom has 3 computers, every high school teacher has a laptop,

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and there are computer labs in every school. The breadth of mathematics software available in Weston is particularly impressive. At the elementary schools children are using *FasttMath* to solidify their basic number facts, and *Study Island* to help prepare for the MCAS tests. *Study Island* helps teachers to identify areas where they need to re-teach; parents can use it, too, there's home web access. Middle and high school students have access to *Scheme*, *Geometer's Sketchpad*, and *Fathom*. Weston is far ahead of many, if not most, school districts in its technology resources for mathematics.

Suggestions for Enhancements

The Review Committee supports the following teacher suggestions:

Elementary School (K-5):

- Additional sets of manipulatives, such as overhead fraction bars and others. At present teachers have to sign out manipulatives, which makes access difficult.
- Additional computer projectors as well as Smartboard technology, as tools to strengthen pedagogy.
- More information on the best technologies and more release time for working with and exploring the potential of various software already owned by Weston
- More training and more materials for providing challenging differentiation
- More mathematics games to supplement the curriculum
- Greater consistency in the Grade 3 mathematics across the elementary schools
- Additional Kathy Richardson materials and training
- Professional development in teaching *Investigations* for new teachers and teachers hired since its implementation

Middle School (6-8)

- A second laptop cart
- Release time for teachers to learn from each other, e.g., to see how some teachers are using technology
- More differentiation materials to meet the needs of students who may be caught in the cracks between the quick-paced students and the slower ones in the class
- A new record-keeping approach that tracks each student's growth and progress from year to year

High School (9-12)

- A second laptop cart
- Release time for teachers to learn from each other, e.g., to see how some teachers are using technology
- Integration with other disciplines. The mathematics program may wish to look at the document, *Teaching Mathematical Biology in High School*, produced in connection with a 2005 summer workshop held at Rutgers on connections between mathematics and biology.²⁶

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Recommendations

The Committee offers the following recommendations for opportunities to further strengthen the teaching and learning of mathematics in the Weston Public Schools.

Elementary School (K-5)

- An achievement gap does exist for a small number of children. A current and future challenge is that over 50% of METCO students have English Language Learners (ELL) issues. Expanded interventions and support are needed to help these children, particularly at the elementary level when they are developing their reading skills.
- There are no direct services, i.e., regular education support, beyond Grade 1. The Field School (Grades 4 and 5) has a tutor available for 15 hours per week but this is not sufficient. Teachers and parents would like to see regular education support for Grades 2 and 3 such as the direct services and intervention programs currently being provided to Grade 1. The Committee recommends that the Weston Public Schools take steps to address this unmet need.
- Elementary school faculty expressed concern that children entering the Field School from the two K-3 schools, Woodland and Country, *might* have inconsistent backgrounds. They indicated that their lack of joint planning meant they could not *know* that their programs were inconsistent. They recognize the need to coordinate across primary schools, and then to vertically align with Field. The Committee recommends that such joint planning be implemented.

Secondary School (6-12)

- Teachers observed that the achievement gap for METCO students narrows from September to June but grows back over the summer. They also observed that METCO students are underrepresented in Honors courses. In summer 2007 Weston will be piloting a six-week bridge program to address these issues. The Committee applauds this initiative, but cautions that not all students wish to or are able to take advantage of summer programs. Weston should consider exploring the possibility of developing an intensive program for the beginning of the school year to jump-start these students.
- Teachers, students, parents, and administrators voiced concern that differentiation practices may be falling short. Mathematics has just two levels: College Prep and Honors. The top students in College Prep courses feel under-challenged. The top students in Honors courses feel under-challenged. The Committee recommends that teachers be encouraged to locate and/or develop materials to enrich class offerings. One possible source of supplemental material for use in differentiation might be the Phillips Exeter Academy (PEA) mathematics problems. Other possible sources are textbook readings and web resources.

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- The Topics courses for middle school mathematics courses and Algebra 2 are very favorably regarded by teachers and students. Teachers, students, and parents feel a Topics course for Geometry is now needed. The Committee endorses this recommendation.
- Teachers and administrators uniformly identify the achievement gap as a priority. They desire to find the root causes and ways to address them. The Committee agrees that the achievement gap is a major issue; it is a systemic problem confronting all public school systems. The Committee urges Weston to collaborate with other school systems and other national education organizations to explore this issue and investigate best practices. One potential resource is the Montgomery County Public Schools in Montgomery County, Maryland.

Responses to the Committee Charge

Question 1: Does the K-12 Mathematics Program, based on the Weston Mathematics Standards and Big Ideas, provide students with the necessary content and skills to be successful students and users of mathematics beyond high school?

There is no direct evidence to address this question because Weston does not gather longitudinal data. However, Weston is not unique in this; the Program Review Committee does not know of any school district in the country that does so.

On the other hand, there is strong indirect evidence that the answer is yes.

As one example, a study by Achieve, Inc. found that sixty percent of college students who took Algebra 2 and other high-level mathematics courses in high school said they felt well-prepared for college, compared to 26% of students who did not take them. All Weston High School students must take three years of mathematics, including Algebra 2. This indicates that Weston students will be successful beyond high school.

More indirect evidence emerged from the Committee's review of written documents and empirical data such as the performance of Weston students on standardized mathematics exams, classroom observations and meetings with teachers. Our findings are categorized below.

- **The Weston Mathematics Standards**

The Weston Mathematics Standards strongly align with the Massachusetts Curriculum Frameworks for Mathematics (November, 2000) and the national standards set forth by the National Council of Teachers of Mathematics (NCTM) in the *NCTM Principles and Standards for School Mathematics* (2000). The NCTM standards, from which the Massachusetts Curriculum Frameworks were drawn, specify the topics, concepts, and skills that are deemed to be needed for students to be successful users of mathematics in the 21st century:

“We live in a mathematical world. ... The level of mathematical thinking and problem solving needed in the workplace has increased dramatically. ... the Standards for school mathematics describe an ambitious and comprehensive set of goals for mathematics instruction. The first five Standards present goals in the mathematical content areas of number and operations, algebra, geometry, measurement, and data analysis and probability. The second five describe goals for the processes of problem solving, reasoning and proof, connections, communication, and representation. Together, the Standards describe the basic skills and understandings that students will need to function effectively in the twenty-first century.”²⁷

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- **BIG IDEAS**

The BIG IDEAS philosophy of the Weston mathematics program in Weston emphasizes deep understanding of fundamental mathematical concepts and acquisition of the skills that are needed for understanding the concepts in context. This approach sets a tone for every mathematics class and gives direction and cohesion to the entire mathematics program.

- **Student Performance**

Standardized test scores have historically been outstanding, and they continue to compare favorably with scores in surrounding, comparable communities.

- **College placements for the Class of 2006**

In 2006, 94% went on to four-year colleges, including the most competitive colleges and universities in the country.

- **SAT statistics for the Class of 2006**

(155 students) as compared to national SAT statistics²⁸ were as follows:

- Math SAT I

National average: 518

Weston average: 632 (95% took the exam)

Wayland: 624; Wellesley: 634; Concord-Carlisle: 614; Lexington: 629²⁹

- Math 1C SAT II

National average: 593

Weston average: 643 (38% took the exam)

- Math 2C SAT II average:

National average: 644

Weston average: 704 (30% took the exam)

- **MCAS statistics for Weston as compared to surrounding, comparable communities:**

- MCAS Scores for Grade 4

Weston percent in Advanced/Proficient range: 72%

Higher than many surrounding communities

- MCAS scores for Grade 6

Weston percent in Advanced/Proficient range: 75%

Wayland: 89%; Wellesley: 96%; Concord-Carlisle: 98%; Lexington: 89%

- MCAS scores for Grade 10

Weston percent in Advanced/Proficient range: 95%

Wayland: 96%; Wellesley: 89%; Concord-Carlisle: 90%; Lexington: 89%

- **ERB data**

"In comparing the Weston 2006 average scaled scores in mathematics with those of the Suburban and Independent schools, Weston continues to score higher at each grade in both the 50% and 90% percentile markers (See Figure 2). This is the third year in a row that such a gap exists between the Weston scores and the other two subsets. In fact, this year there is a twenty-point difference at the 90th percentile between the Grade 7 Weston score of 423 and the Grade 7 Independent score of 403."³⁰

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ERB 2006-Mathematics 1 & 2 Scaled Scores

Grade	50% Percentile			90% Percentile		
	Weston	Suburban	Indep.	Weston	Suburban	Indep.
3	301	296	300	339	329	331
4	319	307	310	349	341	340
5	345	333	335	377	365	365
6	347	337	340	381	370	371
7	381	364	367	423	404	403

The Committee was able to visit one-third of all K-12 mathematics classes. The content that Committee members observed being covered, and the materials from the references in our meeting room, clearly showed that the Weston Mathematics Department is providing their students with adequate content and skills for further study in mathematics. In our classroom visits across the grades we saw students engaged in problem-solving. Students worked on longer and thoughtful problems, as well as straightforward work that strengthened concepts and skills in manipulation and arithmetic. The students whom we observed clearly had the skills to do the tasks presented, were successful at their level of understanding, and able to articulate their thinking to classmates with clarity.

Middle school teachers confirmed that students arrive with necessary prerequisite skills to meet the curriculum goals for Grade 6, indicating the elementary schools were appropriately meeting the Weston Standards.

High school mathematics teachers indicated they were pleased with the skills that students brought as they transitioned to high school.

For the future, to address the question of whether the K-12 Mathematics Program, based on the Weston Mathematics Standards and Big Ideas, provides students with the necessary content and skills to be successful students and users of mathematics beyond high school, Weston may wish to gather longitudinal data such as satisfaction surveys of alumni or their employers or college advisers.

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Question 2: Does our program assist students in making effective progress in attaining our learning standards?

The learning standards are well thought out and clearly stated. From the Committee's limited time in Weston, it was difficult to see how well assessments are aligned with the standards, and if students are being measured based on those standards. To capture data on a particular student's progress in attaining the standards throughout a single mathematics course, it would be necessary to explicitly design questions or activities to match the standards. To assess the progress of a particular student over the period 9-12 (or 6-12 or K-12), a portfolio approach might be considered, where samples of embedded assessment are archived over the period.

On the other hand, classroom observations, review of samples of children's work, and interviews with teachers provide valuable indirect information; and this information leads us to answer, yes, for the most part.

- **Classroom observations**

There was certainly ample evidence in every class that we observed that teachers were planning curriculum and instruction around the standards. In the classes we visited, we saw a variety of approaches used for different students in the small group work that helped the individuals feel comfortable in the class. All the teachers we visited created a supportive atmosphere where students were comfortable in asking questions without intimidation and answering questions without fear of being wrong. The atmosphere that the teachers developed in their classes was supportive and certainly helped students progress in their learning. Students seem to have an excellent grasp of what they are learning and why.

- **Review of written materials (e.g., samples of student work)**

The Committee reviewed end-of-year course assessments at the secondary level and agrees that they reflect alignment with the Weston Mathematical Standards.

While the elementary end-of-year assessments also are aligned with the Weston (and Massachusetts) Mathematics Standards, they do not consistently reflect the core approach of the elementary mathematics program, which emphasizes that students should provide explanations in the form of numbers, pictures or words for their work. This is most notably true of the Grade 3 assessment.

- **Interviews with teachers**

The Country elementary faculty forum reported concerns that Country and Woodland *might* be supplying Field with students with inconsistent backgrounds because the two schools did not plan enough together, but they also said that their lack of joint planning meant that they could not *know* that their programs were inconsistent. They want to coordinate across primary schools and then vertically with Field. Teachers also mentioned wanting more comprehensive and thorough training with *Investigations* as a way of improving the use of the program. At the very least, such extra planning and communication would be reassuring and helpful to the teachers, and it may contribute to assisting students in making effective progress.

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- **Supports for at-risk learners**

The Committee agrees that the Weston mathematics program provides a wide range of mathematics experiences for students. If progress is measured by student performance on standardized tests, then it can be said with confidence that the students are making effective progress in the aggregate. If progress is measured by whether all students successfully complete a given course or are passed onto the next grade, then, overall, Weston students are making effective progress. Few students fail mathematics courses at the secondary level. It is rare for a student not to pass to the next grade in the elementary schools.

The question is, "What does effective progress mean in the context of a high achieving school system?" Does simply "passing" constitute effective progress? Some students continue to struggle with mathematics, most notably English Language Learners (ELL) students and METCO students. Supports (tutoring, after school homework help, technology) and direct intervention programs have been put into place in all grades to ensure that the students who struggle receive the help that they need to progress in their understanding of mathematics.

We describe the supports by level, and note gaps as reported to the Committee.

- a. **Grades 1-3**

The Grade 1 Mathematics Intervention Program is particularly notable in its success in helping students make significant progress as measured by grade equivalency performance on the Test of Early Mathematics Ability (TEMA-3). The average gain was around two years after 6 months of the intervention. Upon retesting in the fall, there was little regression in scores. There is no mathematics intervention program in Grades 2 and 3, unless a student has an IEP.

Additional observation: There is evidence in the benchmark assessments and sample work that teachers are keeping track of attainment of standards. What was not clear was how plans were formed for children *not* meeting the standards (other than the intervention program and SPED).

- b. **Grades 4-5**

This year a mathematics support program has been implemented in Grades 4 and 5 for regular education students. Identified students receive 30 minutes of mathematics tutoring individually or in very small groups once a week. Other than anecdotal reports from teachers and students, there is no data at this time which measures the success of this intervention.

- c. **Middle School**

The middle school has a supplementary mathematics program called Topics. Identified through test scores and teacher recommendations, students in level II mathematics classes are scheduled into two additional mathematics blocks per week with a different mathematics teacher than their regular mathematics teacher. Students receive homework/classroom support, which could involve the re-teaching of newly presented concepts and skills. To the extent possible, some pre-teaching of concepts occurs in a Topics class. Students in a level II class can choose either to take an A or B test. 'B' tests only assess the essential standards

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of the unit, while 'A' tests include extension questions. The highest grade that can be obtained on a 'B' test is a B. This choice allows students the opportunity to monitor the pace of their learning. This program helps struggling students to have the extra time and attention needed to maintain the pace of the regular mathematics class.

d. Achievement Gap

i. Elementary School

Test scores validate that children are meeting the standards. The question still remains of how the achievement gap is being met, especially for METCO students.

ii. Secondary School

METCO students are underrepresented in level 1 Honors mathematics classes in the middle school and in Honors mathematics courses in the high school. A C+ in 8th grade Honors Algebra 1 is a prerequisite to taking Honors Geometry in high school. The real challenge is to understand why so few METCO students are achieving even at that level in 8th grade, and then to address that disparity.

A possible intervention could include having students who are on the cusp of eligibility between College Prep/Honors courses take a summer school course to prepare them to take the Honors level course; for example, students might take Honors Geometry in the summer for no credit before taking Honors Geometry in 9th grade. During our two-day visit, we learned that Weston will be piloting such a program in summer 2007. The underlying reasons for the achievement gap, however, require further study.

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Question 3: Does our core mathematics program provide an appropriate balance of computation and problem solving experiences as well as concepts and skills?

We affirmed, in Question 1, that Weston's program "provide[s] students with the necessary content and skills to be successful students and users of mathematics beyond high school." In our view, the program contains a good balance of everything, and this includes computation and problem solving. We base our conclusion on classroom observations, interviews with teachers, and examination of written materials.

On the other hand, the Committee was made aware that some parents feel that more attention needs to be paid to developing computational fluency at the elementary grades. Some have enrolled their children in after-school programs such as the Russian Schools and Kumon schools to develop computational skills. The parent samples were small: Ten parents attended the forum for elementary school parents, and six parents attended the forum for secondary school parents; in addition, a half-dozen parents who were unable to attend the forums shared their views by e-mail. Because the sample sizes are small and may be biased, we are unable to draw firm conclusions except to suggest that the extent and reasons for this may warrant further consideration. Communicating to parents the goals and practices of the mathematics program may help to ease concerns.

We summarize our findings by level.

- **Elementary School (K-5)**

In every grade we visited, emphasis in classroom lessons was on problem solving and children were given opportunities for computation practice. Because our visit was a snapshot, both computation and problem solving were not always seen in the same classroom. This does not mean the opportunities do not exist. Across grades, we *did* see *both*. Moreover, the level of balance was evident in the collection of student work reviewed for elementary students.

Teachers have worked to develop a curriculum that blends concepts and skills. They have drawn upon some of the best teaching resources currently available, including TERC's *Investigations into Number, Data, and Space* curriculum, known for its focus on problem-solving, and a new software that promotes number facts, *FasttMath*. Teachers, students, support instructional staff, and principals were uniformly excited about *FasttMath*, which Weston adopted last year. It provides ten minutes per day of fact practice and it has a diagnostic feature that tailors instruction to fit the student's needs. We observed a Grade 2 lab class where children were practicing their number facts with *FasttMath*. We also saw teachers use it as a tool for differentiation, during regular classes.

We add that Grades 4 and 5 offer some minor intervention to assist students achieve fluency. Teachers use Scott Foreman Addison Wesley (SAW) Teacher Resource package for computation support. Other grades indicated they would be interested in

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these resources to balance the program.

- **Secondary (6-12)**

The classes that we observed exhibited an excellent balance between general rules and concepts on the one hand, and specific computational skills on the other. The teachers clearly articulated connections between the bigger concepts and the mathematical methods. They encouraged students to approach the same problem from different angles, leading to a fuller understanding of the topics at hand (e.g. elimination, substitution and graphing as ways to solve the same system of equations). Additionally, instead of rote memorization of important equations and concepts, students reach those major ideas through their own work (e.g. the Law of Cosines).

One small cautionary note: Middle school teachers express some dissatisfaction with the basic fact competency of some students. Perhaps students entering middle school in future years having had the *FasttMath* experience will demonstrate greater basic skill competencies.

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Question 4: Do we have sufficient technology and do we use it effectively?

In general, teachers love the technology and are eager for more. Very important, they know why they want the technology, seem to be using it thoughtfully and well with clear content goals and pedagogical reasons in mind, and seem to have enough other needs met so that this one can sensibly rise to the top.

Here are some examples, from classroom observations, meetings with teachers, and review of written materials, of how we saw teachers effectively using technology in their teaching.

- **Elementary School**

The Committee observed teachers who integrated technology smoothly and skillfully in the classroom.

Classroom observations

- Technology is visible in the classrooms and generated student work.
- We saw a mix of creative and more routine tasks on the computer.
- Computer labs are available for class sessions and there are computers in each room.
- There are a variety of activities offered on the server and the web.

Conversations with teachers

- Teachers were enthusiastic about technology and appreciative of the training models used.
- Teachers expressed a desire for time to work and get to know more computer programs.

- **Secondary School**

Teachers varied in the extent to which they used technology. Some used it sparingly; others fully integrated it with their daily class activities. There were opportunities where technology might have been used to more advantage.

Classroom observations

- In College Prep Geometry, the students did labs in *Geometer's Sketchpad* designed to teach them about the properties of quadrilaterals. (Note: The students were not doing the labs while the Committee was there, but the teacher provided copies of the materials.)
- Students used calculators very appropriately in Grade 7 mathematics for computation.
- At the middle school the students had previously used the computer lab to make graphs. They discovered the computers did not give them the correct information when looking for the mode. If there was more than one mode they were only given one. Not only was the technology used for a mathematical goal but also for a learning goal regarding the inappropriate use of technology or the need to check technology.

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- In Honors Geometry, the teacher had prepared some of the more complex diagrams from homework in *Geometer's Sketchpad*. He then projected these diagrams on the board so that students could use them when explaining problems to their classmates.
- Students in AP Statistics use their calculators on a daily basis, and also do occasional projects in *Minitab*.
- Students in Honors Precalculus went to the computer lab to explore the properties of polynomials and polynomial functions.
- Although several classrooms did have 15-16 computers in the back of the room, the Committee is not aware if the computers are able to support the software the teachers wish to use.

Curriculum materials

- An Honors Geometry project about angle measures of stars using *Dr. Scheme*
- A web-based lab about periodic motion for Honors Precalculus.
- A *Fathom*-based project about linear regression for College Prep Precalculus.

Conversations with teachers

- The department recently purchased and has begun to investigate Maple as a computer algebra system. Surely teachers will be exploring the potential for such software in the mathematics classroom. Certainly, there are always possibilities for more technology in the department, but we got a strong sense from the teachers that they are open to the use of technology and are willing to take the time to learn how to use it to improve the learning of their students.

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Question 5: Do our hiring practices and professional development programs assure quality instruction in mathematics?

- **Elementary (K-5)**

Due to time constraints, discussion of elementary school hiring practices was beyond the scope of the Committee's visit. On the other hand, the Committee heard uniformly positive things about professional development opportunities from elementary school teachers.

Conversations with teachers

- Teachers are overwhelmingly appreciative of the opportunities being offered for professional development.
- The \$1200 per year for professional development is greatly appreciated.
- Professional development for shared experience and growth is very much supported. For example, this fall every teacher at the Field School and several teachers and the principals of the Country and Woodland Schools participated in an online graduate course, *Teaching Math Fundamentals on the Way to Algebraic Thinking in Elementary School*, sponsored by Harvard University.
- TEAM/Department meetings provide useful information for all to use.
- There was overwhelming support for the K-5 Curriculum Specialist in the area of support and professional development. She is more than willing to give in-house workshops and mini-lessons. They are helpful and very relevant.
- When queried, teachers offered these suggestions for additions:
 - Teachers would like to have more Kathy Richardson seminars.
 - They would like to observe each other teach.
 - There were some calls for more professional development for teachers around the use of *Investigations*. Some teachers felt that *Investigations* is too hard to read/use on one's own, and that new teachers especially, but even some of the older teachers, do not have enough support to use it really well.

- **Secondary (6-12)**

The chair of the Committee met with the secondary principals, and there was an opportunity to ask briefly about hiring practices. The principals observed that at the same time as the mathematics teachers have been revising the curriculum there has been lots of turnover due to retirements. One consequence, they said, has been a nice fusion of fresh ideas and a variety of teaching approaches that weren't there five or six years ago. The Committee affirms that we did observe Weston teachers apply fresh ideas and a variety of teaching approaches.

Conversations with teachers

- The professional development reimbursement is generous, appreciated, and used. Weston's commitment to professional development is reflected in its financial support for teachers taking courses and workshops outside of the district.
- Teachers can be reimbursed up to \$1,200 for courses/workshops. In the last two years, teachers have sought professional development for:

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- expanding their use of the programming language *Scheme* as a tool in several classes; utilizing *Geometer's Sketchpad* software in geometry courses; using *Fathom* for graphing and statistical modeling; understanding and addressing the achievement gap in mathematics; and, developing Topics courses for Grades six and seven.
- When queried as to their suggestions for additional professional development, some teachers suggested having additional release time to watch colleagues teach and observe other styles.

In their classroom visits and meetings with mathematics teachers, the Committee found the teachers to be highly competent in both mathematics and pedagogy. They used a wide range of teaching methods, they were skillful in sustaining student interest and class discussion, and they were open to new approaches. The Committee was impressed by the quality and the commitment of every faculty member we met. It was also clear that there are ample professional development opportunities, and that every faculty member took advantage of many of them. The group of Weston mathematics teachers seems extremely strong. The teachers also work hard to take advantage of professional development and appear to be constantly rethinking their teaching. The group appears to be very collegial. Like the elementary school teachers, the secondary teachers were very positive about the wide range of professional opportunities they are afforded.

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Additional questions that delve into more specific areas and as such are subordinate to the four questions above:

Question A: Do our efforts to differentiate instruction in the elementary and secondary schools through intervention programs, pedagogical practices, and course offerings allow teachers to meet the needs of all students?

Our perception is that all teachers K-12 desire to strengthen their differentiation strategies and provide more differentiation opportunities and materials to students. Elementary and secondary teachers said that differentiation is something they talk about all the time. We note that meeting the needs of all students is realistically not possible. The question is only how badly the needs are being unmet, or whether the unmet needs (however small) are widespread, or systematic in a way that can be avoided.

We summarize our findings by level. We include the perspectives of teachers, students, parents, and administrators.

- **Elementary (K-5)**

Ten parents attended the elementary parent forum. They care about their children's progress in mathematics and offered many reflections on the elementary school mathematics program. These parents feel that teachers know their kids individually and desire that each child make progress. They are very aware that the elementary schools have transitioned from leveling to heterogeneous classes, and some question that decision. More workshops for parents and other opportunities for dialogue may help to communicate what the elementary school mathematics program is about and to ease parental concerns.

- Teachers and parents highly value the Grade 1 Mathematics Intervention program. Children's test scores showed unquestionably that it is successful. Teachers, elementary school principals, and parents would like to see it expanded to Grades 2 and 3.
- Teachers like the Grade 4 before- and after- school intervention program which is based on pre-assessments. They suggest expanding this to other grades.
- Teachers love the TEAM concept and the ability to use flexible grouping. They coordinate mathematics time to be able to exchange students to form groups. The SPED teacher can take students from 8:00 – 8:30 a.m. so they only miss before school morning work.
- Teachers feel that the use of aides in the elementary classrooms allows them to provide guided practice for some students while others work independently or with the classroom teacher.
- Teachers feel that quizzes and homework are differentiated.
- Teachers feel the need for training and materials on challenging differentiation. They need enrichment projects and will be working on these this summer.
- Some parents feel that children needing more help with their mathematics facts are not receiving adequate attention. Some are enrolling their children in after school Russian Schools and Kumon schools in order to develop fluency.

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- Some parents feel that concrete manipulatives should be used to a greater extent to help children who learn kinesthetically, in particular, to help children who are dyslexic.
- Some parents feel that *FasttMath* is not being used to full extent.
- Some parents feel that not enough is being done to challenge children who have ability in mathematics.

- **Secondary (6-12)**

As may be expected during a two-day visit, the Program Review Committee observed variations in the extent to which differentiation instruction was used from class to class.

The Committee also heard some teachers, students, and parents voice concerns that students in the cusp between College Prep and Honors courses are feeling under-challenged. The Committee is mindful that the sample sizes for both groups were small, making generalizations difficult. Moreover, there is potential bias in the parent sample, as these were the parents who had a strong enough opinion to come to the meeting or to send an email. However, the fact that this dissatisfaction was voiced across constituencies suggests this may warrant further investigation.

- Based on interviews with the SPED staffs of both the middle and high school, the Committee was impressed with how closely the Mathematics Department works with both groups. SPED staffs were very complimentary of the Mathematics Department, and felt that the Department was working hard to educate even the weakest students.
- Topics classes for level II middle school courses seem to be effective and creative intervention techniques for meeting the needs of students who struggle in mathematics. It was particularly impressive to hear that every 8th grade student was enrolled in a regular Algebra 1 class. At the high school, it appears that the Topics course for Algebra 2 is providing students with a significant amount of additional instruction, both before and after the material is presented in the regular College Prep course. In addition, any student who has an Individualized Education Plan (IEP) receives mathematics support in their tutorial sessions with SPED tutors. The fact that high school students can themselves select a Topics course (in Algebra 2) means they are able to manage their own learning needs.
- There are also rich opportunities for the strongest students. The Honors mathematics classes observed by the Committee were rich in challenging problems for these students, and they appear to truly enjoy these classes. The pedagogical and content quality of Honors level courses is evident from the success of the high school's mathematics scholastic team and the performance of students on nationally normed assessments.
- The Committee believes there is the need to offer greater challenge to students who are the top of the College Prep (level II) classes. On the basis of parent comments, some through the Director of Guidance and the Principal of the High School, there seems to be some dissatisfaction with the level of challenge offered these students in College Prep classes. This was confirmed by the Committee in an informal meeting with 13 students from grades 9 – 12 (these were a mix of Honors and College Prep students; 9 girls and 4 boys). There are two concerns: (1) Some high school students and some parents reported that a

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significant number of students in the College Prep courses find College Prep courses too easy, but find the Honors offerings too difficult. (There are some efforts to differentiate by giving “A” and “B” level tests in College Prep Geometry, but this does not seem to be enough); and, (2) Some students and parents reported that some Honors students feel that their courses are slowed down by slower students taking the class.

Overall, the Committee believes that Weston has been thoughtful and proactive in addressing the wide ranging needs of students. Topics courses and other supports are particularly helping students who struggle with mathematics. One possible source of supplemental material for use in differentiation might be the Phillips Exeter Academy (PEA) mathematics problems. These problems, and there are many, cover the gamut from Algebra 1 through multivariable calculus and discrete mathematics, and they can be downloaded from the PEA mathematics website.³¹

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Question B: Do teachers have the necessary and appropriate materials to provide instruction for all children?

The Committee members saw very adequate materials in all the rooms they visited. The extent to which they were used varied. Teachers expressed satisfaction with the availability of materials to teach mathematics. The Committee agrees with the following comments.

Suggestions for enhancement:

- Teachers feel confident requesting materials they need. The curriculum leaders have done an excellent job of introducing new materials.
- While there seems to be overall satisfaction at the elementary level, some teachers indicated that they need more manipulatives in their classrooms.
- Teachers who want to expand the use of computers in their classroom would like to have a Smart Board installed in their classroom.
- Some teachers said they would like more time to gain greater familiarity and facility with available software.
- The K-5 Mathematics Curriculum Specialist suggested that professional libraries at each school would encourage sharing of ideas and materials.

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Question C: How effective in supporting students are the coordination and articulation in place across grades and schools?

The Program Review Committee agrees that the Weston Mathematics Standards provide a clear vision of good mathematics for all students. The BIG IDEAS and benchmark statements make explicit what students should know and what they should be able to do. The documents received by the Committee reflect a clearly articulated and vertically aligned mathematics curriculum.

For the most part, coordination and articulation seem to be working well across grades and schools. It appears that greater coordination for Grade 3 may be indicated (see below).

- **Elementary (K-5)**

- The elementary teachers have developed teaching guides and outlines for each grade level. Common assessments at each grade level ensure that all teachers reach the same goals and outcomes.
- The elementary teachers feel that the TEAM concept is helping with coordination of information, but they expressed a desire for more cross-grade meeting time to improve vertical alignment of the curriculum.
- Some teachers feel there needs to be greater coordination across Grade 3 because the students are entering Grade 4 at the Field School with different skills depending on the primary school they attended.

- **Secondary (6-12)**

The Committee believes that there is good coordination across the secondary program. Middle school teachers meet weekly across courses for grade level planning. In addition, they give common assessments for each grade. Secondary teachers have updated unit teaching guides for most courses. These guides help to ensure that the concepts and the skills that are detailed in the Weston Standards are being addressed.

Question D: Are children regularly problem solving and communicating their thinking?

Not only are students regularly problem-solving, but they are approaching those problems with an array of tools and methodologies. Moreover, all students, from kindergarten through Grade 12, are asked to communicate their ideas through presentations. With the exception of one class that was being introduced to the MCAS study tool, *Study Island*, students across levels and across grades were engaged in problem-solving.

We saw good questioning techniques in classes. Elementary school children were clearly comfortable talking about mathematics and sharing ideas. “Why” was often asked after an answer was given. “What needs to be done?” and “How will you do that?” sustained the class discussion. For classes where students solved problems in small groups, the teachers provided summaries along with reflections on how the group process worked and on ways the students could work better.

The Secondary Mathematics Department Head has emphasized that classroom activities be centered on rich and challenging problems. In secondary mathematics classes, we saw wonderful communication: Students worked in pairs and in groups, they asked questions of each other and the teacher, and they presented their findings to the class. Teachers expected students to be able to explain their thinking and to work in front of the class either at an overhead or at the board.

This variety of communications methods, exhibited through an assortment of activities, seems to be precisely what makes mathematics classes “fun,” to use a favorite term of both the middle and high school students. This rich diversity of communications enables the culture of the Weston Schools in which mathematics is visible and spoken.

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Conclusion

The Weston mathematics program is an exemplary program. The mathematics teachers and curriculum leaders are talented professionals who are committed to helping all students realize their full mathematical potential. Over the past several years, there have been two major changes in the program: (1) the move from homogeneous to heterogeneous classes, (2) the transition to a curriculum that favors thinking/explaining over rote memorization or procedures. Each of these changes is a tremendous undertaking on its own, and the Weston mathematics program has made solid progress in both.

The Weston Mathematics Standards and BIG IDEAS which the teachers developed align strongly with state and national standards for mathematics; very important, the BIG IDEAS and accompanying benchmark statements under each of the Weston Mathematics Standards make explicit what the teachers believe Weston students should know and should be able to do. The mathematics teachers and curriculum leaders have energetically and collaboratively been engaged in designing their own curriculum to implement the BIG IDEAS vision. They strive continually to be sure the curriculum is cohesive; the elementary teachers have developed teaching guides and outlines for each grade level, and secondary teachers have developed teaching guides and common assessments for all courses. There are many concrete measures of the success of this program, including the high performance of Weston students on normed national and state exams, and the high acceptance rate of Weston's seniors into colleges, including some of the most competitive. There are several equally powerful, though less tangible, measures of the program's success: the evident high regard that Weston teachers, staff, and administrators hold for the mathematics teachers and leaders, as well as the BIG IDEAS vision which they have bravely and boldly made explicit; the supportive and engaging classroom environments that teachers strive to create; and, perhaps most important, the positive attitudes which Weston students show toward mathematics and their teachers.

We salute the mathematics teachers and curriculum leaders for their superb accomplishments to date, and wish them success as they continue down their well-marked path of program renewal and vigorous professional development.

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We recognize and appreciate that preparing for a program review entails the major investment of time, energy, and resources. We hope that this review report will be useful in guiding the future course of the mathematics program.

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Endnotes

- ¹ Solomon Garfunkel, Executive Director, Consortium of Mathematics and its Applications
Quoted from *Opinion: Because Math Matters*, Notices of the American Mathematical Society, p. 341, March 2007
- ² In 2005-2006, 42% of the new PhDs in the mathematical sciences were earned by U.S. citizens.
See the article, 2006 Annual Survey of the Mathematical Sciences in the U.S., Figure 3 U.S. Citizen Doctoral Recipients, Fall Counts, Notices of the American Mathematical Society, p. 259, February 2007
- ³ In 2003-2004, 13,327 of 1,399,542 bachelor's degrees were conferred in mathematics and/or statistics; source: Digest of Education Statistics: 2005, http://nces.ed.gov/programs/digest/d05/tables/dt05_249.asp
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- ⁵ <http://nces.ed.gov/nationsreportcard/pdf/studies/2007467.pdf>
- ⁶ "AP Students in College: An Investigation of Their Course-taking Patterns and College __Majors", www.collegeboard.com/ap/pdf/validity2.pdf.
- ⁷ www.ed.gov/about/inits/ed/competitiveness/expanding-apip.pdf
- ⁸ Why AP Matters, Newsweek, May 2006
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- ¹² <http://nces.ed.gov/programs/coe/2002/analyses/private/sa04.asp>
- ¹³ www.nces.ed.gov/nationsreportcard/pdf/main2005/2007468_1.pdf
- ¹⁴ Figure 12 Twelfth Grade NAEP mathematics achievement-level results in 2005, Nation's Report Card: 12th-Grade Reading and Mathematics 2005, <http://nces.ed.gov/nationsreportcard/pdf/main2005/2007468.pdf>
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- ²¹ Ibid
- ²² Ibid
- ²³ www.boston.com/news/education/k_12/articles/2006/08/29/2006_sat_scores_for_machusetts/
- ²⁴ www.boston.com/news/education/k_12/articles/2006/08/29/2006_sat_scores_for_machusetts/
- ²⁵ www.nais.org/resources/article.cfm?ItemNumber=148902
- ²⁶ Joseph Malkevitch, Teaching Mathematical Biology in High School
<http://dimacs.rutgers.edu/Workshops/Biomath/slides/Malkevitch.pdf>
- ²⁷ Overview to NCTM's *Principles and Standards for School Mathematics*
URL for this citation: <http://standards.nctm.org/document/chapter1/index.htm>
- ²⁸ www.collegeboard.com/prod_downloads/about/news_info/cbsenior/yr2006/national-report.pdf
- ²⁹ www.boston.com/news/education/k_12/articles/2006/08/29/2006_sat_scores_for_machusetts/
- ³⁰ *Weston Public Schools Student Performance and Achievement Report: The Annual Review of Educational Records Bureau (ERB) and The Massachusetts Comprehensive Assessment System (MCAS) Testing Program*
- ³¹ Website of mathematics enrichment, <http://math.exeter.edu/dept/materials/index.html>