Teaching Math in Washington's High Schools: Insights from a Survey of Teachers in High Performing or Improving Schools

A Report Prepared for
The Office of Superintendent of Public Instruction

Prepared by:

Ana M. Elfers
Margaret L. Plecki
Michael S. Knapp
Gahram J. Yeo
Michelle L. McGowan

University of Washington
College of Education

June 30, 2007

This report was commissioned by the Washington State Office of the Superintendent of Public Instruction and is available for download from their website (www.k12.wa.us). Additional support for this work was provided by the Center for Strengthening the Teaching Profession, as part of CSTP's longstanding effort to understand teaching quality and the characteristics of Washington's teaching force (download at www.cstp-wa.org).

The suggested citation for this report is:
Elfers, A. M., Plecki, M. L., Knapp, M. S., Yeo, G. J. and McGowan, M. L. (2007). Teaching Math in Washington's High Schools: Insights from a Survey of Teachers in High Performing or Improving Schools. Seattle, WA: University of Washington.

For technical questions about this report, contact: aelfers@u.washington.edu

Table of Contents

List of Tables

List of Charts

Executive Summary

Improving student performance in mathematics is the focus of considerable attention in Washington state. Most agree that improving mathematics teaching and support for mathematics instruction is key, but there is a lack of consensus on how best to accomplish these goals. This study, commissioned by the Office of Superintendent of Public Instruction, provides Washington educators and policymakers with information regarding the nature and context of mathematics teaching in Washington high schools. The study is based on a survey administered in spring 2007 to mathematics teachers in high schools that have demonstrated strong or improving performance on state mathematics assessments over time. Given this sampling strategy, the teachers surveyed are not representative of all math teachers statewide. However, the views of these teachers are particularly instructive about what may be working well for them and what their school or district is doing to support math instruction.

Math Teachers' Assignment, Preparation and Experience

High school mathematics teachers in schools with strong or improving math performance in Washington indicate that they feel well-prepared for their assignment and have the right knowledge to design and offer instruction for their students. For most, their current mathematics assignment is closely matched to their training, and nearly all report having a major or minor in math. Despite their preparation, knowledge and training, many teachers indicate they do not always have the right tools or supports to offer appropriate instruction to their students. While they are confident of their subject matter preparation and of the college preparation they received, they are less confident that they have the right materials to support instruction and the right professional development. Additionally, nearly half indicate they rarely or never have adequate time for planning and preparation.

The findings from this survey support the premise that teaching experience matters with regard to mathematics instruction. Teachers with less experience lack confidence in their knowledge and skills and have fewer strategies for instruction and assessment. Novice math teachers indicate that they less frequently present mathematical concepts using a variety of formats or adapt materials and textbooks. They are less likely to examine student work with other teachers and they find the lack of one-one-one assistance for students and the variety of special learning needs in the room to be a greater challenge than their more experienced colleagues. When teachers are asked to explain what has helped them the most to become more effective in working with math students, they frequently mention teaching experience.

School staffing decisions around teaching assignments can play an important role in student learning. According to teachers in these high performing or improving schools, the most important factors in determining math teaching assignments are teachers' qualifications or experience. Other factors of considerable importance include the

teachers' stated wish to teach a particular course, the teachers' ability to deal with particular grade levels or academic levels, and the logistics of the school's master schedule, though there are some differences based on the size of the school. While struggling students generally are not assigned to the least experienced teachers in these schools, few teachers indicate that their school engages in deliberate efforts to assign the best teachers to students who struggle in mathematics.

Instructional Strategies, Assessment and Differential Supports for Students

Nearly all of the math teachers in these schools that are doing well or improving in math performance indicate that they use multiple instructional strategies and emphasize problem-solving and critical thinking in their classrooms. However, not all teachers are in agreement about the degree of discretion they have in deciding the content of the courses they teach or whether students learn best when grouped by prior academic achievement. Most teach classes with students of different achievement levels, but most often students of the same ability level are grouped within the same class. These findings suggest that at least to some extent, students in these schools are grouped by achievement level and that teachers themselves are divided on whether this is an effective strategy for student learning. When inquiring about teacher beliefs regarding mathematics instruction, the vast majority of teachers agree that their own efforts as a teacher can significantly impact student learning.

Using assessments to adjust instruction is an area where these teachers report feeling less prepared than in other aspects of their teaching. Most teachers surveyed report using intervention tools with students who are struggling in math, but only half use diagnostic assessments to help identify learning needs. Just as teachers indicate that they monitor student progress by student participation and feedback in class, giving quizzes, tests and reviewing homework, this standard approach may not take into account all that is needed to make appropriate assessment decisions and adjust instruction. Less than a third of the teachers report they examine student work with other teachers for purposes of assessment.

Most teachers in these high performing or improving schools indicate that their school offers a variety of programs and activities to support student learning in mathematics. After-school tutoring or other math assistance programs are available in 90 percent of the teachers' schools and nearly two-thirds offer some support through summer math programs. Few teachers indicate that their school offers peer tutoring, math clubs or other extra-curricular mathematics activities. Teachers in smaller schools generally report lower levels of available support. Overall, teachers indicate that their greatest challenges in working with students who are struggling in math are the lack of one-on-one assistance and the variety of learning needs in the classroom.

Textbooks and Instructional Materials

Textbooks and instructional materials play an important role in math instruction, particularly given that the overwhelming majority of these teachers indicate they use the texts and materials adopted by their district. Less than half adapt the textbook, at least to some extent, to use with materials they design themselves. Most teachers indicate that they spend at least 75 percent of their teaching time using district-adopted texts and instructional materials, while a third of the teachers spend at least a quarter of their instructional time using teacher-developed instructional materials and tools. However, teachers are not overly satisfied with the math textbooks they are using, as only a quarter (27 percent) strongly agree that they are generally satisfied with their textbooks, and another 35 percent somewhat agree. A lack of appropriate curriculum and textbooks to work with struggling students is identified as a moderate or great challenge by 38 percent of teachers, and nearly half of novice teachers report this sentiment. Seventy-two percent of the teachers use computers or other technology in their classrooms with some frequency. Among the most popular uses are graphing calculators and online systems to track student progress and grades. However, not all teachers have equal access to technological tools, with smart boards being accessible to only one-third of the teachers.

Collaboration and Supports for Math Teachers

A strong sense of professional community is reported by teachers as a key factor contributing to their school's success in working with mathematics students. Most teachers indicate they work together to select content, topics and skills to be taught, as well as to share ideas about how to help underperforming students. Teachers report working together less frequently to select textbooks and materials, examine data or students work to identify learning needs. The math teachers report finding the most guidance and support for improving their own math instruction from other teachers in their building or from their math department chair or lead teacher.

Teachers report that the most useful professional development support they engaged in during the last twelve months was regularly scheduled collaboration with other teachers. Nearly all of the math teachers found regularly scheduled collaboration or opportunities to observe other math teachers to be somewhat or very useful in impacting their instruction, though over a third of the teachers did not have the opportunity to observe other teachers.

Successful School and Teacher Practices

The teachers surveyed overwhelmingly attribute their school's success in mathematics to the quality of instruction by math teachers (94 percent attribute some or a great deal of success to this factor), followed by a strong sense of professional community (80 percent). School leadership is another factor identified by teachers, with 72 percent of agreeing that the leadership at their school works hard to help them improve their

performance, and 62 percent attributing the success at their school in part to school leadership that supports mathematics improvement. Teachers also recognize that the level of readiness of students upon entering high school also impacts their school's success. Some variation exists in teachers' responses by level of teaching experience and type of school.

With regard to issues of improving mathematics across the K-12 curriculum, many teachers note the importance of curricular alignment across grade levels and believe that opportunities should be provided for teachers to work with their counterparts at different levels toward this goal. Additionally, these teachers emphasize the need for student mastery of basic skills and discourage the use of calculators in the earlier grades. Finally, many of these secondary teachers would encourage those teaching math in the lower grades to have math-specific credentials or some level of math expertise.

Policy Recommendations

The findings from this study speak to a number of areas in which math educators and policymakers should take notice, particularly given that these teachers work in schools with strong or improving math performance. Teachers' responses are consistent with current research, particularly with regard to the importance of strong subject matter knowledge and preparation. This research supports maintaining a focus on preparing and recruiting math teachers with strong preparation and subject matter knowledge and reinforcing efforts by higher education institutions to strengthen pathways into teaching for aspiring mathematics teachers. As new math teachers enter the workforce, additional targeted induction and supports should be provided, including mentoring and collaboration with experienced math colleagues.

For those math teachers who are already in the workforce, it is important to provide opportunities for them to upgrade their knowledge and skills. Schools should pursue strategies designed to retain high quality math teachers, including an emphasis on developing a collaborative culture. Additionally, schools and districts should consider assignment practices and staffing patterns in order to maximize the alignment of teachers' qualifications and experience with the specific needs of students in the school.

Both novice and experienced teachers report feeling less confident in their assessment abilities. This is of particular concern given the need to adjust instruction to meet the varying learning needs of students, especially those who are struggling with mathematics. Given these findings, educational leaders might consider instructional supports which focus on helping teachers improve their ability to use assessments to identify student learning needs and adjust instruction. This might include providing opportunities for teachers to work together to examine student data and better align curriculum. Teacher preparation institutions should consider how they prepare teachers to use both formative and summative assessments and the ways in which they can be used to improve instruction.

District decisions regarding the adoption of textbooks and curricular materials are particularly important since teachers frequently use district adopted texts and materials for the delivery of instruction and for purposes of assessment. Teachers report they aren't overly satisfied with the math texts they are currently using. Districts and schools should continue to focus on the selection of high-quality texts and curricular materials that are linked to learning expectations and provide supports for students who struggle in math. They should also provide training and support on the use of adopted texts and materials, including how to employ assessment strategies to adjust instruction that is guided by texts.

In order for teachers to work most effectively with their students in mathematics, teachers indicate that professional community and a supportive culture at the school matters. Regularly scheduled collaboration and observing other teachers are among the most useful forms of professional development according to these teachers. Teachers recognize that the support they receive from school leaders contributes to their efforts in the classroom. They attribute the success their school has experienced in part to school leadership that supports mathematics improvement. This, coupled with findings about school collaboration, imply that the leadership in these schools is making it possible for teachers to work together and receive the kinds of support they need. These findings suggest that those in leadership positions should consider creating working conditions that support the establishment of a collaborative professional culture around mathematics curriculum and instruction. School leaders could also work to ensure that teachers are familiar with the instructional goals and content of all the math courses taught at their school.

Washington state does not currently have the data capacity to identify secondary teachers by courses and grades taught. Building a better base of information about teachers, teaching and support for teachers' work could result in an information resource that would enable answering important questions about the state's teacher workforce. Given Washington's goals for improving teaching and learning, improving state data capacity would enable educators and policymakers to know whether goals are being reached and how to improve the possibility of reaching them.

Teachers' voices are an important resource in understanding the conditions and supports they need to most effectively work with mathematics students. The findings from this study provide useful information regarding ways in which districts and schools can focus their efforts to support teacher and student learning in mathematics, as well as to help inform future directions for math education in this state.

Introduction

In an age of accountability, mathematics education and the lackluster performance of American students on international, national and state assessments continues to be a concern. While there is a convergence of opinion from key leaders on the importance of improving mathematics teaching, there is a lack of consensus on how best to accomplish this goal. Federal efforts have focused on "highly qualified" teachers in every classroom as a key element of the No Child Left Behind Act (NCLB). States have invested in standards and assessment programs and have developed programs, materials and professional development opportunities to support improvement in mathematics.

In Washington state, educators have been involved in the development of the Essential Academic Learning Requirements (EALRs) and Grade Level Expectations (GLEs) which provide the basis for Washington's standards and learning goals in mathematics. The adoption of the Washington Assessment of Student Learning (WASL) as a measure of student performance and graduation requirement has ratcheted up pressure on teachers to increase student learning in mathematics. Despite some improvement on the mathematics portion of the WASL by students at all grade levels, the 2007 Washington legislature postponed the graduation requirement that students pass the math and science portions of the WASL until 2013.[1] Districts continue to report a shortage of highly qualified mathematics teachers (Lashway, Bryant, Burton & Hett, 2007) and these shortages are expected to increase as additional courses in mathematics are offered.

In an effort to provide Washington educators and policymakers with information regarding the nature and context of mathematics teaching in Washington high schools, the Office of Superintendent of Public Instruction (OSPI) commissioned the study presented in this report. The study is based on a survey targeted toward mathematics teachers in high schools that have demonstrated strong or improving performance on state assessments in mathematics. Information from the survey and other sources provides a window into what mathematics educators can tell us about effective classroom practices and the areas in which they believe additional support and training may be needed.

In April 2007, a research team at the University of Washington administered the survey to high school mathematics teachers in a strategic sample of high schools that are performing well or have shown sustained improvement in mathematics on the 10th grade WASL. Because the survey was targeted toward teachers in schools that have shown strong or improving performance in math over time, they represent only the views of teachers in schools that are either doing well or improving their ability to prepare the state's high school math students. By examining the data collected from this teacher survey, the study offers information that is useful to Washington policymakers, state

[1] State lawmakers also passed a bill during the 2007 legislative session which focused specifically on improving mathematics and science education. The tenets of the bill include a review of state standards and assessments in mathematics, the creation of an after school mathematics support program, the creation of a program for mathematics and science coaches, and limited scholarships to new entrants pursuing mathematics or science endorsements. Additionally, new legislative funding was made available for math and science professional learning.

department officials, district administrators, professional developers, pre-service educators and others in a position to influence the preparation, recruitment, professional development and retention of high school mathematics teachers.

Background and Literature Review

Math Teacher Training, Credentials, Experience and Student Achievement

Policymakers have been concerned about the qualifications of math teachers and whether their training has adequately prepared them for teaching math and helping students to meet state standards. The U.S. Department of Education (2006) has calculated that only 41 percent of math teachers nationwide have a college degree in mathematics, so this raises the question as to what kind of training math teachers have received. The No Child Left Behind Act has mandated that in order to be considered "highly qualified," high school teachers must be able to convey that they have knowledge of a subject area. This knowledge can be conveyed through having an undergraduate major, graduate degree or major-equivalent credits in the specific subject(s) they teach or state-level subject certification.

At the same time, certification may not be a sufficient measure of preparedness for teaching high school level math. Education researchers have found that the understanding or knowledge of mathematics that teachers-in-training demonstrate is not sufficient for teaching the curricula promoted by the National Council of Teachers of Mathematics' *Principles and Standards of School Mathematics* (Ball, 1988a, b, 1990a, b; Graeber & Tirosh, 1990; Kinach, 1996; McDiarmid, 1990; National Council of Teachers of Mathematics, 2000). Kinach (2002) argues that the disparity between mathematics teacher training and teachers' grasp of the subject to teach effectively to professional standards indicates that pre-service teacher training needs to be reassessed along the lines of knowledge acquisition and demonstration of knowledge through teaching.

While existing studies of secondary school math teachers suggest that subject-specific teacher education training does not necessarily indicate depth of understanding of mathematics content to be conveyed in the classroom (Ball 1991; Even 1993; Swafford, Jones & Thornton 1997), Hill, Rowan and Ball (2005) have shown that teachers' understanding of the material is very important for improving student achievement in mathematics. Along these lines, some studies have drawn correlations between high school math teachers' knowledge of mathematics (as measured through training or credentials) and student performance (Darling-Hammond, Holtzmann, Gatlin & Heilig, 2005; Laczko-Kerr & Berliner, 2002). Researchers have argued that secondary school math teachers who have math majors, advanced degrees in math or some university coursework in math and/or a math certification are better prepared to help improve student achievement than are their counterparts without training in mathematics (Goldhaber & Brewer, 2000; Hill, 2007, Monk, 1994; Rice, 2003; Rowan, Chiang & Miller, 1997; U.S. Department of Education, 1998). A 2006 report published by Michigan State University's research group PROM/SE (Promoting Rigorous Outcomes in

Mathematics and Science Education) indicated that while about half of the high school math teachers in their study had a math major, nearly 25 percent had neither a math major or a math minor, which the authors suggest may be why nearly half of the teachers in their sample felt inadequately prepared to teach more advanced subject material within their math courses. Additionally, a recent national survey of middle school math teachers has indicated that the most knowledgeable math teachers are most likely to be teaching in the most affluent schools, which results in an uneven distribution of quality in math education across the socio-economic spectrum (Hill, 2007).

While teacher training and induction is a crucial component to cultivating student achievement, teachers' experience teaching math is also an important piece to understanding student success (Rice, 2003). Research has shown that effectiveness in the classroom comes with time, particularly as beginning teachers have a steeper learning curve during their first three to five years of teaching (Murnane & Phillips, 1981; Rosenholtz 1985). Leinhardt's (1989) study of elementary school teachers indicates that math teachers' experience in the classroom is a strong measure of the range of skills that a teacher brings to creating lesson plans, building in flexibility to the curriculum, explaining and clarifying the material, and enhancing student understanding of mathematics.

Professional Development

In a context in which statewide assessments of student learning have been increasingly used as a measure of successful teaching, education policy researchers have argued that state testing policies affect the ways in which math teachers tailor their teaching aims (Cohen & Hill, 2000; Wiley & Yoon 1995). Previous research indicates that high school math teachers have little control over deciding what kind of curriculum to teach due to the sequential pattern in which math courses are taught, and even less control over choosing their teaching materials like textbooks (Stodolsky & Grossman, 1995). Yet teachers are more likely to teach towards the skills that students are expected to demonstrate on the state tests. Cohen and Hill's (2000) survey of California math teachers revealed that when teachers had professional development opportunities around reform efforts, student performance improved. Thus, they argued that opportunities for professional development around math policy reforms are a crucial component in helping students to meet state standards. Along these lines, groups such as the National Council of Teachers of Mathematics and the National Board for Professional Teaching Standards have called for increased opportunities for teachers to enhance their professionalization.

Professional development can take many forms, including expert speakers, study groups, curriculum development, teaching observation and evaluation, and mentoring programs (Guskey, 2000). Ball (1996, 501-502) has posited that “the most effective professional development model is thought to involve follow-up activities, usually in the form of long-term support, coaching in teachers' classrooms, or ongoing interactions with colleagues,” which have confirmed teachers' own assessments of effective professional development strategies (Garet, Porter, Desimone & Yoon, 2001). Baker (1999) has argued that high school math and science teachers would benefit most from professional development

opportunities that focus on the substance of teachers' specific content areas and how students learn the material in this subject. Empirical research points to the effectiveness of training teachers on the variations in which students think about, learn and comprehend mathematics (i.e. the Cognitively Guided Instruction project) (Borko, 2004; Carpenter, Fennema, Peterson, Chiang & Loef, 1989; Kennedy, 1998), regular meetings for teachers to discuss and strategize on issues related to teaching mathematics (Featherstone, Pfeiffer, & Smith, 1993), and summer session professional development seminars in teaching mathematical concepts (Wilson, Lubienski, & Mattson, 1996). Additionally, a 1997 study of professional development for secondary math teachers suggested that teachers should be encouraged to develop their "technological competence" to prepare them for teaching students how to use technology (i.e. calculators and computers) to solve math problem and for analytical reasoning (Grassl & Mingus, 1997).

Professional Community and School Leadership

Educational policy researchers have drawn correlations between teacher learning and implementation of educational policy goals and the supports provided by professional communities in which teachers work (Little, 2003; Smylie & Hart, 1999). In schools with strong professional communities, educators are more likely to change their instructional strategies and practices and students are more likely to show improvements in learning (Elmore, Peterson & McCarthey, 1996; Lee & Smith, 1996; Louis, Marks & Kruse, 1996; Louis & Marks, 1998; Newmann et. al, 1996, Newmann, King & Youngs, 2000; Roseholtz, 1991; Yasumoto, Uekawa & Bidwell, 2001).

In studies of reforming schools (Louis and Marks, 1998) and the relationship between high school organization and learning math and science (Lee, Smith & Croninger, 1998), researchers suggest that the strength of professional community within a school and social support for improving student performance are closely correlated to student achievement. Marks and Printy (2003) reported in their analysis of 24 reforming elementary, middle and high schools nationwide that "transformational" school leadership does not necessarily enhance the quality of instruction or student performance, but when school leadership and strong instructional leadership work together, there is a positive impact on student achievement.

Factors in High School Teacher Retention

Often teachers leave the schools in which they teach for personal reasons--the desire for career change or family pressures--but organizational conditions may potentially be part of the story. According to a series of national studies, lack of collegial and administrative support, student misbehavior and disinterest, insufficient salary, lack of teacher autonomy, unreasonable teaching assignment, lack of professional development opportunities, and inadequate allocation of time all contribute to the departure of teachers (Ingersoll, 2003; Kelly, 2004; Luekens et al., 2004; National Center for Education Statistics, 2003).

There is little empirical research specific to the retention and mobility of high school teachers, and existing studies of high school teachers' reasons for staying or leaving their positions have been limited. Researchers analyzing data from the National Schools and Staffing Survey found that secondary school teachers reported a lower commitment to staying in the teaching profession than their counterparts in combined schools (Ingersoll & Alsalam, 1997). Surveys of high school teachers (Bradley & Loadman, 2005; Burnetti 2001; Ruhland 2001) have revealed that high school teachers' reasons for entering and staying in the profession are the same as what has been reported in the literature for teachers at all levels. Brunetti (2001) reported in his survey of California high school teachers that additional reasons for staying in teaching include a love for the subject that they teach, the autonomy that their positions allow them, collegiality in the workplace, and the vacation time afforded to teachers.

In Washington state, the overall rate of high school teacher retention closely mirrors the state profile, although some differences do emerge (Elfers, Plecki & McGowan, 2007). A smaller proportion of high school teachers move within their district as compared to all teachers. An analysis of teacher retention by experience level indicates that the rate at which both beginning and novice high school teachers move out of district is higher than for all high school teachers and the percent of novice high school teachers who stay in the same school is slightly higher than the state profile. Finally, the percent of beginning high school teachers who leave the Washington education system is higher than that of all beginning teachers statewide.

Research Questions

In this study we seek to gain a better understanding of mathematics education in Washington state by assessing teachers' views of their content knowledge, their pedagogical approaches, and the role that schools and districts play in helping them improve their mathematics instruction. The target group for this inquiry is teachers who are located in schools showing steady improvement or strong performance on state mathematics assessments. The following general research questions form the basis for the design of the survey items:

1. What is the nature of high school teachers' preparation in mathematics, current teaching assignment and their perceptions of preparedness to teach their mathematics courses?

2. What conditions, supports or professional learning opportunities do teachers indicate enable them to most effectively work with students in mathematics?

3. Which texts, materials, assessments and instructional practices do teachers use in their classrooms and how effective do they find them to be?

4. What supports do teachers report as being available to assist students who struggle in mathematics?

5. What factors do teachers attribute to the success their school has experienced in mathematics and what insights do they have about how to improve the quality of mathematics instruction?

Data and Methods

The findings presented in this report are based primarily on a survey of mathematics teachers located in a strategic sample of high schools in Washington state during the 2006-07 school year. The goal in the selection of the schools was to accurately represent the population of high school teachers in schools that have demonstrated strong or improving performance of their students in math over time on the WASL. A multi-dimensional sampling strategy was developed using OSPI's most recent publicly available information on schools (2005-06) linked to corresponding school WASL and other demographic information.

Multi-dimensional Sampling Strategy for Schools

Ninety Washington high schools (with approximately 700 math teachers) were selected for the study based on steady improvement or strong performance on the 10th grade mathematics WASL over time. Schools included in the study met one of the following criteria:[2]

1) High performance with improvement (27 schools, 21 participating[3]). These schools are in the top quartile of all schools on mathematics WASL performance, they have met AYP, and they have demonstrated a gain of at least 15 percent on the WASL over a five year period.

2) Overall improvement (36 schools, 32 participating). These schools are not in the top quartile of all schools on the mathematics WASL, but have met AYP and have demonstrated a gain of at least 15 percent on the WASL over a five year period for all students.

3) Notable improvement with subgroups (17 schools, 12 participating). These schools have made significant improvements among historically under-served groups of students (low-income, Black, Hispanic and Native American students) but they do not represent the strongest WASL averages as a whole. A number of these schools have high proportions of low-income or ethnic/racial minority students.

[2] Schools may have met these criteria but were excluded from the study for the following reasons: 1) The high school did not report WASL scores at the 10th grade level. Additionally, schools which did not report WASL scores by subgroups were less likely to be included in the study. 2) The high school had not been open for at least six years. These schools do not have WASL trend data available that is comparable to the rest of the sample.

[3] Schools with at least one teacher responding to the survey were listed as participating. Many schools, particularly larger schools, had multiple respondents.

4) Consistently high performance, high SES (10 schools, 7 participating). The performance levels of these schools have not changed considerably (less than 15 percent improvement on the WASL over the five year period), but they are consistently high performing. They have very low percentages of students in poverty. These schools are in the top quartile of all schools on mathematics WASL performance and they have met AYP.

All high school mathematics teachers who had a publicly available email address at the school and were identified on the school website as a teacher in the mathematics department or otherwise identified as teaching mathematics at the school were invited to participate.[4] Other persons teaching math whose names did not appear as either part of the formal math department or listed as teaching math at the school were not necessarily included. The web-based survey was developed, piloted and administered in spring 2007.

An overview and comparison of the characteristics of the sample schools and respondents' schools is provided in Table 1. By linking potential respondents to their schools' characteristics, we were able to determine whether or not the respondents' schools effectively represented the potential sample. As can be seen in Table 1, a majority of the schools (80 percent) had at least one teacher who responded to the survey. It should be noted that very small high schools (enrollment less than 400 students) are somewhat underrepresented in the sample of respondents (14 percent had at least one participating teacher, compared to 26 percent who were invited).

[4] This method of identifying those teachers who are currently teaching mathematics courses was employed because the state does not currently have a database which contains teaching assignments by subject matter.

Table 1: Characteristics of Invited and Responding Schools				
	Potential Schools		Participating Schools	
	Number	Percent	Number	Percent
Number of Schools	90		72	80.0%
School Categories	Potential Schools		Participating Schools	
Exemplary Performance	27	30.0%	21	29.2%
Exemplary Improvement	36	40.0%	32	44.4%
Notable Improvement	17	18.9%	12	16.7%
High Performing (less diverse)	10	11.1%	7	9.7%
Building Enrollment				
1-399	23	25.6%	10	13.9%
400-999	16	17.8%	13	18.1%
1,000-1,499	17	18.9%	16	22.2%
1,500-1,699	19	21.1%	18	25.0%
1,700+	15	16.7%	15	20.8%
Student Poverty				
0-20%	34	37.8%	31	43.1%
21-35%	33	36.7%	27	37.5%
36-50%	15	16.7%	11	15.3%
51-100%	8	8.9%	3	4.2%
% White Students				
0-49%	6	6.7%	4	5.6%
50-79%	33	36.7%	26	36.1%
80-89%	29	32.2%	25	34.7%
90-100%	22	24.4%	17	23.6%

A comparison of the enrollment size of the districts that had teachers who were invited to participate in the survey (potential districts) and the districts that had teachers who actually responded to the survey (participating districts) is provided in Table 2.

Table 2: Characteristics of Invited and Responding Districts				
	Potential Districts		Participating Districts	
	Number	Percent	Number	Percent
Number of Districts	72		55	76.4%
District Enrollment				
20,000+	9	12.5%	9	16.4%
10,000-19,999	10	13.9%	9	16.4%
5,000-9,999	11	15.3%	10	18.2%
1,000-4,999	24	33.3%	19	34.5%
999 and under	18	25.0%	8	14.5%
Total	72	100.0%	55	100.0%

As shown in Table 2, more than three-quarters (76 percent) of potential districts are represented in the sample of actual respondents. As was the case for the smallest schools, the smallest districts (enrollment less than 1,000) are somewhat underrepresented among the participating districts (15 percent participated compared to 25 percent who were

invited). However, for the most part, the demographic characteristics of the participating schools and districts closely match those of the potential schools and districts.

Survey Sample and Participants

The survey was successfully deployed to 682 public high school teachers in the 90 sample schools with a return rate of 31 percent (214 responses). No incentives for participation were offered. The fact that the characteristics of the actual survey participants very closely resemble the pool of teachers invited to participate in the study offers evidence that the respondents are a reasonably accurate representation of the sample. These characteristics include the distribution of participating teachers from the sample schools by region of the state, teachers' age, experience and ethnicity (see Table 3).

Table 3: Characteristics of Invited and Responding Math Teachers

	Sample		Respondents	
	Number	Percent	Number	Percent
Number of Teachers	682		214	31.4%
Educational Service Districts				
101	104	15.2%	28	13.1%
105	19	2.8%	4	1.9%
112	55	8.1%	20	9.3%
113	25	3.7%	10	4.7%
114 - Olympic	17	2.5%	7	3.3%
121 - Puget Sound	298	43.7%	96	44.9%
123	20	2.9%	7	3.3%
171 - North Central	15	2.2%	2	0.9%
189 - Northwest	129	18.9%	40	18.7%
Teacher Age in 2005	(N=680)*		(N=212)*	
21-30	172	25.3%	49	23.1%
31-40	195	28.7%	53	25.0%
41-50	160	23.5%	48	22.6%
51-60	135	19.9%	54	25.5%
61+	18	2.6%	8	3.8%
Teacher Ethnicity	(N=680)		(N=212)	
Asian/Pacific Islander	29	4.3%	9	4.2%
African American	4	0.6%	1	0.5%
Hispanic	11	1.6%	4	1.9%
Native American	4	0.6%	0	0.0%
White	632	92.9%	198	93.4%
Experience in 2005	(N=680)*		(N=212)*	
0-4 years	195	28.7%	56	26.4%
5-14 years	238	35.0%	66	31.1%
15-24 years	148	21.8%	58	27.4%
25 yrs or more	99	14.6%	32	15.1%

**Missing demographic data for 2 teachers*

Findings

This sample of 214 high school mathematics teachers offers a detailed look at the context of teaching mathematics in Washington, and the nature and quality of support for teachers. The teachers surveyed are not representative of all math teachers statewide. Rather, these teachers are located in Washington high schools that have shown strong or improving performance in mathematics over time. As such, their views are instructive about what may be working well for them as an individual math educator, as well as what the school or district may be doing to support math instruction. The findings are summarized under the following headings:

- Assignment and Preparation
- Instructional Strategies
- Teachers' Views of Assessment
- Textbooks and Instructional Materials
- Supports for Math Students
- Collaboration and Supports for Math Teachers
- Successful School and Teacher Practices

Assignment and Preparation

> *Nearly all of the teachers surveyed have a major or minor in mathematics. The vast majority of these teachers solely teach mathematics (87 percent), but they teach a variety of math courses, with almost a third indicating they teach an integrated math course. More than four-fifths of teachers believe they always have the right content knowledge and they indicate that their teaching assignment closely matches their preparation in all ways. Despite their preparation, knowledge, and training, many teachers indicate that they do not always have the right tools or supports to design and offer appropriate instruction to their students. Only a fifth indicate they always have the right materials and only one-third report they always have the right professional development support. Nearly half of the respondents (47 percent) indicate they rarely or never have adequate time for planning and preparing for instruction. The most important factors in determining math teaching assignments are teachers' qualifications or experience. Struggling students generally are not assigned to the least experienced teachers, but few teachers indicate that their school engages in deliberate efforts to assign the best teachers to these students.*

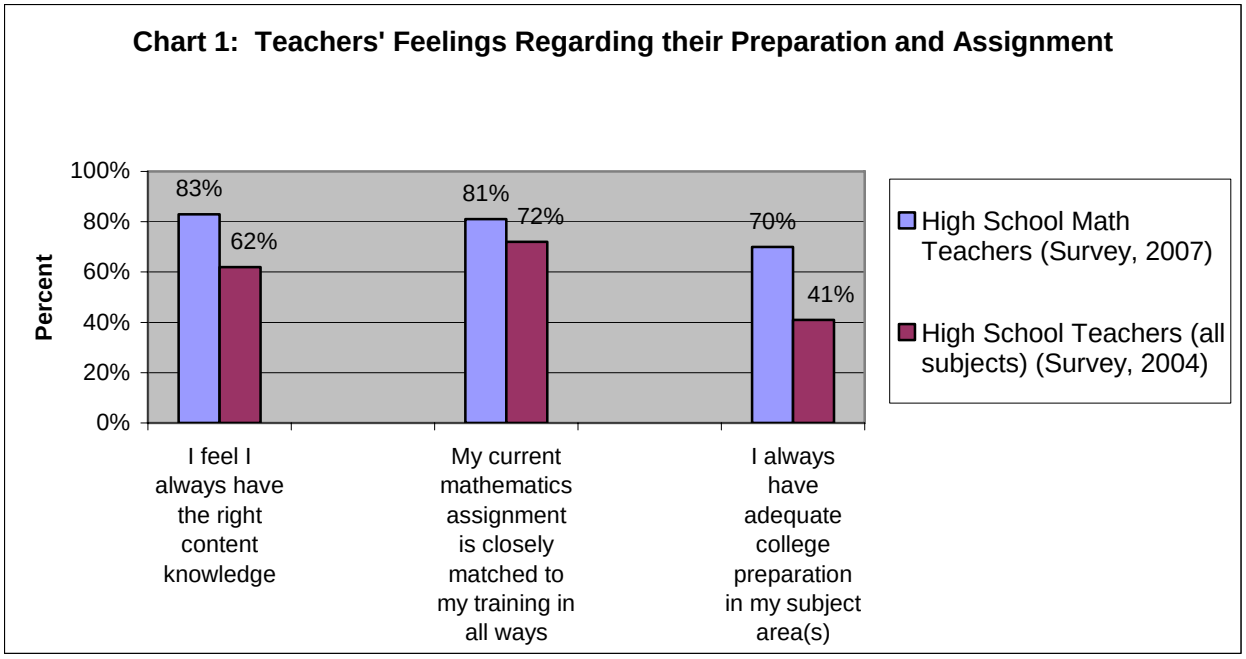
The mathematics teachers surveyed represent the full range of teaching experience. This is important, given that teachers' perspectives may change at different points in their career. The majority (80 percent) are teachers who have taught math for five or more years, and half (51 percent) have been at the same school for at least five years. Most of the teachers participating in the survey are mid-career professionals with between 5 and 24 years of experience teaching math (61 percent). Approximately 20 percent have

taught math for less than five years, and the remaining 19 percent represent the most veteran math teachers (25 or more years of experience). The distribution of these teachers by experience is very similar to high school teachers statewide with approximately 20 percent of the least and most experienced high school teachers on either end of the experience continuum (Elfers, Plecki & McGowan, 2007).

Most of the respondents teach only mathematics courses (87 percent), but they teach a variety of math subjects. Sixty percent teach at least one course in algebra (pre-algebra, elementary, intermediate or advanced), over half (53 percent) teach calculus or pre-calculus, and more than a quarter teach geometry (27 percent). Nearly a third (31 percent) of the respondents indicate that their teaching assignment includes various integrated math courses. The fact that half of these schools now offer some form of integrated math reflects a shift from the traditional mathematics course offerings in high schools. Of the 28 teachers who teach some non-math classes, 16 are currently teaching science.[5]

The teachers who responded to the survey indicate that they feel well-prepared for their assignment and have the right knowledge to design and offer instruction for their students. Eighty-three percent indicate they always have the right content knowledge and 81 percent indicate that their current mathematics assignment is closely matched to their training in all ways. These statistics are considerably higher than a sample of Washington high school teachers[6] surveyed as part of a larger study in 2004-05 who responded to similar questions (Knapp et al., 2005). Of the high school teachers surveyed in 2004, only 62 percent indicated they always have the right content knowledge to design and offer instruction to their students, compared with 83 percent of these math teachers. Seventy-two percent of the Washington high school teachers from the previous surveys indicated their current classroom teaching position was closely matched to their training in all ways compared with 81 percent of the math teachers in this survey (see Chart 1).

[5] While one might expect to find more teachers in these schools teaching non-math classes, the sampling strategy mitigated against including teachers whose primary teaching field was something other than math.
[6] The respondents referenced here are disaggregated from a representative sample of all Washington teachers. These teachers were located in high schools of varying performance levels and taught a variety of high school subjects.



2007 Math Survey Sample: N=214
2004 Teachers Survey: High School Teachers only N=90; Reported in Teachers' Count: Support for Teachers' Work in the Context of State Reform (Knapp, et al., 2005).

Nearly all of the respondents have a major or minor in mathematics. Seventy percent of the math teachers surveyed report holding a major in mathematics, 10 percent in science and 4 percent in engineering. Half of the non-math majors report having a minor in math. Whether this effect of teachers' strong mathematics subject matter preparation operates through self-selection (individuals seeking to work in particular kinds of schools), through deliberate school or district hiring practices (e.g., actively recruiting individuals with a major or minor in math) or the influence of federal policies such as NCLB (requirement for "highly qualified" teachers) is unclear. At present, it is not possible to know the extent of out-of-field teaching in high school mathematics in Washington state, so comparisons between this group of respondents and all high school mathematics teachers in the state cannot be made.

Most teachers in these schools indicate that they feel somewhat or very prepared to teach advanced mathematics courses, prepare students for state assessments and use a variety of instructional approaches to meet student needs (see Table 4 for more details). Compared to the statewide survey of teachers in 2004, a larger percentage of these math teachers indicate they feel very prepared to ready students for state assessments than high school teachers in the previous surveys (55 percent of the respondents in the current survey versus 21 percent of all high school teachers in the previous survey). This may be due in part to greater exposure to the WASL. The 10th grade mathematics WASL has been in place since 1998-99, and so math teachers have had more experience preparing students for the WASL as compared with teachers in subject areas that are not tested or only more recently tested (e.g., science) through the WASL. Overall, these teachers do not believe they lack the knowledge to serve struggling students. Eighty-one percent

indicate this is not a challenge or only a small challenge in working with struggling students in their mathematics classes.

Table 4: Teachers' Preparedness for Teaching Advanced Courses, Readying Students for State Assessments and Using a Variety of Instructional Approaches and Assessments

Teachers' self-reported preparedness to…	Percent feeling somewhat or very unprepared	Percent feeling somewhat prepared	Percent feeling very prepared
…teach advanced mathematics courses	11%	24%	65%
…prepare students for state assessments in mathematics	8%	36%	55%
…use a variety of instructional approaches to meet student needs	7%	37%	56%

Sample: N=214

In their own words, teachers expressed the importance of subject matter knowledge and preparation through open-ended text questions in examples such as these:

What has helped you the most to become more effective in working with mathematics students? "*My strong background in mathematics.*"

In what ways do you believe mathematics instruction could be improved across the K-12 curriculum? "*Keep math teachers who are experienced and have a strong mathematics background.*"

As might be expected of novices in any profession, teachers with less experience teaching math lack confidence in their knowledge and skills and have fewer strategies for instructional assessment. Over a quarter (28 percent) of the respondents with less than 5 years of experience teaching math indicate they feel somewhat or very unprepared to teach advanced mathematics. They also are less likely to feel very prepared for using a variety of instructional approaches and to ready students for state assessments. Table 5 displays differences in teachers' responses based on years of experience teaching mathematics.

Table 5: Teachers' Feelings of Preparedness Based on Experience Levels			
Teachers' self-reported preparedness to…	Percent feeling somewhat or very unprepared	Percent feeling somewhat prepared	Percent feeling very prepared
…teach advanced mathematics courses			
1-4 years of experience	28%	37%	35%
5 or more years of experience	7%	20%	72%
…prepare students for state assessments in mathematics			
1-4 years of experience	12%	56%	33%
5 or more years of experience	8%	31%	60%
…use a variety of instructional approaches to meet student needs			
1-4 years of experience	11%	56%	33%
5 or more years of experience	5%	32%	61%
…use a variety of assessments to adjust instruction			
1-4 years of experience	19%	54%	28%
5 or more years of experience	14%	34%	51%

Sample = 214

Despite their preparation, knowledge, and training, many teachers in these schools with high or improving math performance indicate that they do not always have the right tools or supports to design and offer appropriate instruction to their students. While respondents were confident of their subject matter knowledge (83 percent indicate they always have the right content knowledge) and of the college preparation they received (71 percent indicate they always have adequate college preparation in their subject area), they were less confident of having the right materials to support instruction. Twenty-one percent indicate they always have the right materials and another 70 percent indicate that they sometimes do. The right professional development support was also less available for some teachers. Only 32 percent indicated they always have the right professional development support, while 58 percent indicated they sometimes do. Additionally, 47 percent indicate they rarely or never have adequate time for planning and preparation for instruction.

School staffing decisions around teaching assignments can also play an important role in student learning. Determining who is assigned to teach specific courses and which students are enrolled in those courses is a complex task that has a variety of equity implications. As is the case with most high schools, the 72 schools represented in the study offer a range of mathematics courses. A majority of the schools offer courses which include pre-algebra or algebra (elementary, intermediate or advanced), geometry, trigonometry, and calculus or pre-calculus. Additionally, half of respondents' schools offer some form of integrated math courses, business, applied or "general" math, and nearly a quarter offer WASL preparation or WASL support classes. Fifteen percent of the respondents' schools offer courses aimed at general math support or mathematics labs.

According to survey participants, the most important factors in determining math teaching assignments at their school are teacher qualifications, experience, or teachers'

stated interest in teaching a particular course. Nearly all teachers (91 percent) indicate that the teachers' qualifications or experience in teaching a particular course are moderately or very important factors in determining math teaching assignments at their school. The most veteran math teachers (25 or more years teaching math) hold this view more strongly than less experienced colleagues, in particular teachers with less than five years of experience (63 percent compared with 33 percent respectively, indicate this was very important).

Other factors of considerable importance (moderately or very important) in math assignment decisions include the teachers' stated wish to teach a particular course (81 percent), the teacher's ability to deal with particular grade levels or academic levels (75 percent), and the logistics of the school's master schedule (72 percent). Table 6 provides additional information.

Table 6: Teachers' View of Factors Used in Determining Math Teaching Assignments

	Moderately or very important	Not a factor or slightly important
Teachers' qualifications or experience in teaching a particular course	91%	8%
Teacher's stated wish to teach a particular course	81%	18%
Teacher's ability to deal with particular grade levels or academic levels	75%	24%
Logistics of the school's master schedule	72%	27%
Meeting the demands of subject and course enrollments at the last minute	57%	41%
Preferences of the math department chair or school administrator	57%	42%
Teacher's seniority in the school/district	56%	43%
Deliberate efforts to assign the best teachers to the students who struggle the most in math	33%	65%
Department policy to rotate course assignments	30%	68%

Sample: N=214

Factors of lesser importance in assignment decisions include department policy to rotate course assignments and deliberate efforts to assign the best teachers to struggling students. According to 64 percent of the teachers, struggling students are not assigned to the least experienced teachers. However, only 33 percent report that the school engages in deliberate efforts to assign the best teachers to students who struggle most in math. Additionally, over half of the teachers (57 percent) indicate that AP courses and/or other advanced math courses are almost always taught by the most senior teachers.

School size does have an impact on staffing decisions, though it should be noted that the respondents from schools with an enrollment under 1,000 comprise only 15 percent of the sample. Nevertheless, the logistics of the master schedule is a very important factor in

staffing decisions for 42 percent of teachers in these schools compared with 25 percent of the teachers in larger schools. Meeting the demands of subject and course enrollments at the last minute was moderately or very important for 71 percent of teachers in schools under 1,000, compared with 56 percent of the teachers in larger schools. The teacher's stated wish to teach a particular course and the preference of the math department chair or school administrator were factors of lesser importance in staffing decisions for smaller high schools. For more information, see Appendix A.

Instructional Strategies

> *Nearly all teachers surveyed indicate they use multiple instructional strategies and emphasize problem solving and critical thinking in their classrooms. Less experienced math teachers report using a variety of visual formats less frequently than their more experienced colleagues. Teachers are not in agreement about the degree of discretion they have in deciding the content of the math course they teach. Teachers also are equally split in their views about whether students learn best when grouped by academic achievement level. However, the majority of teachers (60 percent) indicate that none of their classes include students of mixed achievement levels. When inquiring about teacher beliefs regarding mathematics instruction, the vast majority of teachers agree that their own efforts as a teacher can significantly impact student learning.*

The teachers surveyed in these schools with high or improving math performance use a variety of pedagogical strategies to communicate mathematical concepts and processes. Virtually all of the teachers (98 percent) emphasize multiple strategies, problem solving and critical thinking. Among a list of strategies used in math instruction, over half of the respondents indicate that they often present mathematical ideas using a variety of visual formats and have students work in small groups on math activities. Teachers less frequently mention that they often require students to: explain their answers using more than one approach, explain their reasoning to the class, or review and discuss their work with other students. Few teachers have students work on an individual project that takes several days, or ask students to reflect on their progress and set individual goals for learning. This was only done once in awhile or not at all by 87 and 72 percent of teachers respectively. See Table 7 for more information.

Experience appears to matter with regard to the use of some instructional strategies. For example, teachers with less than five years experience teaching math report less frequently presenting mathematical ideas using a variety of visual formats. Only 40 percent of these teachers often use a multiple visual formats compared with 55 percent of their more experienced colleagues.

Table 7: Selected Instructional Strategies: Frequency of Use by Math Teachers

	Often or Frequently	Sometimes or Somewhat Frequently	Once in awhile, Rarely or Never
Use multiple strategies for describing a mathematics problem	65	33	1
Present mathematical ideas using visual formats (e.g., graphs, three-dimensional displays, etc.)	52	42	6
Have students working in small groups on math activities	53	34	13
Requiring students to explain their answers using more than one approach	21	52	27
Have students explain their reasoning to the class	17	53	30
Have students review and discuss their work with other students	38	43	19
Have students reflect on their progress and set individual goals for learning	7	21	72
Have students work on an individual project that takes several days	1	12	87

Sample: N = 214

The math teachers surveyed are evenly split regarding particular teaching practices such as whether to cover material quickly to ensure all material has been addressed prior to testing or whether to place more emphasis on teaching discrete basic skills. Fifty-two percent of teachers indicate that they cover material quickly to make sure they address all the material, and a similar percentage indicate they place more emphasis on teaching discrete basic skills. That said, ninety-three percent of the teachers surveyed agree to some extent that an established amount of mathematics content should be covered at each grade level.

Teachers are not in agreement on the degree of discretion they can exercise over content decisions. Forty-three percent of teachers agree that they generally have a free hand in deciding the content of the math courses they teach, while 56 percent disagree. Teachers with less than five years of experience (68 percent) feel that they have much less of a hand in determining the content of their math courses than do their counterparts with 25 or more years of experience (45 percent).

Teachers are also divided on the issue of ability grouping. They are equally split (50-50) on whether they believe students learn best when grouped by prior academic achievement. As teachers' experience incrementally increases, a higher percentage indicate that students learn best when grouped by prior academic achievement. Thirty-seven percent of teachers with less than five years of experience agree, compared with 68 percent of those with 25 or more years of experience.

Most of these teachers teach classes with students of different achievement levels,[7] but most often students of the same achievement level are grouped within the same class. Sixty percent of teachers indicate that none of their classes include students of mixed achievement levels. Seventy percent indicate that they teach at least one class of high achieving students and over half (54 percent) teach at least one class of relatively low-achieving students. A higher percentage (66 percent) of the teachers in smaller schools (student enrollment less than 1,000) report teaching classes of students of mixed ability (within the same class) than teachers in larger schools (35 percent). These findings suggest that at least to some extent students in these schools are tracked by achievement level or ability group, and that teachers themselves are divided on whether this is an effective strategy for student learning.

Regarding their beliefs about mathematics instruction, teachers uniformly report that understanding how to solve math problems is as important as getting the correct answer and allowing students to struggle in math could be necessary for learning (92 and 98 percent agree or strongly agree, respectively). The majority (86 percent) of the teachers strongly agree that if a student suggested a solution to a math problem that they hadn't thought of previously, they would not be uncomfortable.

These teachers also believe that their own efforts as a math instructor can significantly impact student achievement. Ninety-one percent somewhat or strongly agree that by trying a different teaching method, they can significantly affect a student's achievement in math. Sixty-one percent somewhat or strongly agree that they could get through to even the most difficult or unmotivated students, but 43 percent indicate that no matter how hard they try, some students will not be able to master certain aspects of mathematics. Table 8 provides information on teachers' sense of efficacy to affect student learning.

Table 8: Teachers' Beliefs Regarding their Ability to Affect Student Learning

Teachers' agreement with the following statements:	Percent strongly agree	Percent somewhat agree	Percent somewhat disagree	Percent strongly disagree
By trying a different teaching method, I can significantly affect a students' achievement in math.	41%	50%	8%	1%
I can get through to even the most difficult or unmotivated students.	8%	53%	34%	5%
No matter how hard I try, some students will not be able to master certain aspects of mathematics	8%	35%	34%	23%

Sample: N=214

[7] Teachers were asked to identify the number of mathematics classes they teach according to students' achievement level compared to the school as a whole. The four categories were: relatively high-achieving students, students with average achievement level, relatively low achieving students and students with mixed achievement levels.

Teachers' Views of Assessment

> *Using assessments to adjust instruction is an area where teachers report feeling less prepared than other aspects of their teaching. Only half of teachers use diagnostic assessments to help identify learning needs for struggling students. Over 90 percent of teachers use student participation and feedback in class, classroom quizzes, and end of unit tests to assess their instruction, and 80 percent use homework completion and homework quality to make decisions about math instruction. More than half indicate that they never or only occasionally examine data or student work with other math teachers.*

A teacher's ability to adjust their instructional approach often depends on their ability to assess what students know and are able to do through both formative and summative assessments. Teachers in this survey report feeling somewhat less prepared in using assessments to adjust instruction than other aspects of their teaching (e.g., teaching advanced math courses, preparing students for state assessments, using a variety of instructional approaches to meet student needs).[8] For example, less than half (46 percent) report feeling very prepared to use a variety of assessments to adjust instruction, compared to 65 percent who feel very prepared to teach advanced mathematics courses. Only half (52 percent) use diagnostic assessments to help identify learning needs for struggling students.

When inquiring about the kinds of assessment strategies they utilize, over 90 percent of the teachers use student participation and feedback in class, classroom quizzes, and end of unit tests to assess their math instruction either somewhat or a great deal. Eighty percent use homework completion and quality to make decisions about math instruction. Teachers with over 5 years of experience rely somewhat more heavily on homework completion and quality than less experienced teachers when making assessment decisions (82 versus 72 percent use these strategies somewhat or a great deal). See Table 9 for more information.

Table 9: Assessment Strategies Used by Teachers to Make Instructional Decisions

	A great deal	Somewhat	Not at all or a little bit
Student participation and feedback in class	57%	36%	7%
End of unit tests	51%	37%	11%
Classroom quizzes	44%	49%	7%
Homework completion and quality	32%	48%	20%
WASL released items	8%	28%	63%
Examining student work with other teachers	4%	26%	70%

Sample: N=214

[8] For a comparison of responses to this item, see Table 4.

Most teachers do not examine student work with other teachers. This issue was probed on two separate survey items with similar results. More than half of the teachers indicate that they never or only occasionally examine data or student work with other math teachers in their school to identify learning needs. Of some concern is the fact that math teachers with less than five years of experience report that this happens even less frequently. Seventy-two percent of these novice math teachers indicate that they never or only occasionally examine data or student work with other math teachers in their school to identify learning needs. It should be noted that nearly two-thirds of teachers in the schools showing "high performance with improvement" indicate they work together with teachers in their school a moderate amount or a great deal in examining student data compared with less than 40 percent of teachers in other schools (65 versus with 39 percent).

A related survey item revealed similar findings. Less than a third of the teachers (30 percent) report that they examine student work with other teachers for purposes of assessment either somewhat or a great deal, however, size of the school appears to make a difference in this regard. Forty-five percent of teachers in smaller schools (less than 1,000 students) indicate they examine student work with other teachers somewhat or a great deal compared with only 27 percent of teachers in larger schools (more than 1,000 students).

Relatively few math teachers (36 percent) use WASL released items for assessment either somewhat or a great deal, though it is likely that some of the teachers do not teach WASL grades. Released WASL items are used as an assessment strategy more frequently by experienced teachers and those in smaller schools. Nearly half (48 percent) of teachers in smaller schools (less than 1,000 students) indicate they use WASL released items with some frequency. Additionally, teachers with 15 or more years of experience indicate they use WASL released items with greater frequency than their less experienced colleagues (44 versus 30 percent, indicate using them either somewhat or a great deal). Finally, teachers in the "consistently high performance, high SES" school category are nearly three times less likely to report that they use WASL released items in assessment decisions (16 versus 47 percent of teachers in other schools use WASL released items somewhat or a great deal).

Less than half of teachers report using Grade Level Expectations (GLEs) for assessing student learning. Forty-three percent of teachers sometimes or often use GLEs for assessing specific aspects of student learning, and 31 percent sometimes or often use GLEs to find better ways of demonstrating what students have mastered.

Most teachers report using intervention tools with students who are struggling in math. Three-quarters of the math teachers indicate that they use intervention tools with struggling students, however only half (52 percent) use diagnostic assessments to help identify the learning needs of struggling students. It is unclear from the results of this survey what teachers are using to determine appropriate intervention tools.

Finally, a majority of teachers indicate that they use district adopted textbooks, and as such, these textbooks may be an important tool for assessment. In the next section we examine the use of instructional materials and textbooks by teachers in these schools.

Textbooks and Instructional Materials

> *Most teachers indicate they use the textbooks and instructional materials adopted by their district. More than half report that they spend at least 75 percent of their teaching time using district-adopted texts and materials (61 percent). Less than half of the teachers indicate that they adapt the textbooks, at least to some extent. However, teachers are not overwhelmingly satisfied with the math texts they are using, as only a quarter strongly agree that they are generally satisfied with their textbooks. A lack of appropriate curriculum and textbooks to work with struggling students is identified by 38 percent of teachers as a moderate or great challenge, and nearly half of novice teachers report this sentiment. Nearly three-quarters of teachers use computers or other technology in their classrooms. Among the most popular uses are graphing calculators and online systems to track student progress and grades. However, not all teachers have equal access to technological tools, with smart boards being accessible to only one-third of teachers.*

Textbooks form an important component of the mathematics curriculum for many schools. Together with other instructional materials, they are often used for curricular and sequencing decisions, as well as daily lesson planning and assessment. The alignment of the mathematics curriculum with instruction and assessment practices has become a focus of Washington state's efforts to improve student performance, particularly with regard to the WASL.[9] Districts also are playing a more active role in curriculum and textbook decisions. Slightly over half of the teachers attribute some of their school's success in mathematics to the quality of curriculum materials (either a great deal, 16 percent, or somewhat, 37 percent). Given this backdrop, we asked the teachers to give us their views on the instructional materials which they routinely use in their math classrooms.

Teachers report that they frequently use the texts and curriculum materials that are adopted by their districts. The overwhelming majority of math teachers (92 percent) indicate that they use the instructional texts and materials adopted by their district. Nearly two-thirds of the teachers (65 percent) have received training in how to use the adopted curriculum materials. Less than half (48 percent) adapt the textbook, at least to some extent, to use with materials they primarily design (see Table 10). As might be expected, 70 percent of the most veteran teachers (25 or more years of experience) indicate they adapt the textbook to use with materials they primarily design, compared with 43 percent of their less experienced colleagues.

[9] For more information see the report summarizing an examination of mathematics and reading textbook alignment commissioned by OSPI, "Washington State Instructional Materials Review: K-12 Mathematics and Reading Core/Comprehensive Materials" (OSPI, 2005).

Most teachers (61 percent) indicate that they spend at least 75 percent of their teaching time using district-adopted texts and instructional materials, while a third of teachers indicate that they spend at least a quarter of their instructional time using teacher-developed instructional materials and tools. Forty percent indicate that they do not use curriculum that has not been endorsed by the district (and is not teacher-developed).

Table 10: Teachers' Views on Instructional Materials

	Strongly agree	Somewhat agree	Somewhat or strongly disagree
I use the instructional texts and materials for mathematics adopted by my district	69%	23%	8%
I have received training in how to use the curriculum materials adopted by my district	36%	29%	35%
I am generally satisfied with the math texts that I am using	27%	35%	37%
I adapt the textbooks to use with materials I primarily design	14%	34%	52%

Sample = 214

Teachers are somewhat satisfied with the math texts they are using. Sixty-two percent indicate they are generally satisfied with their textbooks (27 percent strongly agree, 35 percent somewhat agree). Teaching experience does not appear to make a difference in teachers' overall satisfaction with their textbooks, but teachers in smaller schools (less than 1,000 students) show greater satisfaction with the texts they are using (77 percent) than their counterparts in larger schools (60 percent). Additionally, among the teachers who are not satisfied with their math texts, the majority indicate that they do not have adequate time for planning and preparing lessons and consider the lack of appropriate curriculum or texts to be a moderate or great challenge in working with struggling students.

Schools generally have adequate resources to support the math curriculum, according to 60 percent of the teachers. However, a lack of appropriate curriculum and textbooks to work with struggling students is identified by 38 percent of the teachers as a moderate or great challenge. In particular, this issue is mentioned by nearly half of the teachers (49 percent) with less than five years of experience.

We also asked the math teachers to identify the best textbooks and curriculum materials they have used this year. A list of the best textbooks as identified by the teachers is provided in Appendices B and C. About 20 percent of teachers indicated that they weren't satisfied with the texts or instructional materials available to them. Slightly over half of the teachers attribute some of their school's success in mathematics to the quality of curriculum materials (either a great deal, 16 percent, or somewhat, 37 percent).

If the math teachers surveyed use Washington's Mathematics Grade-Level Expectations (GLEs) as a reference point in their teaching, they most often use them to explicitly align curriculum and for curriculum development. GLEs are less frequently used for purposes of assessment or for demonstrating student progress. Table 11 provides additional information regarding the purposes and frequency with which these teachers use the mathematics GLEs.

Table 11: Teachers' Usage of Washington's Mathematics Grade-Level Expectations (GLEs)

	Often	Sometimes	Not at all or Rarely
Explicitly align curriculum, instruction and assessment	27%	37%	36%
Curriculum development	24%	38%	38%
Organize learning activities more explicitly around state or state-derived standards	15%	30%	53%
Improve instructional practices	13%	31%	55%
Assist in assessing specific aspects of student learning	12%	30%	56%
Find better ways of demonstrating what students have mastered	6%	25%	67%

Sample: N=214

Nearly three-quarters of the math teachers use computers or other advanced technology in their classrooms. Among the most popular uses of technology are graphing calculators and online systems to track student progress and grades. Over three-quarters of the math teachers indicate they <u>often</u> use an online system to track student progress and grades. Only one third of the teachers have access to smart boards. When smart boards are available, 59 percent of the teachers indicate that they use them <u>often</u> with their students. Table 12 provides information on teachers' use of technology and frequency of use, for those who have access to them. It is important to note that teachers in the "consistently high performance, high SES" school category appear to be better equipped with technological resources to support student learning compared to other schools. For example, all of the teachers in this school category had access to graphing calculators and 64 percent had access to smart boards. They also indicate the highest rates of use for these resources.

Table 12: Teachers' Usage of Technological Resources				
For those who have access to these resources*	Often	Sometimes	Rarely	Unavailable
Online system to track student progress and grades	78%	16%	6%	7%
Graphing calculators	77%	16%	7%	6%
Smart boards	59%	16%	25%	67%
Web-based curriculum resources	14%	36%	50%	15%

** Frequency calculated based on the percentage of teachers who had access to the resource.*

Web-based resources are available to 85 percent of the math teachers. Among those who have access to this technology, half rarely use them. Only 28 percent of teachers use OSPI's web-based instructional support modules. However, among teachers in smaller schools (less than 1,000 students), 48 percent indicate they use these support modules.

Supports for Math Students

> *The vast majority of teachers report that after-school tutoring or other programs that provide additional help in math are available at their schools, and two-thirds of teachers indicate that their school offers summer math programs. Supports for students with special learning needs are also reported by most teachers to be available and provide a moderate or great deal of support to those students. Fewer teachers indicate that their school offers peer tutoring, math clubs, or other extra-curricular activities. Teachers in smaller schools generally report lower levels of available support. Overall, teachers indicate that their greatest challenges in working with students who are struggling in math are the lack of one-on-one assistance and the variety of learning needs in the classroom. The majority of teachers do not report a lack of support by school leadership or lack of knowledge as a challenge in serving these students.*

Teachers indicate that their schools offer a variety of programs and activities to support student learning in mathematics. After-school tutoring or other math assistance programs are available in 90 percent of these schools, and according to teachers, these opportunities offer a moderate or great deal of support for students. Few schools offer before-school or zero period mathematics classes (30 percent), but two-thirds offer some support through summer mathematics programs. Table 13 provides information regarding supplementary programs for students learning mathematics and the degree to which teachers indicate they offer support.

Table 13: Availability of Supports for Student Learning in Mathematics in Surveyed Schools				
	A great deal	A moderate amount	Occasionally	Not at all
After-school tutoring or programs in which mathematics help is available	52%	30%	8%	11%
Supports for students with special learning needs	32%	49%	18%	1%
Summer mathematics programs	28%	38%	26%	8%
Support for highly capable students	28%	40%	21%	12%
Mathematics club or extra-curricular activites	22%	28%	16%	33%
Support for students who need extra help but do not qualify for special services (such as LAP or special education)	19%	40%	33%	8%
Support for English language learners	19%	38%	30%	12%
Peer tutoring	16%	31%	36%	17%
Before-school or zero period mathematics classes	10%	9%	12%	69%

Sample = 214

According to most teachers in these schools, support for students with special learning needs is available, with 81 percent indicating a moderate or great deal of support for these students. Two-thirds of the teachers indicate their school offers a moderate or a great deal of support for highly capable students, and 57 percent indicate a similar level of support for English language learners. For those students who need extra help but do not qualify for special services (such as LAP or special education), 59 percent of the teachers indicate their school offers more than occasional support. Fewer teachers indicate that their school offers peer tutoring, mathematics clubs, or extra curricular activities.

School size appears to matter with regard to access to particular kinds of supports for students who are learning mathematics. Teachers in smaller schools (less than 1,000 students) indicate fewer supports with regard to after-school tutoring, summer programs, English language learners, highly capable students and extracurricular activities, such as math clubs. Table 14 provides a summary of this information.

Table 14: Degree of Support for Student Learning in Mathematics: Differences by School Size			
	A great deal	A moderate amount	Not at all or occasionally
After-school tutoring or programs in which mathematics help is available			
Student enrollment 1-999	42%	26%	32%
Student enrollment 1,000+	53%	30%	16%
Summer mathematics programs			
Student enrollment 1-999	19%	29%	52%
Student enrollment 1,000+	29%	40%	31%
Support for highly capable students			
Student enrollment 1-999	13%	32%	52%
Student enrollment 1,000+	30%	40%	29%
Support for English language learners			
Student enrollment 1-999	23%	13%	62%
Student enrollment 1,000+	18%	43%	39%
Mathematics club or extra-curricular activities			
Student enrollment 1-999	10%	10%	80%
Student enrollment 1,000+	24%	31%	44%

Sample = 214, Enrollment 1-999 =31, Enrollment 1000+ = 183

Teachers in the school category "notable improvement with subgroups" generally serve the most diverse student populations. These teachers indicate that their schools provide more support for summer mathematics programs, students with special learning needs and English language learners than teachers in the other school categories. Teachers in schools in the "consistently high performance, high SES" category generally provide fewer supplementary supports for students learning mathematics, with the exception of extra-curricular activities such as mathematics clubs. Eighty percent of the teachers in these schools indicate that a moderate amount or a great deal of support is offered for extra-curricular activities.

Overall, the math teachers surveyed indicate that their greatest challenges in working with struggling students are the lack of one-one-one assistance for students and the variety of learning needs in the room. The lack of one-on-one assistance for students is a moderate or great challenge for 78 percent of the teachers, as is the variety of special learning needs for three-quarters of the teachers. Appropriate curriculum and textbooks is identified as a moderate or great challenge by 38 percent of the teachers (for more information see Table 15).

Lesser challenges for these teachers in serving struggling students include a lack of support by school leadership or a lack of knowledge to serve students. Less than a third of the teachers indicate that a lack of support by school leadership is a moderate to great challenge. Most feel strongly that they do not lack the knowledge to help struggling students in their classes (81 percent indicated it was not a challenge or only a small challenge).

Table 15: Extent to which Teachers Consider Certain Issues a Challenge in Working with Struggling Students		
	Moderate or great challenge	Not a challenge or small challenge
The lack of one-on-one assistance for students	78%	22%
The variety of special learning needs in the room	76%	24%
The lack of appropriate curriculum or texts	38%	62%
Lack of support by school leadership	32%	67%
My lack of knowledge to serve these students	18%	81%

Sample = 214

Nearly two-thirds of the teachers (64 percent) report that struggling students in their school are not assigned to the least experienced teachers. However, only 53 percent report that resources are specifically targeted for students who have the greatest difficulties in math. In write-in responses on the survey, teachers also report a considerable challenge to be a lack of concern on the part of students for their own success in learning mathematics.

Teachers' level of experience does make a difference with regard to the degree of challenge these teachers identify in working with struggling students. The variety of special learning needs in the room and a lack of one-on-one assistance for students is a much greater challenge for teachers with less than five years of experience teaching math. See Table 16 for more information.

Table 16: Challenges in Working with Strugglng Students: Differences by Teacher Experience			
	Great challenge	Moderate challenge	Not a challenge or small challenge
The lack of one-on-one assistance for students			
1-4 years of experience	61%	26%	14%
5 or more years of experience	33%	43%	23%
The variety of special learning needs in the room			
1-4 years of experience	42%	49%	9%
5 or more years of experience	26%	46%	28%

Sample: 214; 1-4 years experience = 43, 5 or more years experience = 171

Collaboration and Supports for Math Teachers

A strong sense of professional community is a factor often reported by teachers as a key factor contributing to their school's success in mathematics. Most teachers indicate that they work together to select content, topics, and skills to be taught, as well as share ideas about how to help underperforming students. Teachers report working together less frequently to select textbooks and materials or examine data or students work to identify learning needs. Teachers mostly rely on other teachers in their building, including a

math department chair or lead teacher for guidance and support. When considering professional development, nearly all teachers found regularly scheduled collaboration with other teachers to be the most useful form of professional learning. However, 36 percent of teachers had no opportunity to observe other math teachers in the past 12 months.

Professional community and support within schools can be a key factor for teachers in providing effective classroom instruction. Apart from the quality of instruction by math teachers in their school, the next most important factor teachers attribute to their school's success in mathematics is a strong sense of professional community. The professional development opportunities these teachers find most useful occur when they work together with colleagues in their school on substantive issues of teaching and learning.

Teachers in these schools are familiar with the content and goals of the math courses taught by other teachers. They often work together to select content, topics and skills to be taught, and determine the sequence of course offerings (between 73 and 80 percent indicate working together a moderate amount or a great deal on these tasks). Two thirds share ideas about how to help underperforming students and engage in intellectual discourse around mathematics.

However, these teachers indicate they do not often work together to select textbooks or other instructional materials. These math teachers indicate they work with their peers even less frequently on examining data or student work to identify learning needs or consider ways to apply state and district standards to the curriculum (see Table 17).

Table 17: Extent to which Math Teachers Work Together at their School on Various Tasks

	A moderate amount or a great deal	Occasionally or not at all
Select content, topics and skills to be taught	80%	20%
Determine the sequence of course offerings	74%	25%
Share ideas about how to help underperforming students	67%	32%
Engage in intellectual discourse around mathematics	67%	32%
Consider ways to apply state and district standards to the curriculum	58%	41%
Select textbooks and other instructional materials	56%	42%
Examine data or student work to identify learning needs	45%	54%

Sample = 214

These math teachers report finding the most guidance and support for improving their own math instruction from other teachers in their building and from their math department chair or lead teacher. Forty-three percent of the math teachers surveyed

indicate they receive a great deal of guidance or help to improve their math instruction from other teachers in their building. Over a third (36 percent) of teachers report they receive a great deal of guidance from their math department chair or lead teacher (see Table 18 for details). One teacher described the support received from colleagues in the following way, *"So far, my collaboration with a few of my mathematics colleagues, especially my department head, has had the greatest impact on my teaching."*

Table 18: Sources of Instructional Support and Guidance for Teachers

For those who had access to these individuals or resources	Great deal of guidance	Some Guidance	No Guidance
Other teachers in their building	43%	50%	7%
Math department chair or lead teacher	36%	47%	16%
Math coach or curriculum specialist	17%	38%	45%
Professional mathematics organization (e.g., NCTM)	5%	54%	41%
Principal or assistant principal	4%	48%	48%
Other teachers in my district	4%	46%	50%
Mathematics network	8%	46%	46%
College or university instructors	6%	32%	62%
State or regional math specialist (OSPI, ESD staff)	3%	27%	71%

Teachers also found some guidance from their professional mathematics organization, from a math coach or curriculum specialist, and from their building principal or assistant principal. Fifty-four percent of the math teachers report receiving some guidance and support from professional mathematics organizations. But teachers are divided on the extent to which math coaches and others provide support and guidance when they are available. Over a third of the teachers indicate that a math coach or curriculum specialist was not available and a similar percentage indicated that they did not participate in a mathematics network. Less than forty percent (38 percent) of math teachers who have math coaches available attribute some or a great deal of their school's success in improving mathematics performance to this resource.

The most useful professional development support that the math teachers engaged in during the last twelve months included regularly scheduled collaboration with other teachers. Nearly all of the math teachers found regularly scheduled collaboration with other teachers and opportunities to observe other math teachers to be somewhat or very useful in impacting their math instruction (94 and 95 percent, respectively). Over a third of the teachers (36 percent) did not have the opportunity to observe other math teachers. One teacher explained the importance of collaboration in the following narrative response: *"We feed off of each other's ideas and collectively come up with better solutions to problems than we could have on our own. We also work hard to be*

consistent between classrooms, so each student has the same experience in a particular level, regardless of who their teacher is."

Ninety-one percent of the teachers rated workshops or conferences as somewhat or very useful in impacting on their instruction (see Table 19). Other professional development activities these teachers found to have an impact on their instruction included examining school-wide data on student performance, mentoring and/or coaching and college or university courses. Eighty percent of teachers found collecting and/or examining school-wide data on student performance to be somewhat or very useful. Three-quarters of teachers (76 percent) who received mentoring and/or coaching found it to be somewhat or very useful and as did 75 percent of those who attended college or university courses, though in both cases, a quarter of those who participated did not find it useful. It is important to note that only a little over half of the teachers received some form of mentoring or coaching (58 percent), or participated in a college or university course (51 percent).

Table 19:Impact of Professional Development Activities on Math Instruction During the Last 12 Months

*For those who participated in these activities**	Very useful	Somewhat useful	Not Useful
Regularly scheduled collaboration with other teachers	54%	40%	6%
Observations of other math teachers	34%	61%	5%
Attending workshops or conferences	33%	58%	9%
Mentoring and/or coaching received	25%	52%	24%
College or university courses	23%	52%	25%
Collecting and/or examining school-wide data on student performance	15%	65%	20%

** Rating calculated based on the percentage of teachers who participated in the opportunity.*

In a narrative response, teachers were asked to describe what has helped them the most to become more effective in working with mathematics students. The most frequent theme voiced by 47 percent of teachers was collaboration and professional work with their colleagues. Other themes included teaching experience (30 percent), professional development (24 percent), and subject matter knowledge or strong math background (8 percent). Some illustrative responses from the teachers regarding their views of collaboration and professional community are provided below:

> *"Working with fantastic colleagues has been the most helpful in working with students. In seeing that other teachers are seeing either similar or different issues, it helps me to guide my instruction accordingly."*

"I work in a math department of strong math teachers who share dedication, mutual respect and a passion for teaching mathematics. Not only do we problem solve well together, but we often validate each others perspectives and provide emotional, philosophical and intellectual support."

In the final section of the findings, we discuss teachers' views of the factors that contribute to the success at their school in improving student performance in mathematics. These school and teacher practices provide insight into how teachers understand their individual and collective work as a math educator within their school and district context.

Successful School and Teacher Practices

When asked to identify factors related to their school's success in mathematics, teachers most often noted the quality of instruction by math teachers (94 percent) and a strong sense of professional community (80 percent). School leadership is another factor identified by teachers, with 72 percent of teachers agreeing that the leadership at their school works hard to help them improve their performance, and 62 percent attributing the success their school has had in part to school leadership that supports mathematics improvement. Teachers also recognize that the level of readiness of students upon entering high school also impacts their school's success. Some variation exists in teachers' responses by level of teaching experience and type of school. With regard to issues of improving mathematics across the K-12 curriculum, many teachers note the importance of curricular alignment and emphasize the need for student mastery of basic skills in the earlier grades.

The teachers surveyed overwhelmingly attribute their school's success in mathematics to the quality of instruction by math teachers (94 percent attribute some or a great deal of success to this factor). As previously mentioned, a strong sense of professional community is the next most frequently mentioned contributing factor (80 percent attribute some or a great deal of success to this). Other factors to which teachers attribute some of their school's success include school leadership in support of mathematics improvement, the adoption of specific mathematics initiatives or programs in their school, and the level of readiness of students upon entering the school. For more information on the factors teachers attribute to their school's success in mathematics, see Table 20.

Table 20: Factors to which Teachers Attribute Success in Improving Student Mathematics Performance at their School			
	A great deal	Somewhat	Not at all or a little bit
Quality of instruction by math teachers in this school	63%	31%	6%
A strong sense of professional community in this school	50%	30%	20%
School leadership supporting mathematics improvement	28%	34%	37%
The adoption of specific mathematics iniatives or programs in this school	24%	35%	41%
The level of readiness of students upon entering our school	18%	40%	42%
The quality of curriculum materials	16%	37%	44%
Adequate time for planning, preparation and instruction	8%	25%	65%

Sample = 214

These teachers' views of their school's success in mathematics differ by length of experience as a math teacher. Experienced teachers (five or more years teaching math) attribute a great deal more of the success to the quality of instruction by math teachers, professional community, support of school leadership and the level of readiness of students upon entering the school, than their less experienced colleagues.

Regardless of overall experience, the length of time a teacher has been at the school may make a difference in how teachers perceive their school's success. For example, 71 percent of teachers who had been at the school at least five years indicated that the quality of instruction attributed a great deal to success in math at the school, compared with only 55 percent of teachers at the school for less than five years.

According to these teachers, school leadership is an important factor for improving student performance at the school. Sixty-two percent attribute the success their school has experienced in part to school leadership that supports mathematics improvement. Seventy-two percent of the teachers report that the leadership at their school works hard to help them improve student performance. As noted earlier, the principal or assistant principal also provides at least some guidance to math teachers in helping them improve their instruction (52 percent indicate some or a great deal of guidance).

Many of the teachers recognize that the support they receive from school leaders contributes to their efforts in the classroom. Coupled with findings about school collaboration, this implies that the leadership in many of these schools is making it possible for teachers to work together and receive the kinds of support they need. The following excerpts from teachers' narrative responses support this finding:

"The administrators are committed to holding students to high standards of conduct and academic performance. The teachers are expected to teach and the students are expected to learn. Everyone knows their job. This culture is very special."

"The administrators are supportive of teachers receiving further training outside of the classroom. Also, the administrators (and other teachers) are sensitive to helping each other share the work load so one teacher 'doesn't have to do it all.'"

"The administrators at the school level and district level just keep on encouraging me to keep on doing what I am doing. It is my goal to become a better and more knowledgeable teacher each year. With the freedom that they give me and the support that they give me, I feel like I have really grown. By my personal growth, I am better able to help my students grow."

When the schools in the study are disaggregated by school sampling category, the factors to which teachers attribute school success in mathematics reveal some differences. The four school sampling categories outlined earlier in this document are summarized below:

High performance with improvement – top quartile in math and demonstrated gains over time
Overall improvement – demonstrated gains in math over time
Notable improvement with subgroups – significant improvements with low-income or racial/ethnic minority students
Consistently high performance, high SES – top quartile but have low percentages of students in poverty or minority students.

While the number of schools and responding teachers is comparatively small in some of the categories, the differences in teachers' viewpoints are illustrative of differences in various school contexts.

For all of the teachers, the quality of instruction by math teachers is central to improving math performance. However, not all schools face the same challenges. Teachers in "consistently high performance, high SES" schools recognize that a great deal of their success can be attributed to the level of readiness of students upon entering school (52 percent compared to 13 percent of teachers in other schools). Teachers in the "high performance with improvement" category of schools attribute a greater percentage of their success to a strong sense of professional community (74 percent compared to 43 percent of teachers in other schools), and to school leadership supporting mathematics improvement (41 compared with 25 percent). Teachers in schools that have shown "overall improvement" or "notable improvement with subgroups" attribute less success to professional community, which may be lacking (42 compared with 66 percent of teachers in other schools).

An examination of teacher responses based on the school categories also reveals differences in assignment practices and targeting of resources to help struggling students. Fifty-six percent of the math teachers in schools in the "notable improvement with subgroups" category indicate that students who struggle in math are often assigned to the

least experienced teachers compared with only 33 percent of teachers in the higher performing schools. Additionally, 44 percent of the teachers in these schools strongly agree that AP courses or other advanced math courses are almost always taught by the most senior teachers compared with only 31 percent of teachers in the schools showing higher performance in math.

With regard to issues of improving mathematics instruction across the K-12 curriculum, the teachers in this survey offer many useful suggestions though their open-ended responses on the survey. Many teachers note the importance of curricular alignment across the grade levels, and emphasize the need for "clear," "well-articulated" and "specific" standards and/or GLEs with math concepts and skills that are appropriate for each grade level. Many consider the current GLEs to be "fuzzy," "too difficult to align the K-12 in a functional way" and "not adequate to prepare students for college." Teachers call for opportunities to talk with other teachers across grade levels and to work cooperatively and collaboratively to align curriculum.

Along with the emphasis on aligning and sequencing the curriculum, many teachers mention the need for mastery of basic skills in the earlier grades. Teachers strongly believe that high school students with low basic skills are more likely to be at risk of failing. Many high school teachers in the survey discourage K-5 teachers from allowing students to use a calculator. Rather they would stress the mastery of arithmetic skills such as subtraction, multiplication and division and early interventions for elementary and middle schools students who need extra support to master these skills. A teacher responds:

> *"I feel that too many students are being pushed through the curriculum without mastery or understanding and they have a harder and harder time each year. This happens especially in the lower grades (elementary and junior high) and then, there is no good place for them in high school."*

Many of these high school teachers also would encourage those teaching math in the lower grades to have math-specific credentials or expertise. Teachers indicate that math training and math specialist support for elementary and middle school math teachers is needed now and eventually K-8 teachers should be "required to be math-endorsed" for quality instruction. Teachers view smaller class size and collaboration as ways to make their daily teaching more responsive and meaningful. Smaller class size was mentioned as a way to "allow teachers more time to address individual learning needs" and "help each student who is struggling."

Teachers' collaboration is viewed as crucial for developing professional community that facilitates both math learning and teaching. Teachers emphasize "carving out time for math teachers to collaborate in teaching courses, training, and designing and improving curriculum together." One teacher explained:

> *"Support small professional communities on a regular basis to take on and solve their unique local problems proactively as opposed to the current structure that*

fosters reactive interventions to whatever the current issue happens to be. Support peer to peer interactions that allow for regular peer observations and coaching and collaborations in the classroom."

The open-ended comments described above provide some perspectives on issues that are also addressed in other survey items. When examining their individual comments, teachers emphasize the importance of standards and well-aligned curriculum, the need for students to come well-prepared for high school math, and the benefits of a professional, collaborative culture.

Discussion

Much has been written in recent years about mathematics education. Teachers' responses to these survey items are consistent with other recent research in this area, particularly with regard to the importance of subject matter knowledge and preparation. Researchers have posited that teachers with preparation in and knowledge of mathematics are better prepared to help improve student achievement (Hill, 2007; Rice, 2003), and respondents to this survey in high-performing or improving schools indicate they are generally well-prepared and are well-matched to the courses they are teaching. Overall, they are confident of their knowledge and skills. The quality of instruction by math teachers is the most frequently mentioned reason for improvement in math performance at their schools.

In summarizing 30 years of research in mathematics education, Tom Romberg emphasizes the importance of strong subject matter knowledge. He writes, "Teachers must understand the structure of mathematic domains. Knowledge of the network of relationships is critical when making decisions about student understanding and the sequence of instruction" (Romberg, 2002, p. 2). Findings from this survey and other research (Baker, 1999; Cohen & Hill, 2000; Darling-Hammond, Holtzmann, Gatlin & Heilig, 2005) speak to a focus on attracting individuals with strong subject matter knowledge into teaching, and upgrading the knowledge and skills of individuals already in the teaching force. The findings also emphasize the importance of assignment practices and staffing patterns in schools in order to maximize the alignment of teachers' qualifications and experience with the specific needs of students in the school. It is instructive that struggling students in these schools are generally not assigned to the least experienced teachers. However, few teachers report that their school engages in deliberate efforts to assign the best teachers to students who struggle most in math.

The findings from this survey support the premise that teaching experience matters in mathematics instruction, which is consistent with findings from previous research (Rice 2003). Teachers with less experience indicate that they lack confidence in their knowledge and skills and have fewer strategies for instruction and assessment. Novice math teachers indicate they less frequently present mathematical concepts using a variety of formats or adapt materials and textbooks. They are less likely to examine student work with other teachers and find the lack of one-on-one assistance for students and the

variety of special learning needs in the room to be a greater challenge than their more experienced colleagues.

When teachers themselves were asked to explain what has helped them the most to become more effective in working with math students, apart from collaboration and professional work with their colleagues, the next most frequently mentioned theme was teaching experience. One teacher explained the importance of experience in the following way, "My experience teaching and reflections on my teaching have shaped my instruction more than any other factors." Another teacher wrote how "teaching all math from pre-algebra through calculus at some point in my teaching career" gave him/her a breadth of experience to become a more effective teacher. This theme is also echoed in the voice of a less experienced teacher: "This is my second year teaching. The main thing that has helped me to this point is experience. As I become more familiar with students and more familiar with the curriculum, I feel more comfortable teaching it."

Regardless of teachers' level of experience and despite their preparation, knowledge and training, many teachers in these schools indicate that they do not always have the right tools or supports to design and offer appropriate instruction to their students. While teachers are generally confident of their subject matter knowledge, and the college preparation they received, they are less confident of having the right materials to support instruction. Twenty-one percent indicate they <u>always</u> have the right materials and 32 percent indicate they <u>always</u> have the right professional development support. Nearly half indicate they rarely or never have adequate time for planning and preparation for instruction. Nevertheless, these teachers believe in their own efficacy as math instructors as evidenced by the strong majority of teachers who indicate that by trying a different teaching method they can affect a student's achievement.

There are a number of instructional issues on which nearly all of these math teachers agree, including the use multiple instructional strategies, and an emphasis on problem-solving and critical thinking. But they are split with regard to particular teaching practices, such as whether to cover material quickly to ensure all material has been addressed prior to testing, or whether to place more emphasis on teaching discrete basic skills. They are not in agreement on the degree of discretion they can exercise over content decisions and the issue of ability grouping. For example, they are equally divided on whether they believe students learn best when grouped by prior academic achievement. Despite years of discussion and debate by educators on whether students of mixed ability levels should be taught in the same classroom, most often in these teachers' classrooms, students are grouped by prior performance. These findings suggest that at least to some extent, students in these schools are grouped by ability level and that teachers themselves are divided on whether this is an effective strategy for student learning. With respect to new trends in mathematics, an interesting finding from this survey is the extent to which integrated math courses are being offered as part of the curriculum.

Textbooks and instructional materials play an important role in math instruction since teachers primarily use district adopted texts and materials for the planning and delivery of

instruction and for purposes of assessment. Among the survey findings on curricular materials, several concerns surface. First, since teachers base a good deal of their instruction and planning on textbooks and instructional materials adopted by the district, curriculum selection becomes even more important. It should be noted that teachers aren't overly satisfied with the textbooks they are currently using and about half adapt textbooks to use with other materials they primarily design. And for 38 percent of teachers, the lack of materials is a significant challenge in working with struggling students. Additionally, with a heavy reliance on district adopted materials, there may be a tendency to cover the content of the book rather than base their instruction on the needs of their students.

Use of assessments to adjust instruction is an area where teachers report feeling less prepared than other aspects of their teaching. This finding is consistent with research conducted at the Wisconsin Center for Education Research. Tom Romberg writes, "Most mathematics teachers are aware that they acquire considerable informal evidence about their students, yet they rarely use such evidence in judging students' progress. In fact, current data show that most mathematics teachers could benefit from professional development designed to help them learn how to make good use of their informal assessments" (Romberg, 2002, p. 2). Most teachers surveyed report using intervention tools with students who are struggling in math, but only half use diagnostic assessments to help identify learning needs. Just as teachers indicate they monitor student progress by giving quizzes, tests and reviewing homework, this standard approach may not take into account all that is needed to make appropriate assessment decisions and adjust instruction. Less than a third of teachers report they examine student work with other teachers for purposes of assessment. It is unclear from this survey what teachers are using to determine appropriate intervention tools.

Supplementary programs and activities to support student learning in mathematics are common in the respondents' schools. As would be expected, the nature and frequency of programs and activities varies depending on the size of the school and the needs of the student population. The greatest challenges for teachers working with students struggling in math are the lack of one-one-one assistance and the variety of learning needs in the classroom. Teachers generally do not report a lack of support by school leadership or their lack of knowledge to serve these students as a challenge.

Among the strongest findings from this study is the impact of collaboration and professional community on teachers' sense of efficacy with regard to math instruction. This finding is consistent with existing research drawing correlations between the strength of the professional community within a school and social support for improving student performance (Elmore, Peterson & McCarthey, 1996; Lee, Smith & Croninger, 1998; Marks & Printy, 2003; Newmann, King & Youngs, 2000; Rosenholtz, 1991; Yasumoto, Uekawa & Bidwell, 2001). A strong sense of professional community is one of the key factors to which teachers' attribute their school's success in mathematics. Most teachers indicate they work together to select content, topics and skills to be taught, as well as to share ideas about how to help underperforming students. Teachers rely most heavily on other teachers in their building and their math department chair or lead teacher

for professional guidance and support. When considering professional development, nearly all of the teachers found regularly scheduled collaboration with other teachers to be the most useful. Despite this strong affinity for collaborative work, teachers indicate they do not often work together to select textbooks or other instructional materials and even less frequently examine data or student work together to identify learning needs.

The central factors to which teachers attribute their school's success in mathematics are the quality of instruction by math teachers and a strong sense of professional community. Other factors to which teachers attribute some of their school's success include school leadership in support of mathematics improvement, the adoption of specific mathematics initiatives or programs and the level of readiness of students upon entering the school. The role of school leadership as a factor in improving student performance in math is a surprise finding from the survey. Overall, math teachers in these high performing or improving high schools are positive about the effort of their leaders. Nearly three-quarters of the teachers indicate the leadership works hard to help them improve student performance and 62 percent attribute in part the success their school has experienced in improving math performance to school leadership that supports math improvement. This coupled with findings about school collaboration imply that the leadership of these schools is making it possible for teachers to work together and receive the kinds of support they need.

While the survey results support some existing math improvement strategies, they also raise questions with regard to ways in which teachers could be better supported in their efforts to improve teaching and learning. In the next section we offer specific policy recommendations based on the findings from this study.

Policy Implications

Improving student learning in mathematics is a highly complex challenge. The findings from this survey of high school mathematics teachers in high performing or improving schools shed light on some of these complexities and have implications for policymakers at state, district, and school levels. In this concluding section, we outline policy implications in the following seven areas: (1) teacher knowledge and experience, (2) teacher assignment and retention, (3) assessment and differential supports for students, (4) textbooks and materials, (5) professional learning and collaboration, (6) leadership, and (7) data system capacity.

Teacher Knowledge and Experience

The great majority of teachers in these high performing or improving schools feel well-prepared and well-matched to the courses they are teaching. They most frequently mention the quality of instruction by math teachers as the reason for improvement in math performance at their school. Teachers in these schools firmly believe that they can positively affect student achievement, and that they have the right knowledge to work

with struggling students. However, novice math teachers in these schools lack confidence in their knowledge and skills and have fewer strategies for instruction and assessment. Based on these findings, the following suggestions for policymakers are offered:

- Maintain a focus on preparing and recruiting math teachers with strong preparation and subject matter knowledge.
- Upgrade the knowledge and skills of individuals already in the teaching force.
- Provide additional, targeted induction and supports for novice math teachers, including mentoring and collaboration with experienced math colleagues.
- Support alternative avenues into the profession.
- Reinforce efforts by higher education institutions to strengthen pathways into teaching for aspiring mathematics teachers.

Teacher Assignment and Retention

In schools that are showing strong or improving performance in math, teachers' qualifications and experience are very important in determining assignments. Teachers in these schools report that struggling students are generally not assigned to the most inexperienced teachers. However, for the most part, the schools do not engage in specific, deliberate attempts to assign the best teachers to students who struggle the most. In addition to teaching assignment, other school working conditions may impact a teacher's desire to stay in the job. The presence of a collaborative culture, support from administrators, and adequate time for planning and preparation are factors that encourage teachers to remain in their schools. In light of these findings, policymakers and leaders might consider the following:

- Pursue strategies designed to retain math teachers, including an emphasis on developing a collaborative professional culture.
- Consider assignment practices and staffing patterns in order to maximize the alignment of teachers' qualifications and experience with the specific needs of students in the school.
- Provide adequate time for planning and preparation.

Assessment and Differential Supports for Students

Teachers in these schools feel less confident of their abilities in the area of assessment. This finding holds true for both experienced and novice math teachers. This is of particular concern given the need to adjust instruction to meet the varying learning needs of students, especially for those who are struggling with mathematics. Survey findings indicate that some additional supports are available to help students, but that the availability of support varies among different types of schools. Some teachers,

particularly novice teachers, report that the lack of one-on-one assistance and the variety of learning needs in the classroom present a considerable challenge for them. These findings point to the following policy considerations:

- Focus on helping teachers improve their ability to use a variety of assessments to identify student learning needs and adjust instruction.
- Provide opportunities for teachers to examine student data to assist with instructional decisions and better align curriculum.
- Ensure that additional supports are available to students who need them.
- Encourage teacher education institutions to focus on issues of assessment in their preparation of pre-service mathematics teachers.

Textbooks and Materials

District decisions regarding the adoption of textbooks and curricular materials are particularly important since teachers frequently use district adopted texts and materials for the planning and delivery of instruction and for purposes of assessment. Teachers aren't overly satisfied with the math texts they are using, and about half of the teachers adapt the textbook, at least to some extent, to use with materials they design themselves. Teachers report lower levels of involvement in textbook decisions than some other aspects of their collaborative work. Some teachers also indicate a need for texts and materials that are appropriate for struggling students. Given this information, policymakers might consider the following:

- Continue to focus on the selection of high-quality texts and curricular materials that are linked to learning expectations and provide supports for students who struggle in math.
- Provide training and support on the use of adopted texts and materials, including how to employ assessment strategies to adjust instruction that is guided by the texts.

Professional Learning and Collaboration

In order for teachers to work most effectively with their students in mathematics, these teachers indicate that professional community and a supportive culture at the school matters. This includes working collaboratively on curricular issues and familiarity with the content and goals of the courses taught at their school. According to these teachers, regularly scheduled collaboration and observing other teachers are among the most useful forms of professional development. However, many teachers indicate that they only infrequently examine data and student work together. Many also report that they do not have opportunities to observe other teachers. Given these findings in the area of professional learning and support, policymakers could do the following:

- Focus professional development on teacher collaboration regarding curriculum and instructional strategies.
- Include opportunities for teachers to plan together, examine data and student work, and observe one another in the classroom.
- Ensure that teachers are familiar with the instructional goals and content of all the math courses taught at their schools.

School Leadership

Teachers recognize that the support they receive from school leaders contributes to their efforts in the classroom. They attribute the success their school has experienced in part to school leadership that supports mathematics improvement. They also acknowledge that the leadership at their school works hard to help them. This coupled with findings about school collaboration imply that the leadership of these schools is making it possible for teachers to work together and receive the kinds of support they need. These findings suggest that those in leadership positions should:

- Create conditions that support the establishment of a collaborative professional culture around mathematics curriculum and instruction.
- Insure that instructional leadership is provided regarding mathematics instruction and assessment, particularly for novice teachers.

Data System Capacity

As was briefly mentioned earlier in this report, the state of Washington does not currently have the data capacity to identify secondary teachers by the courses they teach. Acquiring the ability to track teachers by subject (e.g., math, science, social studies, etc.) would provide invaluable data about the supply and retention of math teachers, including the capacity to assess the extent to which all students have access to well-qualified math teachers. Progress is underway in improving state data capacity regarding teachers, but policy efforts could be intensified in this area by OSPI:

- Initiate the annual collection of teacher assignment data which can be matched to credentials and other indicators of teacher expertise.
- Improve the accuracy of school level data especially regarding information about staffing allocations, and collect information on the assignment of students to teachers.
- Further develop the relational capacity of state databases about students and teachers.
- Develop the capacity to know which districts, schools and students encounter teachers who are teaching out-of-field.

Teachers play a key role in ensuring that students receive a high quality education in mathematics. The findings from this study offer insights into the nature of schools that are performing well or improving in mathematics. Teachers' views highlight successful practices and draw attention to areas where further support may be needed. The voices of math teachers in this study can help inform future directions for math education in this state.

Acknowledgements

The research presented in this report was commissioned by the Washington State Office of the Superintendent of Public Instruction with support from the Center for Strengthening the Teaching Profession (CSTP). However, the findings and conclusions contained in this report are the sole responsibility of the authors.

References

Baker, P. (1999). Inservice teacher education: form vs. substance. *High School Magazine*, 7(2).

Ball, D. L. (1988a). *The subject matter preparation of prospective mathematics teachers: Challenging the myths.* East Lansing, MI: National Center for Research on Teacher Education.

Ball, D. L. (1988b). Unlearning to teach mathematics. *For the Learning of Mathematics*, 8(1), 40–48.

Ball, D. L. (1990a). Breaking with experience in learning to teach mathematics: The role of a preservice methods course. *For the Learning of Mathematics*, 10(2), 10–16.

Ball, D. L. (1990b). Prospective elementary and secondary teachers' understanding of division. *Journal for Research in Mathematics Education*, 21(2), 132–144.

Ball, D. L. In Kennedy, M (Ed.). (1991). Teaching mathematics for understanding: What do teachers need to know about subject matter? *Teaching academic subjects to diverse learners* (p. 63-83). New York: Teachers College Press.

Ball, D. L. (1996). Teacher learning and the mathematics reforms: What do we think we know and what do we need to learn? *Phi Delta Kappan, 77,* 500-508.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3-15.

Bradley, K. D. & Loadman, W. E. (2005). Urban secondary educators' views of teacher recruitment and retention. *NASSP Bulletin, 89*, 2-28.

Brunetti, G. J. (2001). Why do they teach? A study of job satisfaction among long-term high school teachers. *Teacher Education Quarterly*, 28(3), 49-74.

Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C., & Loef, M. (1989). Using knowledge of children's mathematical thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26,* 499-532.

Cohen, D. K. & Hill, H. C. (2000). Instructional Policy and Classroom Performance: The Mathematics Reform in California. *The Teachers College Record*, 102(2), 294-343.

Darling-Hammond, L. Holtzmann, D. L., Gatlin, S. J., Heilig, J. V. (2005). *Does Teacher Preparation Matter? Evidence of Teacher Certification, Teach for America, and Teacher Effectiveness.* Palo Alto: Stanford University.

Elfers, A. M., Plecki, M. L. & McGowan, M. (2007). *High School Teachers in the Workforce: Examining Teacher Retention, Mobility, School Characteristics and School Reform Efforts.* Seattle, WA: University of Washington.

Elmore, R. F., Peterson, P. L., & McCarthey, S. J. (1996). *Restructuring in the Classroom: Teaching, Learning and School Organization.* San Francisco: Jossey-Bass.

Even, R. (1993). Subject-matter knowledge and pedagogical content knowledge: Prospective secondary teachers and the function concept. *Journal for Research in Mathematics Education*, 24, 94-11.

Featherstone, H., Pfeiffer, L., & Smith, S. P. (1993). *Learning in good company: Report on a pilot study* (Research Report 93-2). East Lansing: National Center for Research on Teacher Learning, Michigan State University.

Garet, M. Porter, A., Desimone, L., & Yoon, K.S. (2001). What makes professional development effective? The results from a national sample of teachers. *American Educational Research Journal.* 38(4), 915-945.

Goldhaber, D. D., & Brewer, D. J. (2000). Does teacher certification matter? High school certification status and student achievement. *Educational Evaluation and Policy Analysis*, 22, 122-145.

Graeber, A., & Tirosh, D. (1990). Evoking cognitive conflict to explore preservice teachers' thinking about division. *Journal for Research in Mathematics Education*, 21(2), 98–108.

Grassl, R. M., & Mingus, T. (1997). Using technology to enhance problem solving and critical thinking skills. *Mathematics and Computer Education,* 31, 293-300.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks: Corwin Press.

Hill, H. C., (2007). Mathematical knowledge of middle school teachers: Implications for the No Child Left Behind initiative. *Educational Evaluation and Policy Analysis*, 39(20), 95-114.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42, 371-406.

Ingersoll, R. M. (2003). *Who controls teachers' work?: Power and accountability in America's schools.* Cambridge, MA: Harvard University Press.

Ingersoll, R. M. & Alsalam, N. (1997). *Teacher professionalization and teacher commitment: A multilevel analysis* (NCES 97-069). Washington, DC: National Center for Educational Statistics.

Kelly, S. (2004). An event history analysis of teacher attrition: Salary, teacher tracking, and socially disadvantaged schools. *The Journal of Experimental Education, 72*(3), 195-220.

Kennedy, M. (1998, April). *The relevance of content in inservice teacher education.* Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA.

Kinach, B. M. (1996). Logical trick or mathematical explanation? Re-negotiating the epistemological stumbling blocks of prospective teachers in the secondary mathematics methods course. Proceedings of the International Group for the Study of the Psychology of Mathematics Education. Columbus, OH: Ohio University.

Kinach, B. (2002). A cognitive strategy for developing pedagogical content knowledge in the secondary mathematics methods course: toward a model of effective practice. *Teaching and Teacher Education*, 18, 51-71.

Knapp, M. S., Elfers, A. M., Plecki, M. L., Loeb, H. and Zahir, A. (2005). *Teachers Count: Support for Teachers' Work in the Context of State Reform.* Seattle, WA: University of Washington. Retrieve from http://www.cstp-wa.org/

Laczko-Kerr, I. & Berliner, D. C. (2002). The Effectiveness of "Teach for America" and Other Under-certified Teachers on Student Academic Achievement: A Case of Harmful Public Policy. *Education Policy Analysis Archives,* 10(37).

Lashway, L., Bryant, B. J., Burton, C., and Hett, A. (2007). *Educator supply and demand in Washington state*. Olympia, WA: Office of Superintendent of Public Instruction.

Lee, V. & Smith, J. B. (1996). Collective Responsibility for Learning and Its Effects on Gains in Achievement for Early Secondary School Students. *American Journal of Education,* 104(2), 103-147.

Lee, V. E., Smith, J. E., & Croninger, R. E. (1998). How high school organization influences the equitable distribution of learning in mathematics and science. *Sociology of Education,* 70(2), 128(23).

Little, J. W. (2003). Inside Teacher Community: Representations of Community Practice. *Teachers College Record,* 105(6), 913-945.

Leinhardt, G. (1989). Math lessons: A contrast of novice and expert competence. *Journal for Research in Mathematics Education,* 20(1), 52-75.

Louis, K. S. & Marks, H. M. (1998). Does Professional Community Affect the Classroom? Teachers' Work and Student Experiences in Restructuring Schools. *American Journal of Education*, 106(4), 532-575.

Louis, K. S., Marks, H. M., & Kruse, S. (1996). Teachers' Professional Community in Restructuring Schools. *American Educational Research Journal*, 33(4), 757-798.

Luekens, M. T., Lyter, D. M. & Fox, E. E. (2004). *Teacher Attrition and Mobility: Results from the Teacher Follow up Survey, 2000-01* (NCES 2004-301). U.S. Department of Education, National Center for Educational Statistics. Washington, DC: U.S. Government Printing Office.

Marks, H. M. & Printy, S. M. (2003). Principal Leadership and School Performance: An Integration of Transformational and Instructional Leadership. *Educational Administration Quarterly*, 39(3), 370-397.

McDiarmid, G. W. (1990). Challenging prospective teachers' beliefs during an early field experience: A quixotic undertaking? *Journal of Teacher Education*, 41(3), 12–20.

Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review*, 13, 125-145.

Murnane, R. J., & Phillips, B. R. (1981). Learning by doing, vintage, and selection: Three pieces of the puzzle relating teaching experience and teaching performance. *Economics of Education Review, 1* (4), 453-465.

National Center for Education Statistics. (2003). *Teacher attrition and mobility: Results from the Teacher Follow-up Survey, 2000-01*. Jessup, MD: U.S. Department of Education.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

Newmann, F. M. and Associates (1996). *Authentic Achievement: Restructuring Schools for Intellectual Quality.* San Francisco: Jossey-Bass.

Newmann, F. M., King, M. B., Youngs, P. (2000). Professional Development That Addresses School Capacity: Lessons from Urban Elementary Schools. *American Journal of Education*, 108(4), 259-299.

Office of Superintendent of Public Instruction (2005). *Washington State Instructional Materials Review: K-12 Mathematics and Reading Core/Comprehensive Materials*, retrieved 6/18/2007 from http://www.k12.wa.us/curriculumInstruct/pubdocs/K12InstructionalMaterialsReview/K-12_InstMatRev_Full.pdf

Promoting Rigorous Outcomes in Mathematics and Science Education (PROM/SE) (2006). *Knowing Mathematics: What We Can Learn from Teachers. Research* Report Vol. 2, East Lansing, MI: Michigan State University.

Rice, J. E. (2003). *Teacher Quality: Understanding the Effectiveness of Teacher Attributes.* Washington, DC: Economic Policy Institute.

Romberg, T. (2002). *30 Years of Mathematics Education Research*. Madison, WI: Wisconsin Center for Education Research, retrieved 6/18/2007 from http://www.wcer.wisc.edu/news/coverStories/30years_math.php

Rosenholtz, S. J. (1986). The organizational context of teaching. In *Learning to Teach.* Champaign-Urbana, IL: University of Illinois.

Rosenholtz, S. J. (1991). *Teachers' workplace: The social organization of schools.* New York: Teachers College Press.

Rowan, B, Chiang, F, & Miller, RJ. (1997). Using research on employees' performance to study the effects of teachers on students' achievement. *Sociology of Education*, 70, 256-284.

Ruhland, S. K. (2001). Factors influencing the retention of secondary business teachers. *Delta Pi Epsilon Journal*, 43(4), 215-28.

Smylie, M. & Hart, A. W. (1999). School leadership for teacher learning and change. *Handbook of research and educational administration.*

Stodolsky, S.S., and Grossman, P.L. (1995). The impact of subject matter on curricular activity: An analysis of five academic subjects. *American Educational Research Journal*, 32(2), 227-249.

Swafford, J. O., Jones, G. A., & Thornton, C. A. (1997). Increased knowledge in geometry and instructional practice. *Journal for Research in Mathematics Education*, 28, 467-483.

U.S. Department of Education. (2006). *The facts about good teachers.* Retrieved June 21, 2007 from http://www.ed.gov.offcampus.lib.washington.edu/nclb/methods/teachers/teachers.html.

Wiley, D. E. & Yoon, B. (1995). Teacher Reports on Opportunity to Learn: Analyses of the California Learning Assessment System (CLAS). *Educational Evaluation and Policy Analysis*, 17(3), 355-370.

Wilson, S. M., Lubienski, S. T., & Mattson, S. (1996, April). *What happens to the mathematics: A case study of the challenges facing reform-oriented professional development.* Paper presented at the annual meeting of the American Educational Research Association, New York City.

Yasumoto, J. Y., Uekawa, K. & Bidwell, C. E. (2001). The Collegial Focus and High School Students' Achievement. *Sociology of Education*, 74(3), 181-209.

Appendices

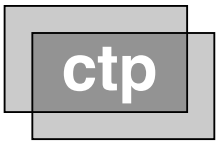
Appendix A: Teachers' View of Factors Used in Determining Math Teaching Assignments: Differences by School Size			
	Very important	Moderately important	Not a factor or slightly important
Logistics of the school's master schedule			
Student enrollment 1-999	42%	36%	22%
Student enrollment 1,000+	25%	46%	27%
Meeting the demands of subject and course enrollments at the last minute			
Student enrollment 1-999	19%	52%	29%
Student enrollment 1,000+	20%	36%	43%
Preferences of the math department chair or school administrator			
Student enrollment 1-999	13%	29%	58%
Student enrollment 1,000+	22%	37%	39%
Teacher's stated wish to teach a particular course			
Student enrollment 1-999	13%	58%	29%
Student enrollment 1,000+	27%	55%	16%

Sample = 214, Enrollment 1-999 =31, Enrollment 1000+ = 183

Appendix B: Math Teachers' Nominations for Best Textbooks and Curriculum Materials (2006-2007)			
Publishers and Programs	Textbooks	Author	Number of Respondents
High school curriculum series			
Glencoe McGraw-Hill	Contemporary Mathematics in Context (Courses 1-4)		24
Core-Plus Mathematics Project			
College Preparatory Mathematics	Algebra, Geometry, Algebra 2		14
Key Curriculum	Interactive Math Program		12
Carnegie Learning Inc	Cognitive Tutor Bridge to Algebra 1, Algebra, Geometry, Integrated Math		8
Holt, Rinehart & Winston	Mathematics in Context: Algebra 1, Geometry, Algebra 2		8
McDougal Littell	Integrated Mathematics 1, 2, 3		5
Scott Foresman Addison Wesley	Secondary School Curriculum		4
University of Chicago School Mathematics Project			
	Math Lab	Slosson	4
Explore Learning	Computer based math curriculum (www.explorelearning.com)		2
Scott Foresman Addison Wesley	Focus on Algebra, Geometry Advanced Algebra		2
Algebra, elementary			
Key Curriculum	Discovering Algebra		2
Geometry			
Key Curriculum	Discovering Geometry	Serra	12
Pearson Prentice Hall	Geometry		3
Glencoe McGraw Hill	Geometry		2
Algebra, intermediate or advanced and Trigonometry			
McDougal Littell	Algebra 2 (2001, 2004)	Larson et al.	7
Key Curriculum	Discovering Advanced Algebra		4
McDougal Littell	Algebra 2 Explorations and Applications (2003)		4
Glencoe McGraw Hill	Algebra 2		3
DC Heath & Co	Algebra 2: An Integrated Approach		2
Houghton Mifflin	Algebra and Trigonometry	Larson & Hostetler	2
Pre-calculus			
Key Curriculum	Precalculus with Trigonometry	Foerster	6
Pearson Prentice Hall	Precalculus: Graphical, Numerical, Algebraic	Demana, Waits, Foley & Kennedy	5
Houghton Mifflin	Precalculus	Larson & Hostetler	3
McDougal Littell	Advanced Mathematics: Precalculus with Discrete Mathematics and Data Analysis	Brown	2
Pearson Prentice Hall	Precalculus	Sullivan	2
Calculus			
Houghton Mifflin	Calculus and Calculus of a Single Variable	Larson, Hostetler, Edwards	13
Key Curriculum	Calculus - Concepts and Applications	Foerster	10
Pearson Prentice Hall	Calculus: Graphical, Numerical, Algebraic	Finney, Demana, Waits & Kennedy	6
Wiley	Applied Calculus	Hughes-Hallett et al.	2
Statistics			
W. H. Freeman & Co.	The Practice of Statistics	Yates, Moore & Starnes	4
Washington Programs			
OSPI	Mathematics Assessment Instructional Support Modules and PAS curriculum		7
New Readers Press	WASL Power!		3

Appendix C: Other Favored Textbooks and Curriculum Materials Mentioned by One Teacher

Publishers and Programs	Textbooks	Author
Glencoe McGraw Hill	MathMatters 1 and 2	
Addison Wesley	Introductory Algebra	Lial, Hornsby & McGinnis
Glencoe McGraw Hill	Algebra 1	
Houghton Miffllin	Algebra	Larson
Houghton Miffllin	Algebra 1	
McDougal Littell	Algebra 1	
Pearson Prentice Hall	Algebra 1	
Pearson Prentice Hall	Developing Skills in Algebra One	Taylor & Taylor
Pearson Prentice Hall	Advanced Algebra	
Pearson Prentice Hall	Algebra 2	
Saxon Publishers	Algebra 2: An Incremental Approach	Saxon
Glencoe McGraw-Hill	Glencoe Geometry: Concepts and Applications	Cummins, Kanold & Kenney
McDougal Littell	Geometry	
Pearson Prentice Hall	Geometry: Tools for a Changing World	Bass et al
Studies in Geometry Series	Circles Workbook	Pelli
Pearson Prentice Hall	Algebra and Trigonometry	Foerster
Houghton Miffllin	Trigonometry	Larson & Hostetler
Addison Wesley	Precalculus: Functions and Graphs	Demana, Waits, Clemens, Osborne & Foley
DC Heath & Co	Precalculus Functions and Graphs	Edwards, Heyd, Hostetler & Larson
Glencoe McGraw Hill	Advanced Mathematical Concepts http://www.glencoe.com/sec/math/precalculus/amc_04/	
Addison Wesley	Calculus and Analytical Geometry	Thomas & Finney
D&S Marketing	Teaching AP Calculus	
DC Heath & Co	Calculus	Larson
Mathematics Association of America	Calculus Materials http://www.maa.org/pubs/calc_articles.html	
Wiley Higher Education	Calculus	Anton
Duxbury Press	Introduction to Statistics and Data Analysis	Peck, Olsen & Devore
Key College Publishing	Workshop Statistics	
Key Curriculum	Statistics in Action	
Pearson Addison Wesley	Stats: Modeling the World	Bock, Velleman, De Veaux
Pearson Prentice Hall	Elementary Statistics: Picturing the World	Larson & Farber
Pearson Prentice Hall	Sullivan Statistics Series	Sullivan
W. H. Freeman & Co.	Basic Practice of Statistics	Moore
Transition Math Project	http://www.transitionmathproject.org/	
Houghton Miffllin	Unified Mathematics Book 2	Rising
Renaissance Learning	Math Computer Modules http://www.renlearn.com/	
Resource Books	http://www.resourcebooks.co.nz/	



Center for the Study of Teaching and Policy

A National Research Consortium

UNIVERSITY OF WASHINGTON (lead institution)

CTP studies the way policies and conditions in schools, districts, states, and teacher education institutions shape the quality of teaching and learning in the nation's elementary and secondary schools. The Center pays particular attention to the ways these policies and conditions interact with each other to influence the teaching profession and its practice.

Participants in CTP's research and dissemination program include researchers at other consortium instituations (Stanford University, University of Michigan, and University of Pennsylvania) as well as other scholars affiliated with Indiana University, Michigan State University, Pennsylvania State University, the University of California at Santa Barbara, the University of North Carolina, and Research for Quality Schools.

The Center's program of research is carried out in collaboration with various other research organizations, among them other OERI-funded research centers, including the Consortium for Policy Research in Education (CPRE), the Center for Research on Education, Diversity, and Excellence (CREDE), and the Center on English Learning & Achievement (CELA). The Center is affiliated with a variety of professional and advocacy organizations that represent teachers, teacher educators, state and local policymakers, disciplinary groups, and educational reform interests.

This report reflects the ongoing collaboration between CTP and the Center for Strengthening the Teaching Profession (CSTP) in Washington state. (See inside front cover.)

Contact Information

Michael S. Knapp, Center Director
Miller Hall M201, College of Education
University of Washington, Box 353600
Seattle, WA 98195-3600
email: mknapp@u.washington.edu

Angie Windus, Center Operations Manager
Miller Hall 203C, College of Education
University of Washington, Box 353600
Seattle, WA 98195-3600
Phone: (206) 221-4114
FAX: (206) 616-8158
email: ctpmail@u.washington.edu

Web Address
http://www.ctpweb.org