An Examination of School-Based Factors Affecting the Grade 8 Mathematics MCAS Performance

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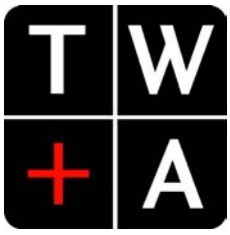

By:

Thomas, Warren + Associates

1501 West Amelia, Suite 101
Phoenix, AZ 85015

29 Matthew Drive
Northampton, MA 01062

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INTRODUCTION

The Massachusetts Education Reform Act of 1993-1994 (MERA) provided for a comprehensive set of reforms that changed almost every aspect of Prekindergarten-12 education in the state in order to improve student learning in all subjects. With the support of industry leaders, teacher unions, and the public at large, the Massachusetts legislature mandated the development of a comprehensive and far-reaching system of standards and accountability measures that would affect all students, teachers, and school districts. For students, this system took the form of Prekindergarten-12 standards (called curriculum frameworks) and accountability measures (the Massachusetts Comprehensive Assessment System or MCAS). For teachers, this system took the form of five-year cycles for license renewal and the requirement of individual professional development plans. For school districts, this system took the form of school and district standards with accountability measures applied through an established schedule of inspections, and ratings based on the inspections and student assessment results.

Over the past eight years, Massachusetts has dedicated significant resources to improving the academic performance of all students, but especially its lowest achieving students. The 2002 Elementary and Secondary Education ("No Child Left Behind") Act strengthens this commitment and seeks to raise the academic performance of all students to the Proficient level and beyond. However, Massachusetts students in Grade 8 mathematics classes are not moving to the Proficient or Advanced level from the Needs Improvement level on MCAS as quickly as they are moving out of the Warning level and into the Needs Improvement level.

In an effort to understand what school-based factors may be related to the lack of progress in increasing the number of students performing at the two highest performance levels, the Massachusetts Department of Education (DOE) retained THOMAS, WARREN + ASSOCIATES to undertake the study described in this document. The study was undertaken to examine and compare Grade 8 mathematics: 1) curriculum; 2) instructional practices; 3) extra support (*e.g.*, tutoring, parental assistance); 4) educator qualifications; and 5) instructional organization (*e.g.*, block scheduling, team-teaching, etc.) across Massachusetts schools. This was intended to be an exploratory study. Its purpose was to identify school-based factors that were significantly associated with schools that exhibited significant increases in the percent of Grade 8 students performing at the Proficient or Advanced levels on the mathematics MCAS, and at the same time exhibited decreases in the percent of Grade 8 students testing in the Warning level. Data for the

analysis were obtained from a survey administered during the winter of 2003 to a cross section of Massachusetts schools. These data were analyzed using statistical and heuristic methods to identify those factors associated with the aforementioned changes in the MCAS test results.

RESEARCH DESIGN

The major goal of the study was to identify school related factors that were associated with changes that occurred in the distribution of Grade 8 MCAS mathematics scores during the four year period[1] between school year 1998-99 and school year 2001-02. The research design was developed in three parts. First, upon consideration of the goals of the study and the available data a methodological approach for analysis was identified. Second, a sampling strategy was prepared. Finally, based on input from the Massachusetts Department of Education, two survey instruments were written to collect the school specific information required to complete the study.

One of the first goals of the research was to develop a set of questions about school-based factors to be asked of a representative sample of Massachusetts Grade 8 administrators and mathematics teachers. The design of this part of the research had two parts: the selection of administrators and teachers to be included in the sample, and the development of a survey instrument. The sampling strategy involved developing a stratified design for selecting schools for inclusion in the survey. Once a school was chosen for inclusion in the sample, the administrators and teachers who would participate in the study were determined by the school principal, with certain restrictions. The design of the collection instrument involved the development of the questions to be included in the survey.

The first element in the sampling strategy by which schools were chosen for inclusion in the survey was to partition the universe of Massachusetts schools. Schools were considered only if they administered the Grade 8 mathematics MCAS test every year of the study period, and administered it to a sufficiently large number of students.

In order to capture longitudinal changes in school-based factors affecting MCAS results, every school included in the sample had to have administered the mathematics MCAS test over each of the four years it was given during the study period. In order to eliminate possible biases introduced by only a few students from a particular school taking the mathematics MCAS test, the sample included only schools that administered the test to at least 50 students in each of the four years of the study period. Thus, in order to have been considered for inclusion in this study a school must have given the mathematics MCAS test each of the previous four years to at least 50 students. There were 308 schools with Grade 8 math classes in Massachusetts that met these criteria as of 2001-02.

In order to capture any factors that were affected by a school being part of either an urban or rural district, schools districts were classified according to their size. School districts with less

1. Hereafter, that four year period will be referred to as the *study period*.

than four schools administering the Mathematics MCAS in school year 2001-02 were classified as "small" districts. All other Massachusetts school districts were classified as "large."

Stratification of schools for inclusion in the sample was based on mathematics MCAS performance. One stratification dimension was defined by an above average increase in the percent of a school's students in the Proficient and Advanced mathematics MCAS levels. Schools were partitioned into two groups based on whether their observed change was above or below the state average change[2] in the percent testing in the Proficient and Advanced level. Similarly, a second stratification dimension was defined by a greater than average decrease in the percent of a school's students in the mathematics MCAS Warning level. Two groups were defined by the first dimension (those with above average increases in the percent of students in the Proficient and Advanced levels and those below the average). Two similar groups were defined based on the second dimension (those above the average decrease in the percent of students in the Warning level and those above the average). Thus the stratification resulted in four groups. Only one of the four groups was targeted as the subpopulation of interest. However, sampling was performed in the four strata independently.

The group that defined the subpopulation of interest represented schools that increased their percent of students testing in Proficient and Advanced by more than the state average, and simultaneously decreased their percent of students in Warning by more that the state average over the study period. For the sake of brevity, these schools will hereafter be referred to as Improving Proficient, Advanced, and Warning (IPAW) schools. The other schools from the remaining three groups were analyzed as a single group, hereafter referred to as non-IPAW schools. Table 1 provides a count of the schools in each of these groups and a description of the overall sample development.

Table 1 ~ Development of Sample Used in Study

	IPAW Schools		Non-IPAW Schools		
Schools	In Large Districts	In Small Districts	In Large Districts	In Small Districts	Total Schools
In Sampling Frame	21	71	69	147	308
In Sample	13	13	25	24	75
Eligible and Agreed to Participate	10	11	23	21	65
Participants					
Eligible and Agreed to Participate	35	36	75	67	213

Algorithmic sampling was performed to identify schools from "small" districts. Schools from the "large" districts were selected for participation in the study by THOMAS, WARREN + ASSOCIATES senior staff to form a representative sample of such schools in a different way.[3] Additionally,

2. The state average change was calculated as the mean of the changes in all 308 schools in the sampling frame.

3. Schools from large districts were selected based on a committee rating process rather than mechanical sampling. It was agreed that mechanical sampling from a small population (90 schools) could potentially

schools from "large" districts were over-sampled. It was noted that there is higher likelihood in "large" districts than in "small" districts of observing a large variability in test results and socioeconomic status among schools. The over-sampling was done because of a concern that the within district variability in test results and socioeconomic status needed to be adequately represented in the final sample. Because of the over-sampling, urban schools were over-represented in the sample and rural schools were under-represented. A preliminary list of 37 schools was selected from "small" districts, and a preliminary list of 38 schools was selected from the "large" districts.

Once the 75 schools were selected for inclusion in the sample, it was necessary to secure an agreement to participate in the study from each school and its school district. Following notification of selection for participation in the study by THOMAS, WARREN + ASSOCIATES, each of the 75 selected school principals was contacted by phone in order to obtain their agreement to participate in the study. Part of this agreement was that each principal would participate in the study and that each would make available the school's Mathematics Coordinator or Mathematics Department Chair[4], if there was one. Additionally, the agreement required that at least one teacher, and as many as two teachers, who had taught at the school and administered the Grade 8 mathematics MCAS test in the 2001-02 school year, would participate in the study. The result of this phone contact was that ten schools were excluded from participation in the study either because they did not meet teacher criteria (six schools) or because they (explicitly or implicitly) declined to participate in the study (four schools). Sixty-five schools met all criteria (32 from "small" districts and 33 from "large" districts), and agreed to participate in the project.

SURVEY DEVELOPMENT AND ADMINISTRATION

A custom, Internet-based, online questionnaire was developed and housed on a secure portion of THOMAS, WARREN + ASSOCIATES' web site. Survey responses utilized CGI scripting in order to register responses electronically. The primary data collection instrument was also available in paper form for those schools that did not have Internet connectivity.

A total of four different data collection instruments were developed. A primary data collection instrument and a supplemental data collection instrument were developed for administrators (principals and math chairs) and teachers. The primary data collection instrument contained four types of questions: multiple-choice, open-ended, choose all that apply, and Likert

lead to a very biased sample. The goal of the committee was to develop a sample that was representative of the population in terms of MCAS results, but also exhibited the diversity of socioeconomic status found in the population. The committee was composed of three senior staff of THOMAS, WARREN + ASSOCIATES, two education specialists and one statistician, all of whom were familiar with the Massachusettts school system. A measure of rater agreement was developed based on the school selections made independently by the members of the committee. The kappa statistic for rater agreement among the members was 0.60 (p=0.00).

4. Throughout the remainder of the document "math chair" will be used to refer to mathematics coordinators or mathematics department chairpersons.

scale ranking. The supplemental data collection instrument had both multiple choice and open-ended questions. In order to provide baseline data, all questions applied to 2001-02. To provide comparative data, some questions asked for responses for 1998-99, but only for personnel who had been at their school since 1998-99.

The primary data collection instruments for administrators and teachers were both segmented into nine sections. These sections are shown in Table 2. Although there was some overlap of questions, the primary teacher data collection instrument contained 78 questions while the administrator data collection instrument contained only 57 questions. The teacher supplemental data collection instrument contained 53 questions while the administrator supplemental data collection instrument contained 67 questions.

Table 2 ~ Sections of the Primary Data Collection Instruments

Teacher	Administrator
Teacher Preparation and Qualifications	School Demographics
Professional Development for Teachers	Staffing and Oversight
Teacher Role	Professional Development for Teachers
Instructional Practices	Instructional Practices
School Curriculum	School Curriculum
School Organization	School Organization
School Goals	School Goals
Student Assessment	Student Assessment
Comments	Comments

The survey instruments allowed for both open-ended and closed-ended (categorical) responses. The closed-ended questions included those where the respondent was asked to rank school-based factors on a Likert-type scale of one (1) to five (5). In this instance, the five ranks formed the potential set of categorical responses for such questions. Other examples included questions with Yes/No responses and selection of an item from a discrete list of items. The categorical responses as a group represented the single largest fraction of the data collected in the study. Approximately 90% of the answers on the two instruments (83% for administrators, and 91% for teachers) were collected as categorical data.

THOMAS, WARREN + ASSOCIATES' senior staff visited the 65 schools included in the original sample between January 5, 2003 and March 17, 2003 to implement data collection procedures. Due to ineligibility (subsequent to its original selection) one school was excluded from the sample. Another school was excluded from the sample due to lack of respondent availability during the interview period. Additionally, no (paper) surveys or supplemental data forms were received from three schools. In total, 60 (30 from small districts and 30 from large districts) of the original 65 schools that had been selected for the study actually completed the survey. The fact that 10 of the IPAW schools were from large districts and 10 were from small districts was not planned but simply due to chance. These 60 schools are shown in Table 3.

Table 3 ~ Schools Included in the Analysis

Small District Schools	Large District Schools
Paul R. Baird Middle School	Boston Latin School
Boston Renaissance Charter School	Boston Latin Academy
Cyril K. Brennan Middle School	Charles E. Brown Middle School
Carlisle School	Central Middle School
Joseph Case Junior High School **	Chestnut Street Middle School
Jonas Clarke Middle School	F. A. Day Middle School
Clinton Middle School	East Somerville Community School **
Silvio O. Conte Middle School	Edward Devotion School
Great Falls Middle School	Robert Frost School
Hanover Middle School **	Forest Grove Middle School
Hastings Middle School **	John F. Kennedy School
Lincoln School	M. Marcus Kiley School
Locke Middle School **	Henry Lord Middle School
Marston Mills Middle School	Morton Middle School **
Mashpee High School **	Mountview Middle School **
Medway Middle School	James L. Mulcahey School **
Milford Middle School East	North Junior High School **
Nauset Regional Middle School **	O'Bryant Math-Science School
Nessacus Regional Middle School **	Henry K. Oliver School
Rupert A. Nock Middle School	John F. Parker Middle School
North Brookfield High School	Dr. William R. Peck Middle School
Oak Ridge School	Pickering Middle School **
O'Donnell Middle School	Thomas Prince School
Plymouth Community Intermediate School **	E. N. Rogers School **
Samoset School **	Roosevelt Junior High School **
Wamsutta Middle School **	South Lawrence East School
Wellesley Middle School	Sullivan Middle School
West Springfield Middle School	James P. Timilty Middle School **
Laura A. White Middle School	Umana-Barnes Middle School
Whitman Middle School	Phyllis Wheatley Middle School **

IPAW schools are indicated by a double asterisk after the school name.

The survey data collection instruments were administered online at 53 schools. Due to computer problems, the lack of Internet connectivity, or lack of availability of participants, print versions of the surveys were administered at some schools. In twelve schools, print versions of the survey were completed by all participants from those schools, and, in another seven schools, print versions were completed by at least one participant. The average return rate for surveys was 95.9% and the average return rate for supplemental data forms was 86.6%. Following the administration of the survey, data for all supplemental data collection forms, paper primary data collection forms, and Interview Observation Forms were entered into a database.

As noted previously, two surveys were administered to each group of participants. The first survey was administered to participating administrators, who included the principals of each school and the math chair, if the school had one. The second survey was administered to participating teachers at each school. Table 4 presents the counts of respondents to the survey.

Table 4 ~ Overall Survey Response Statistics

	Final Count of Participants	Surveys Received	Percent of Final Count	Supplemental Data Forms Received	Percent of Final Count
Principals	65	61	94%	56	86%
Teachers	113	108	96%	98	87%
Math Coordinators or Math Department Chairs	29	27	93%	NA	NA
TOTAL	207	196	95.9%	154	86.6%

Although 108 teachers and 61 principals completed the survey, one principal's responses and one teacher's responses had to be excluded because it was subsequently determined that on the date the survey was administered they did not meet the eligibility criteria. Thus, the quantitative analysis presented in this report used data for only 107 teachers and 60 principals, which resulted in a total count of 194 usable responses to the two surveys. An analysis of response rates indicated that there were no significant differences in non-response across the sampling strata.

FACTORS RELATED TO MCAS PERFORMANCE

The analysis of the data collected from the surveys was undertaken in several parts, each using a different approach to identify factors affecting MCAS performance of the IPAW schools. This multi-approach method was utilized to provide a deeper insight into how their responses to the survey were related to performance on MCAS during the study period.

Analysis of Categorical Responses

As noted previously, a majority of the responses to questions on the survey were collected as categorical data. The structure of these responses allowed the use of the concise statistical methods for the analyses presented in this study.

The categorical data from the surveys were readily analyzed using statistics to identify associations between the responses and MCAS results in groups of schools. A contingency table analysis was performed for the two groups of schools: IPAW schools and non-IPAW schools. In each case, the analysis performed a Pearson test of independence between a specific response to a survey question (e.g., a school factor) and membership in the two groups of schools. The test was performed for each response separately. All tests were therefore univariate tests of association.

Responses to questions were treated as separate school-based factors for the analysis. Each school had a single response from its principal and was treated as if it had a single response[5]

5. The analysis of the administrator responses considered only the responses provided by the principals in the sixty schools in which surveys were completed. Considering only the principals' responses allowed

from its teachers. Rejection of the null hypothesis from the Pearson test[6] was taken to indicate that a given factor (response) was associated with observed differences between IPAW and non-IPAW schools in MCAS performance. Odds ratios were used to identify the direction and strength of the association.

The statistical analysis of the principals' responses identified six factors that were significantly associated with IPAW schools during the four years of the study period, while over 40 factors were identified from the teachers' responses. Factors that were not significantly associated with IPAW schools, either positively or negatively, are not reported here.

Responses from the Administrators

The significant factors from the administrator survey are listed in Table 5. One of these factors was associated with the role of school administrators, three were related to professional development, and two were related to solutions to needs and weaknesses of students.

Table 5 ~ Statistically Significant Factors Reported by Principals: Roles [7]

Factor	Description of Factor Reported by Principal	IPAW Schools
A1.	Superintendent was involved in hiring new Grade 8 math teachers	No
A2.	"Planning and Delivering Lessons" identified as a professional development topic that would help teachers at school	No
A3.	Number of hours of professional development in math content that were offered last year	< 15
A4.	Number of hours of professional development in math pedagogy that were offered last year	< 10
A5.	"More remediation" was identified as a solution that was used to address general skill weaknesses in students	Yes
A6.	Identified "Other Strategy" as way to inform parents on "course content and expectations"	Yes

The Role of School Administrators

Factor A1 indicates that district superintendents of IPAW schools were less likely to be involved in hiring decisions than were the superintendent of non-IPAW schools.

the use of one administrator response from each school. A check on the validity of this approach was performed by examining the agreement between the responses of the principal and the math chair. There was virtually uniform agreement between principals and math chairs. Teacher responses were weighted so that the collective teacher response from a given school was treated as a single response. This prevented responses from schools with two teachers taking the survey from being given twice the weight of schools with only one teacher taking the survey.

6. The null hypothesis was that a factor was not related to the MCAS results. A value of $\alpha = 0.05$ was used to identify the factors that are reported as being associated with changes in MCAS performance.

7. All tests of statistical significance of administrator responses were performed at the $\alpha = 0.05$ level.

Professional Development

Factor A2 indicated that principals at IPAW schools were less likely to report that professional development on planning and delivering lessons would help the teachers at their schools than were principals at non-IPAW schools. Few of the principals (17%) that indicated that such training would help their teachers came from IPAW schools. Moreover, on average IPAW principals were less than half as likely as non-IPAW principals to report the need for such professional development.

Factors A3 and A4 indicate that IPAW schools differed from non-IPAW schools in the hours of professional development offered at the school. IPAW schools were more likely to offer fewer hours of professional development than non-IPAW schools. Specifically, in 2001-02, IPAW schools were found to be more likely to offer 15 or less hours of development in math content, and 10 or less hours in math pedagogy than the non-IPAW schools. In the case of pedagogy, less than one out of five principals (17%) who indicated that their school provided over 10 hours of pedagogy development were from IPAW schools. Similarly, fewer than one out of five principals (12%) who indicated that their school provided over 15 hours of content development were from IPAW schools.

Solutions to Needs and Weaknesses

Factor A5 indicates that principals at IPAW schools were more likely than principals at non-IPAW schools to use remediation as a solution to address students' general skills weaknesses. Principals in over two thirds of IPAW schools (70%) indicated that they used remediation, whereas only about one third (35%) of the principals from non-IPAW schools indicated the use of remediation.

Factor A6 indicates that IPAW principals were more likely to use "other strategies" to inform parents on course content and expectations than were principals at non-IPAW schools. The survey question associated with this factor allowed a principal to enter a write-in response that identified a communication strategy used at a school other than those closed-ended choices provided on the survey instrument. Three out of four (75%) of the principals at IPAW schools who wrote in a response indicated that they used guidance counseling staff to communicate course content and learning expectations to parents. Conversely, no non-IPAW principals indicated the use of guidance counseling staff.

Responses from the Teachers

The statistical analysis of the teachers' responses identified over 40 factors that were significantly associated with changes in MCAS results at IPAW schools during the four years of the study period. These factors are listed in Tables 6, 7, and 9 through 15. These factors are presented topically: characteristics of the instructor; professional development; placement decisions; use of class time; use of education technology; use of MCAS results; potential solutions to student weaknesses; how student weaknesses were addressed; and instructional

planning and other miscellaneous topics.

Instructor Characteristics

Table 6 shows the statistically significant factors associated with individual instructor characteristics. Factors T1 and T2 refer to the length of time an instructor has been teaching mathematics. Factor T1 indicates that instructors at IPAW schools had spent less time teaching at their school than had instructors at non-IPAW schools. Specifically, IPAW schools were found to be more likely than non-IPAW schools to have instructors with less than 11 years time teaching at the school. A similar result is indicated by factor T2. This latter factor indicates that IPAW schools were more likely than non-IPAW schools to have instructors with less than 11 years time teaching within Massachusetts.

Table 6 ~ Statistically Significant Factors Reported by Teachers: Instructor Characteristics[8]

Factor	Description of Factor	IPAW Schools
T1.	Years instructor has taught math at this school	< 11
T2.	Years instructor has taught Grade 8 math in Massachusetts	< 11
T3.	Instructor had an MS Math or an SEC Math license	No
T4.	Instructor indicated that s/he was "well prepared" to design lessons and unit assessments	Yes

Factor T3 indicates that IPAW schools were less likely to have teachers with either a middle school (MS) mathematics license, or a secondary (SEC) mathematics license. Instructors from non-IPAW schools were nearly 1.5 times more likely to indicate that they held either an MS Math or an SEC Math license. Only 1 out of 4 instructors (26%) who indicated that they held either of the two mathematics licenses were from IPAW schools. Finally, factor T4 indicates that IPAW schools were more likely than non-IPAW schools (3.5 times more likely) to have teachers that reported that they were well prepared to design lessons.

Professional Development

Table 7 displays the factors related to professional development. Factor T5 indicates that IPAW schools were less likely to require their instructors to attend in-school professional development than non-IPAW schools during 1998-99 (the beginning of the study period). Similarly, factor T6 shows that teachers at IPAW schools indicate that they only infrequently attended development events other than those held at their own school or offered by their own district. Factor T7 indicates that schools in which "new math teaching methods" was identified as a topic that would help the teachers at the school were less likely to be IPAW schools. Factor T8 indicates that schools in which "needs of above grade students" was identified as a helpful topic also were less likely to be IPAW schools.

8. All tests of statistical significance of teacher responses were performed at the $\alpha = 0.05$ level.

Table 7 ~ Statistically Significant Factors Reported by Teachers: Professional Development

Factor	Description of Factor	IPAW Schools
T5.	Instructors "frequently or always" required to attend in-school professional development events in 1998-99	No
T6.	Instructor attended professional development events other than those offered by own school/district in 1998-99	No
T7.	"New math teaching methods" was identified as a professional development topic that would help instructors at school	No
T8.	"Needs of Above Grade students" was identified as a professional development topic that would help instructors at school	No

Placement into Math Classes

Three types of math class groupings were identified in this study: heterogeneous; top group homogeneous but other groups heterogeneous; and homogeneous. Table 8 indicates the relative frequency of each of these groupings at IPAW and non-IPAW schools.

Table 8 ~ Grouping of Students Used in Schools Sampled

	IPAW Schools (N=20)		Non-IPAW Schools (N=39)	
	Frequency	Percent	Frequency	Percent
Heterogeneous	2	10%	7	18%
Top group(s) homogeneous but other groups heterogeneous	5	25%	13	34%
Homogeneous	13	65%	19	49%

Table 9 presents the factors referring to decision on placement into math classes. IPAW schools tended to have principals that were involved in placement decisions (T9), and these schools considered mathematics achievement, as measured by prior grades, in the placement decision process (T11). Sixteen teachers in 10 of the IPAW schools indicated that some other individual (T10) influenced placement decisions. Most of these teachers (11) reported a guidance counselor as the other major influence[9]. The remaining five teachers reported either the assistant principal (2 teachers) or, erroneously[10], placement tests (3 teachers) as the other major influence.

9. It should be noted that the use of guidance counselors for placement was studied in both IPAW and non-IPAW schools using the data reported in Section 3, Question 7 from the survey. Based on statistical tests, there appeared to be no significant difference in the use counselors for placement decisions between the two school groups *after controlling for the probability that a school reported some influence other than those provided on the list of close-ended items on the survey.*

10. The survey question (factor T11) was designed to elicit information about individuals, not tests, that influenced placement decisions. These three responses may indicate a misunderstanding on the part of the respondents or possibly unclear phrasing of the survey item. Two of these three respondents also

One factor, parental selection (T12), was negatively associated with IPAW schools, indicating that they were less likely than non-IPAW schools to use parental selection as an important factor in math placement. Ten of the eleven schools in which teachers reported parental selection as a placement influence were non-IPAW schools. Finally, teachers in four IPAW schools indicated that some other factor (T13) affected placement decisions. Teachers in three of these four schools indicated that placement tests were the other major influence.

Table 9 ~ Statistically Significant Factors Reported by Teachers: Placement

Factor	Description of Factor	IPAW Schools
T9.	Principal was a major influence on decisions about placement	Yes
T10.	Other individual influenced decisions about placement	Yes
T11.	"Math achievement in grades" identified as an important factor considered in math placement	Yes
T12.	"Parental selection" identified as an important factor considered in math placement	No
T13.	Other factor was identified as an important factor considered in math placement decisions	Yes

Class Time

Factors T14 though T18 related to class time and its uses. Table 10 presents these factors. It was found (T14) that IPAW schools did not schedule math classes on a daily basis. However, over 85% of the teachers at non-IPAW schools reported that their school did schedule math classes on a daily schedule.

Table 10 ~ Statistically Significant Factors Reported by Teachers: Class Time

Factor	Description of Factor	IPAW Schools
T14.	Math classes were scheduled daily during 2001-02	No
T15.	"Re-teaching of Grade 8 content" was identified as an important way teacher spent class time in 2001-02	No
T16.	"Generating estimates" was identified as an important way students spent class time in 1998-99	No
T17.	"Generating hypotheses" was identified as an important way students spent class time in 1998-99	No
T18.	"Making inferences from data" was identified as an important way students spent class time in 1998-99	No

Teachers at IPAW schools were nearly three times less likely to report that re-teaching of Grade 8 content was an important way to spend students class time (T15) than teachers at non-IPAW

responded to factor T13 and on that factor, the respondents consistently reported placement tests as an influence.

schools. Teachers at IPAW schools identified generating estimates (T16), generating hypotheses (T17), and making inferences (T18) were not important activities on which students spent time in math class. More than half (51%) of the teachers at non-IPAW schools indicated either that students spent class time generating estimates, or generating hypotheses, or both. Fully 60% of non-IPAW instructors indicated that students spent class time engaged in at least one of the three activities, in contrast to IPAW schools where only 27% of instructors reported such use of class time.

Education Technology (EDUT)

Table 11 presents the factors associated with the use of educational technology. Teachers from IPAW schools were less likely to indicate that they had more calculators in their classrooms (T19) in 2001-02, as compared to 1998-99, than teachers at IPAW schools. Teachers from IPAW schools also less frequently reported that calculators were used more than once per week (T20) in 2001-02. Moreover, these same teachers were less likely to indicate that in 1998-99 (factor T21), and 2001-02 (factor T22) computers were used in class at least one time during the school year (in contrast to no use).

Table 11 ~ Statistically Significant Factors Reported by Teachers: Education Technology

Factor	Description of Factor	IPAW Schools
T19.	Had more calculators in class last year as compared to 1998-99	No
T20.	Calculators were used more than once per week in 2001-02	No
T21.	Computers were used at least once per year in 1998-99	No
T22.	Computers were used at least once per year in 2001-02	No
T23.	Instructor supplemented math text with computers	Yes
T24.	Instructor supplemented math text with calculators	No

Teachers at IPAW schools were three times less likely to report supplementing the class text with calculators (T24) than teachers at IPAW schools. In contrast, teachers at IPAW schools were more likely to report supplementing the class textbook with computers (T23). Nearly two thirds (65%) of teachers at IPAW schools indicated that they supplemented the class text with computers.

MCAS Preparation and the Use of MCAS Results

Seven significant factors were identified related to the use of MCAS results. These seven factors are shown in Table 12. IPAW schools were more likely to have spent more than seven hours reviewing the test results (factor T25) than were non-IPAW schools. It was found that the review of MCAS results in IPAW schools tended to influence the preparation of students for the MCAS test itself (T26), classroom assessments used (T27), the expectations for learning (T28), the subject matter emphasized in class (T29), the homework assignments (T30), and the use of curricular materials (T31). Teachers in all 20 IPAW schools indicated that the review of the MCAS results influenced at least one of these six instructional practices.

Table 12 ~ Statistically Significant Factors Reported by Teachers: Use of MCAS Results

Factor	Description of Factor	IPAW Schools
T25.	Hours spent by math teachers reviewing Math MCAS results	> 7
T26.	Assistance with, or analysis of, the MCAS results influenced preparation of students for MCAS	Yes
T27.	Assistance with, or analysis of, the MCAS results influenced math assessments used	Yes
T28.	Assistance with, or analysis of, the MCAS results influenced expectations for learning	Yes
T29.	Assistance with, or analysis of, the MCAS results influenced subject matter emphasized	Yes
T30.	Assistance with, or analysis of, the MCAS results influenced homework assignments given	Yes
T31.	Assistance with, or analysis of, the MCAS results influenced use of materials	Yes

Solutions to Needs and Weaknesses

Table 13 shows the four factors related to potential solutions to needs or weaknesses in students. Factor T32 indicates that a pedagogy change was more likely to be used to address observed strand weaknesses in IPAW schools than in non-IPAW schools. Teachers at 16 of the 20 IPAW schools indicated that a pedagogy change had been used for that reason. Teachers at IPAW schools also indicated that accelerated classes were used to address the needs of above grade level students (T33). Teachers at 14 of the 20 IPAW schools indicated that accelerated classes were used.

Table 13 ~ Statistically Significant Factors Reported by Teachers: Solutions

Factor	Description of Factor	IPAW Schools
T32.	"Pedagogical change" was identified as an important means to address identified strand weaknesses	Yes
T33.	"Accelerated classes" were used as an important means to address needs of Above Grade students	Yes
T34.	"More hands-on approaches" was suggested by respondent as a strategy to increase his/her student's math learning	No
T35.	"More practice and homework" was suggested by respondent as a strategy to increase his/her student's math learning	No

Two potential solutions suggested by teachers to help increase math learning for their students were statistically significant, but both were associated with non-IPAW schools. Teachers in 24 of the 40 non-IPAW schools suggested either more hands-on approaches (T34), or more practice and homework (T35), or both as recommended means to increase student learning. In contrast, only teachers at 5 IPAW schools recommended either of these solutions.

Student Assessment

Table 14 identifies the statistically significant factors related to student assessment. Teachers at IPAW schools consistently identified the *Patterns, Relations, and Algebra* math strand as a major area of student weakness. This assessment was indicated both by MCAS results (factor T36) and course grades (factor T37). Teachers at 17 of the 20 IPAW schools reported either that grades, or MCAS results, or both indicated that the *Patterns, Relations, and Algebra* strand was an area of student weakness.

Table 14 ~ Statistically Significant Factors Reported by Teachers: Assessment

Factor	Description of Factor	IPAW Schools
T36.	MCAS results identified the *Patterns, Relations and Algebra* math strand as a major area of student weakness	Yes
T37.	Grades identified the *Patterns, Relations and Algebra* math strand as a major area of student weakness	Yes
T38.	Use of individual presentations was identified as an important strategy to assess learning	No
T39.	Students were assessed with tests or quizzes at least once per week in 2001-02	Yes

IPAW schools were found to be more likely to assess students with tests or quizzes (T39). Teachers at 16 of the 20 IPAW schools indicated that students were assessed with quizzes at least once per week in 2001-02. It was found that IPAW schools were two times less likely than non-IPAW schools to use individual presentations for assessment.

Planning and Miscellaneous Other Factors

Table 15 presents factors related to instructional planning and other miscellaneous topics. Two statistically significant factors were identified related to instructional planning. It was found that teachers in IPAW schools were more likely to spend time planning in a group (T40) than teachers in non-IPAW schools. Conversely, teachers in IPAW schools were less likely than teachers from non-IPAW schools to meet with staff from other grade levels to plan instruction (T41).

Table 15 ~ Statistically Significant Factors Reported by Teachers: Planning and Other

Factor	Description of Factor	IPAW Schools
T40.	Instructor spent time planning instruction in a group with other math teachers	Yes
T41.	Elementary staff, MS staff, and JHS staff met about math courses more than once per year	No
T42.	"Formal parent conferences" were identified as an effective reporting method	No
T43.	Instructor supplemented math text with something other	No

Quantitative Factors from the Supplemental Data

Tables 16 through 18 present factors taken from the supplemental data collection instrument used as part of this study. Unlike the previous section, these factors are not under the control of the district or school. Also, not all of these items were found to be statistically significantly. When the factors differ significantly between the two school groups in each of these three tables the difference is indicated by two asterisks following the factor description.

Table 16 ~ Factors from the Supplemental Data: MCAS Performance[11]

Factor	Description of Factor	IPAW Schools (N=20)	Non-IPAW Schools (N=40)
S1.	Average Percent of Students Tested as Proficient or Advanced (1998-99) **	18%	34%
S2.	Average Percent Increase in Proficient or Advanced (from 1998-99 to 2001-02)	12.9%	0.5%
S3.	Average Percent of Students Tested as Warning (1998-1999) **	49%	38%
S4.	Average Percent Decrease in Warning (from 1998-99 to 2001-02)	-17.2%	-2.1%

In general, schools beginning the study period with a larger percent of students in the Proficient and Advanced Math MCAS levels should find it more difficult to improve their percent in these levels than schools beginning the period with a lower percent in these levels. Factor S1 in Table 16 shows IPAW schools to have begun the study period with a (statistically significant) smaller percent of their students in the Proficient and Advanced Math MCAS levels than non-IPAW schools.

Similarly, schools beginning the study period with a lower percent of students in the Warning Math MCAS level should find it more difficult to decrease the percent in this level than schools beginning with a larger percent in this level. Item S3 in Table 16 shows IPAW schools began the study period with a (statistically significant) larger percent of their students in the Warning Math MCAS level.

To the extent that LEP students tend to have lower scores on the Math MCAS, schools with a smaller percent of LEP students should perform better than schools with a larger percent of LEP students. Factor S11 in Table 17 indicates that IPAW schools had significantly fewer LEP students than non-IPAW schools.

In Table 18, Factor S17 indicates that IPAW schools had significantly fewer new teachers (less than five years experience) during 2001-02. This result is in contrast to Factors T1 and T2 in Table 6 from the teacher responses, which indicate that teachers at IPAW schools had taught math at their school and in Massachusetts for fewer years than teachers at non-IPAW schools.

11. Items followed by a double asterisk (**) exhibit statistically significant differences between the IPAW and non-IPAW school groups when tested with $\alpha = 0.05$.

Table 17 ~ Factors from the Supplemental Data: Institutional Characteristics

Factor	Description of Factor	IPAW Schools (N=20)	Non-IPAW Schools (N=40)
S5.	Number of Schools from "Large" Districts	10	20
S6.	Number of Schools Serving Only Grades 6-8	11	16
S7.	Number of Magnet or Special Focus Schools	3	7
S8.	Average Enrollment during 2001-02	728	866
S9.	Spread in Enrollment [12] (Largest minus Smallest) during 2001-02 **	926	2,103
S10.	Percent of Students Receiving Free or Reduced Lunches in 2001-02	36%	36%
S11.	LEP Students as a Percent of 2001-02 Enrollment **	12%	23%

Factor S16 in Table 18 also tends to contradict another factor in Table 6. Factor T3 indicates Grade 8 math teachers at IPAW schools have fewer math credentials than math teachers at non-IPAW schools. Although the percent of teachers with math credentials in Item S16 is smaller for IPAW schools than for non-IPAW schools, the difference is not statistically significant.

Table 18 ~ Factors from the Supplemental Data: Classroom Indicators, 2001-02

Factor	Description of Factor	IPAW Schools (N=20)	Non-IPAW Schools (N=40)
S13.	Average Number of Sections Taught by Math Teachers	3.7	3.6
S14.	Average Number of Students per Section	21	21
S16.	Percent of Teachers Certified in Math Instruction	65%	73%
S17.	Percent of Teachers with over 5 years of Experience **	42%	30%
S18.	Percent of Grade 8 Students enrolled in Algebra I **	21%	39%
S19.	Percent of Sections in which Alignment of Textbook to Math Standards was rated as *High*	43%	49%
S20.	Percent of Sections where Homework was Assigned **	32%	49%
S22.	Percent of Sections in which *Most* Students [13] Completed Homework when Assigned	37%	36%
S23.	Percent of Sections in which Pairs or Small Groups were used for Instruction in **	93%	86%

The remaining statistically significant differences between IPAW and non-IPAW schools displayed in Table 18 are from factors S18, S20, and S23. IPAW schools were found to have a significantly smaller percent of students enrolled in Algebra I (S18), have significantly fewer sections where homework was assigned in 2001-02 (S20), and had a larger percent of sections in

12. The test for differences between groups for this factor was actually made using a test of the standard deviations of enrollment.

13. For purposes of reporting, "most students" was defined as 90% or more of enrolled students completing homework when assigned.

which pairs or small groups were used for instruction (S23).

Analysis of Qualitative Responses

Qualitative responses are the responses given to open-ended questions by administrators and teachers on both the primary survey instrument and the supplemental survey instrument. Qualitative analysis requires the identification of themes or response clusters through analysis of responses for each question in order to group similar responses together for more succinct discussion of the data. For example, the following responses by principals were placed in the *Instructional Leader* theme: "provided a framework for pedagogy", "insured high standards", "inspired and supported teachers", and "mentored teachers." Significant themes were created in a like manner for each open-ended question.

Table 19 shows the number of open-ended questions considered in the qualitative analysis.

Table 19 ~ Number of Open-ended Questions Analyzed

	Questions		
Participant	Total	On Primary Instrument	On Supplemental Instrument
Principals	21	9	11
Teachers	16	4	12

The same two groups of schools, IPAW and non-IPAW, that were used in the quantitative analysis were used in the qualitative analysis. Table 20 reports the distribution of respondents by group of school.

Table 20 ~ Number of Participants in the Qualitative Analysis

Participant	IPAW Schools	Non-IPAW Schools
Principals	20	40
Teachers	37	70

Upon inspection of the responses to each of the open-ended questions, ten questions were found to contain responses with sufficient information to complete the analysis. The questions covered the following topics: 1) the role of the school administrator; 2) changes in the math program; 3) goals for student learning; 4) placement into math classes; 5) solutions to needs and weaknesses; and 6) MCAS preparation and the use of MCAS results. In this qualitative analysis, the themes are identified and described, and the numbers of similar responses are reported, but only for themes where there was a significant difference between the likelihood of being reported by IPAW and non-IPAW schools. The results are reported by responses from administrators and responses from teachers.

Responses from the Administrators

The Role of School Administrators

In the administrator survey, principals were asked to describe their roles with respect to instructional practice within their school. The themes identified were: observation and feedback; instructional leader; professional development planning and facilitation; and administrative duties. Data for the themes that showed significant differences in the likelihood of being reported by principals at IPAW and non-IPAW schools is shown in Table 21.

Table 21 ~ Qualitative Administrator Responses on the Role of Administrators

	IPAW Principals (N=19)		Non-IPAW Principals (N=38)	
Themes	Frequency	Percent	Frequency	Percent
Observation and Feedback	8	42%	8	21%
Administrative Duties	11	58%	9	24%

Responses related to observation and feedback included observing lessons, discussing observations, and making recommendations for improvement as part of the formal evaluation process and informal review as well. One respondent stated, "as a principal, I mentor, observe, evaluate, and suggest possibilities for in-service training outside the school and generally offer support where needed." IPAW principals were twice as likely as non-IPAW principals to report observation and feedback were an important aspect of their role as an instructional leader.

Administrative duties of principals, identified as being related to instructional practices, included scheduling, chairing meetings, tracking and ordering materials, supplies, and textbooks, managing budget issues, and making staff appointments. IPAW principals were twice as likely as non-IPAW principals to report that administrative duties were an important aspect of their role.

Changes in Math Programs

In the administrator survey, principals were asked to comment on changes in their math programs between 1998-1999 and 2001-2002. Responses clustered around three themes: curricular change; textbook change; and change in MCAS preparation. However, the only theme that showed a significant difference in being reported by principals at IPAW and non-IPAW schools was textbook changes. As can be seen in Table 22, IPAW principals were over twice as likely as non-IPAW principals to indicate there had been a change in textbooks over the study period.

Table 22 ~ Qualitative Administrator Responses on Changes in Math Programs

	IPAW Principals (N=17)		Non-IPAW Principals (N=31)	
Themes	Frequency	Percent	Frequency	Percent
Textbook Change	8	47%	8	26%

Goals for Student Learning

Principals were asked in the administrator survey to describe their school's primary goal for increasing student learning in 2001-2002. The three themes identified were improving MCAS scores, improving learning environment, and making changes in curriculum and instruction. As shown in Table 23, all three of these themes showed significant differences between the likelihood of being reported by principals at IPAW and non-IPAW schools.

Table 23 ~ Qualitative Administrator Responses on Student Learning Goals

	IPAW Principals (N=20)		Non-IPAW Principals (N=40)	
Themes	Frequency	Percent	Frequency	Percent
Improve MCAS scores	9	45%	11	28%
Improve learning environment	3	15%	1	2.5%
Change curriculum, instruction	8	40%	26	65%

Many respondents cited a specific goal to change MCAS results. Examples of these goal statements included reducing the high percent of students in Warning, raising MCAS scores 5 percent, improving ELA scores by two points, and scoring well on the MCAS. IPAW principals were nearly twice as likely as non-IPAW principals to state that improving MCAS scores was a goal for student learning.

An improved learning environment was related to factors such as class size, student placement, class groupings, and length of classes. IPAW principals were five times more likely to cite the goal to improve learning environment as were non-IPAW principals.

A variety of goal statements fell into a theme related to changing curriculum and instruction with the ultimate goal of improving student achievement. Responses included meeting individual needs, offering challenging courses, use of assessment results to drive instruction, and implementation of new textbooks and teaching strategies. Two principals provided clear, concise descriptions of the goals for their schools. One principal spoke to curriculum and program related goals,

> *"The school's primary goal for increasing student learning was to provide a meaningful and challenging program that would enable students to integrate learned knowledge into practical applications of it. To raise the standards and performance goals for all students to meet the challenges of the life-long learner."*

A second principal indicated that improving the learning environment was a goal,

> *"To create an academically challenging standards-based learning environment that is responsive to the needs of all students."*

IPAW principals were only two thirds as likely as non-IPAW principals to report changes in curriculum as a goal. It is of interest to note that a higher percent of principals from IPAW schools (45%) reported specific goals related to improvement in MCAS performance whereas a higher percent of principals from non-IPAW schools (65%) reported goals related to changes in curriculum and instruction.

Placement into Math Classes

In the supplemental administrator survey, principals were asked to describe how eighth grade math students were placed into math classes at their schools. Table 24 presents three types of class groupings identified by principals.

Table 24 ~ Qualitative Administrator Responses on Grouping

	IPAW Principals (N=20)		Non-IPAW Principals (N=39)	
Themes	Frequency	Percent	Frequency	Percent
Heterogeneous	2	10%	7	18%
Top Group(s) Homogeneous but Other Groups Heterogeneous	5	25%	13	34%
Homogeneous	13	65%	19	49%

Schools may group all students heterogeneously, with some schools balancing the classes by student achievement and other identified criteria. A second class grouping involved placing the more advanced students in homogeneous groups based on identified criteria and placing all other students in heterogeneous groups. The third grouping was placement of all students in homogeneous ability groups. In general, schools that used homogeneous groupings had various levels of math courses such Algebra, Pre-Algebra, and General Math.

Three themes for factors considered in math placement decisions were identified: test results; teacher recommendation; and test results and teacher recommendation. However, IPAW and non-IPAW schools differed significantly only in the likelihood of their principal's responses to grouping by test results. The data for grouping by test results is shown in Table 25.

Table 25 ~ Qualitative Administrator Responses on Factors Considered in Placement Decisions

	IPAW Principals (N=20)		Non-IPAW Principals (N=39)	
Themes	Frequency	Percent	Frequency	Percent
Test Results	4	20%	2	5.1%

Most schools have defined criteria for placement of students into classes. Tests results included information from the MCAS test, standardized achievement tests, placement tests, reading and writing assessments, and other school tests. IPAW principals were five times as likely to report using only test results for placing students as were non-IPAW principals.

Solutions to Needs and Weaknesses

Because it was felt that solutions to helping students move out of the Math MCAS Warning level could be different from solutions to helping students move students into the Proficient and Advanced Math MCAS levels, these were asked as separate questions of administrators. Thus administrator responses regarding solutions to student needs and student weaknesses are

presented separately for moving students into Proficient and Advanced levels and moving students out of the Warning level.

Moving Students into Proficient and Advanced Levels

Principals were asked what might help more students move to the Proficient and Advanced levels of the Math MCAS in their school. Their comments clustered around seven strategies; challenging curriculum/enrichment; homogeneous/ability grouping; increased MCAS preparations for students; need for more time on math; improve instruction and/or instructional materials; greater student/parent responsibility/ownership; and remediation. As shown in Table 26, the likelihood of responses to only four of these themes differed significantly between principals at IPAW and non-IPAW schools.

Reported ways to increase student learning through a more challenging curriculum included the need to increase the number of high level math classes, more opportunity for enrichment activities during class and other times during the day, and setting higher expectations. IPAW principals were almost five times as likely to mention one or more of these ways to increase student learning than were Non-IPAW principals.

Table 26 ~ Qualitative Administrator Responses on Solutions for Moving Students into Proficient and Advanced

	IPAW Principals (N=20)		Non-IPAW Principals (N=40)	
Themes	Frequency	Percent	Frequency	Percent
Challenging curriculum / enrichment	9	45%	4	10%
Increased MCAS preparation for students	2	10%	10	25%
Need more time on math	6	30%	4	10%
Remediation	1	5%	6	15%

Responses to increases in MCAS preparation included the need for more practice on open response and short answer questions (with a greater emphasis on writing and explaining strategies), problem solving, using MCAS type questions on daily work and weekly tests, and on test taking strategies. IPAW principals were less than half as likely as non-IPAW principals to suggest increased MCAS preparation as a strategy to improve student learning.

IPAW principals were three times as likely to report providing more time for math instruction as were non-IPAW principals. However, IPAW principals were only one third as likely as non-IPAW principals to report remediation for students on basic skills through tutorials, earlier diagnosis of deficiencies, and increased use of test data for diagnosis.

Moving Students out of Warning

In the administrator survey, principals were also asked to comment on factors that might help

schools move students out of the Warning level of the Math MCAS in their school. Comments clustered around the same seven themes listed above. Five themes showed significantly different response likelihoods between IPAW principals and non-IPAW principals. Table 27 summarizes these data.

Table 27 ~ Qualitative Administrator Responses on Solutions for Moving Students Out of Warning

	IPAW Principals (N=19)		Non-IPAW Principals (N=39)	
Themes	Frequency	Percent	Frequency	Percent
Challenging curriculum / enrichment	4	21%	2	5.1%
Homogeneous / ability grouping	3	16%	1	2.6%
Increased MCAS preparation for students	3	16%	12	31%
Need more time on math	6	32%	7	18%
Greater student/parent responsibility/ownership	7	37%	8	21%

The data in Table 27 shows that principals from IPAW schools were four times as likely as the principals from non-IPAW schools to give responses that fit into the theme to implement a more challenging curriculum as a strategy to move students out of the Warning level. It is instructive to note that a larger percent of both IPAW (45%) and non-IPAW principals (10%) reported that a more challenging curriculum would help students to move into the Proficient and Advanced levels than would help students move out of the Warning level.

IPAW principals were 6 times as likely as non-IPAW principals to suggest increasing the number of homogeneous groups as a strategy for change with students in Warning. Reporting using increased MCAS preparation to help students move out of the Warning level was only half as likely for IPAW principals as for non-IPAW principals. IPAW principals were also almost twice as likely as non-IPAW principals to suggest increasing time for math instruction as a way to help students in Warning.

The likelihood of IPAW principals reporting the need for greater parent and student involvement to provide help for students in Warning was almost two times greater than for non-IPAW principals. In comparison, the overall percent of principals reporting the need for more parent/student involvement for students moving into the Proficient and Advanced levels were lower than for students moving out of the Warning level.

MCAS Preparation and the Use of MCAS Results

Principals' responses to describing MCAS preparation clustered around three themes: embedded in daily instruction; special MCAS preparation period; incentives/rewards; and remediation/tutoring to improve basic skills. However, only in the incentives/rewards responses

theme was the likelihood of responses between IPAW and non-IPAW principals different. This is shown in Table 28.

Table 28 ~ Qualitative Administrator Responses on MCAS Preparation

	IPAW Principals (N=17)		Non-IPAW Principals (N=33)	
Themes	Frequency	Percent	Frequency	Percent
Remediation/tutoring to improve basic skills	8	47%	8	26%

Responses from the Teachers

Changes in Math Programs

In their survey, teachers were asked to comment on changes in their math programs between 1998-99 and 2001-02. Their responses clustered around curricular change, textbook change, and change in MCAS preparation. The two themes where there was a significant difference between the likelihood of teacher responses in IPAW and non-IPAW schools is summarized in Table 29.

Table 29 ~ Qualitative Teacher Responses on Changes in Math Programs

	IPAW Teachers (N=26)		Non-IPAW Teachers (N=57)	
Themes	Frequency	Percent	Frequency	Percent
Textbook Change	8	31%	6	11%
Change in MCAS Prep	10	38%	14	25%

Teachers at IPAW schools were three times more likely to report changes in textbooks over the study period than were teachers at non-IPAW schools. However, roughly one quarter of the teachers surveyed were not able to give a response to this question because they did not teach eighth grade math in 1998-99.

Changes in MCAS preparation included an increase in MCAS tutorials, in work on test taking strategies, practice on MCAS open-ended and short response questions using samples from previous MCAS tests, skill practice on responding to open-ended questions, and MCAS preparation periods. IPAW teachers were one and a half times more likely to report changes in MCAS preparation than were non-IPAW teachers. In a summary of changes one teacher stated,

> *"Using [new sharpen-up books and copies of old tests] we can more effectively teach the 5 strands of the Framework. The new books expose the students to multiple choice short answer and multi-step problems on a daily basis. They provide real world connections and I no longer hear … when am I ever going to use this?"*

Solutions to Needs and Weaknesses

As was the case when considering responses from administrators to solutions to student needs and weaknesses, teacher responses to helping students move into the Math MCAS

Proficient and Advanced levels are considered separately from teacher responses to helping students move out of the Warning level.

Moving Students into Proficient and Advanced

Similar to the administrators, teachers were asked what might help more of their students move to the Proficient and Advanced levels of the Math MCAS. Responses clustered around seven strategies: challenging curriculum/enrichment; homogeneous/ability grouping; increased MCAS preparation for students; need for more time on math; improve instruction and/or instructional materials; greater student/parent responsibility/ownership; and remediation. The four strategies shown in Table 30 were the only ones where the likelihood of responses of teachers at IPAW schools were significantly different from teachers at non-IPAW schools.

Table 30 ~ Qualitative Teacher Responses on Proficient and Advanced

	IPAW Teachers (N=35)		Non-IPAW Teachers (N=66)	
Themes	Frequency	Percent	Frequency	Percent
Challenging curriculum / enrichment	8	23%	2	3%
Homogeneous / ability grouping	5	14%	4	6%
Increased MCAS preparation for students	10	29%	9	14%
Need more time on math	2	5.7%	8	12%

The first theme in Table 30 includes the need to increase the number of high level math classes, more opportunity for enrichment activities during class and other times in the day, and setting higher expectations as ways to increase student learning through a more challenging curriculum. IPAW teachers were six times more likely to give this response than non-IPAW teachers.

The second theme in Table 30, reporting the need for more homogeneously grouped classes as a way to increase learning, was over two times more likely to be given by a teacher at an IPAW school than one at a non-IPAW school.

Responses to increases in MCAS preparation included the need for more practice on open response and short answer questions (with a greater emphasis on writing and explaining strategies), problem solving, using MCAS type questions on daily work and weekly tests, and work on test taking strategies. Teachers at IPAW schools were twice as likely to suggest increased MCAS preparation as a strategy for moving students into Proficient and Advanced than were teachers at non-IPAW schools. One teacher provided a comprehensive description of MCAS preparation efforts. The teacher noted that preparation included,

> *"Improving test-taking strategies ..., teaching lessons from MCAS type questions ..., developing open response question strategies ..., reviewing previous MCAS tests for their grade level and for Grade 10 ..., using these reviews to generate lessons on the topic or standard being addressed in the question ..., [and] having students understand the different domains in the framework."*

Teachers at IPAW schools were only half as likely to suggest providing more time for math instruction than were non-IPAW teachers.

Moving Students Out of Warning

Comments by teachers on the factors that might help schools move students out of the Warning level of the Math MCAS in their school clustered around the same seven strategies as described above. Table 31 summarizes the three strategies where the likelihood of teachers responses differed significantly between IPAW and non-IPAW schools.

Table 31 ~ Qualitative Teacher Responses Regarding Solutions for Warning

	IPAW Teachers (N=35)		Non-IPAW Teachers (N=65)	
Themes	Frequency	Percent	Frequency	Percent
Homogeneous / ability grouping	3	8.5%	2	3%
Increased MCAS preparation for students	10	29%	5	7.7%
Greater student/parent responsibility/ownership	14	40%	16	25%

Teachers as IPAW schools were almost three times as likely as teacher at non-IPAW schools to suggested homogeneous grouping as a strategy for helping students in Warning. This is consistent with teachers at IPAW schools being almost twice as likely as teachers at non-IPAW schools to suggest this strategy for movement into Proficient and Advanced (see Table 30).

Teacher at IPAW schools were four times as likely to suggest increasing MCAS preparation for students as were teachers at non-IPAW schools. Also, teachers at IPAW schools were almost twice as likely as teachers at non-IPAW schools to report feeling that greater student/parent responsibility/ownership would help students move out of the Warning level. A similar trend was observed for administrators.

Finally, it is important to note that differences in school based factors that could affect MCAS results are not as evident in comparing IPAW and non-IPAW schools (with the exceptions noted above) as comparing recommended strategies for moving students into the Proficient and Advanced levels with strategies for moving students out of the Warning level.

Analysis of Agreement between Participants

In addition to the analysis of school-related factors, an analysis of agreement in the responses between participants was performed. This was done for both administrator responses and teacher responses with a goal of determining whether agreement between participants was related to performance on the Grade 8 Math MCAS. It was posited that high levels of disagreement in responses, particularly for administrators, could be an indication of challenges in the administration and delivery of quality mathematics instruction.

For both the administrators and the teachers, the analysis was undertaken in three parts. In

the first part of the analysis, each response to each question on the relevant survey instrument was considered separately. Certain questions on each instrument elicited multiple responses. Each response to questions with multiple responses was treated as a separate item for analysis[14]. In the case of the administrators, the answers made by the two administrators to each response item were then compared for agreement, which resulted in 27 comparisons (see Table 32). These 27 comparisons were studied as a group for each question, and were used in the first of the two statistical tests of agreement, which corresponded to the first part of the analysis. A similar analysis was performed for the teachers.

Table 32 ~ Administrators Participating by School

Participants at School	Count of Schools
Principal Only	33
Principal and Math Chair	27
Total	60

In the second part of the analysis, the results for each school were studied separately for schools that had two administrators, and for the schools that had two teachers. As with the first part of the analysis, the responses for the two administrators were compared on a response by response basis. However, in this second analysis all the responses for each pair of administrators were studied together as a group. The analysis resulted in a second statistical test of agreement[15]. A corresponding analysis was performed for the teachers.

In the third and final part of the analysis, the percent agreement (calculated in the second part of the analysis) was used to measure the association between IPAW schools and the level of agreement on the responses was calculated. Specifically, a statistical test was performed to determine whether the level of agreement was a significant predictor[16] of whether a school was an IPAW school.

In summary, it was found that level of agreement between the two administrators was not associated (in a predictive sense) with a school being an IPAW school. In contrast, higher agreement between teachers was found to be a significant predictor of IPAW status.

Agreement Results for Administrators

Nearly 50 percent of the responding schools had math chairs participate in the survey, as

14. Throughout this section, the individual response items to a given question will be referred to generically as "responses."
15. The two tests of agreement were performed using a kappa statistic for interrater agreement.
16. The agreement percentages were used in a survey-weighted logistic regression model with a single regressor, namely the percent agreement observed between the two teachers. The model predicted whether a school was an IPAW school. The test performed was a Student's *t* test of the significance of the coefficient on the single regressor in the model. The test was performed at the 95% confidence level.

shown in Table 32. For the schools with both a principal and a math chair, the results from the first part of the analysis showed statistically significant agreement between the responses from the two administrators on about 80 of the responses (43%) on the survey.

There were no responses where principals and math chairs showed statistically significant disagreement. The three responses where the 27 principals and the 27 math chairs showed the strongest agreement related to the time students spent in math instruction, the school's primary goal for MCAS improvement, and whether teacher aids served below grade level students.

In the survey administrators were asked about the time students spent receiving math instruction. The responses were used to identify whether students received more than 50 minutes of math instruction on average per day during school year 2001-02. In every school with two administrators, the administrators agreed on their responses to this survey item leading to a high agreement statistic ($p<0.001$).

The administrators were also asked whether their school's primary goal for student improvement on the MCAS was moving students into Proficient and Advanced. Also in every school, the administrators agreed on their responses to this response item leading to a high agreement statistic ($p<0.001$). Notably, only 2 schools in the 27 indicated that their primary goal was *only* to move students into Proficient and Advanced. In 17 of the 25 schools in which administrators indicated that their school had some other goal, the administrators identified the school's primary goal as moving students out of Warning, and *also* moving students into Proficient and Advanced.

Finally, the administrators were asked whether teacher aides at their school served below grade level students. In 25 of the 27 schools, the administrators agreed on their responses to this survey item again leading to a high agreement statistic ($p<0.001$).

In the second analysis, the administrator results were considered one school at a time. In all of the 27 schools, the two administrators were found to exhibit statistically significant agreement across their 190 responses. However, only 6 schools exhibited agreement on over 75 percent of the responses. These schools are shown in the Table 33. Based on a regression analysis, it was found that the percent agreement between administrators was not a significant predictor ($p=0.067$) of a school being an IPAW school. It is noteworthy that Boston Latin and Boston Latin Academy exhibited high levels of agreement in as much as these two schools are exam schools.

Table 33 ~ Schools with the Highest Agreement between Administrators

Name of School	Percent of Responses in Agreement	IPAW School?
Rupert Nock Middle	79.0%	No
Chestnut Street Middle	83.7%	No
Boston Latin Academy	85.8%	No
Boston Latin	94.7%	No
Wellesley Middle	95.3%	No
South Lawrence East Middle	96.8%	No

Agreement Results for the Teachers

A similar analysis was performed for the schools with multiple participating instructors. In particular, for schools in which two teachers participated in the survey, the responses for the pair of teachers were examined for agreement. As shown in Table 34, of the 60 schools, 47 schools had two teachers participate in the survey.

Table 34 ~ Number of Teachers Participating by School

Participants at School	Count of Schools
Single Teacher Only	13
Two Teachers	47
Total	60

Considering the questions one at a time for the 47 pairs of teachers, the data showed significant agreement on about 40 percent of the responses (N=148) from the teacher survey.

In contrast with the administrator analysis, there were two responses where the teacher pairs showed significant disagreement based on p-values of a one-sided test. Teachers taking the survey disagreed on whether generating hypotheses was one of the five most common ways students spent math class time in 2001-02. In almost half of the 47 schools (N=21) the two teachers disagreed on this response resulting in a strongly significant level of disagreement (p=0.025). Teachers also reported differing levels of preparedness to use computers to teach mathematics. In more than half of the 47 schools (N=29) the two teachers disagreed on whether they were well prepared to use computers for instruction, again resulting in a strongly significant level of disagreement (p=0.041).

The three responses where the teachers showed the strongest agreement related to whether computers were provided in the class room, class scheduling and whether a team leader was involved in placing students into math classes. In nearly every school (N=44), the teachers agreed on whether computers were provided for the classroom in school year 2001-02 leading to a high agreement statistic (p<0.001). Also in nearly every school (N=43), the pair of teachers agreed on whether math classes were scheduled using a daily schedule (versus block) during 2001-02 leading to a high agreement statistic (p<0.001). Finally, in nearly every school (N=45), the teachers agreed on whether a team leader was involved in decisions about placing students into math classes again leading to a high agreement statistic (p<0.001). Notably, in only five schools did at least one of the two teachers indicate that a team leader was involved in placement decisions.

Results were also considered one school at a time. In all of the 47 schools, the two teachers were found to exhibit statistically significant agreement. In 16 schools, the teachers exhibited agreement on over 75 percent of the responses. Based on a regression analysis, it was found that the percent agreement between teachers was a significant predictor (p=0.037) of a school being an IPAW school.

Considering the schools with the largest percent of responses in agreement shown in Table 35, agreement between teachers does not seem to be related to whether a school is an IPAW school or a non-IPAW school.

Table 35 ~ Schools with Highest Agreement between Teachers

Name of School	Percent of Responses in Agreement	IPAW School?
Robert Frost	75.2%	No
E Somerville Community	75.8%	Yes
Boston Latin	76.4%	No
Wamsutta Middle	76.9%	Yes
Nessacus Regional Middle	77.5%	Yes
Dr. William R. Peck Middle	77.8%	No
Morton Middle	78.1%	Yes
Plymouth Community Inter.	78.1%	Yes
North Junior High School	78.6%	Yes
Whitman Middle	82.5%	No
West Springfield Middle	83.8%	No
O'Byrant Math and Science	84.1%	No
Edward Devotion	85.7%	No
Samoset	87.1%	Yes
Locke Middle	94.9%	Yes
Umana-Barnes Middle	95.7%	No

SUMMARY

This study uncovered no single school based factor that is a panacea for improving Grade 8 mathematics MCAS test scores. What it did do was identify a number of school based factors associated with schools that increased the percent of their students moving into the Proficient and Advanced levels by more than the state average while at the same time decreasing the percent of their students moving out of the Warning level by more than the state average (called IPAW schools in this report). The school based factors that were present in IPAW school and were not present at non-IPAW schools can be categorized as: Who's Teaching?; What's Taught?; How's It Taught?; and To Whom Is It Taught?.

Who's Teaching?

This study found that teachers in IPAW schools were likely to have taught for less than eleven years at both their school and in the Massachusetts school system. Further, they were relatively unlikely to have a math or science credential. These teachers were usually hired at the school level since the district superintendent was generally not involved in the hiring decision.

Teachers at IPAW schools were more likely than teachers at other schools to believe they were "well prepared" to design lessons and unit assessments although they were less likely to be involved in professional development. In particular, teachers at IPAW schools were unlikely to

be required to attend professional development events and usually did not attend professional development events other than at their own school. In comparison with teachers at other schools, IPAW teachers identified no professional development topics that would help math instructors at their school.

What's Taught?

In general, teachers at IPAW schools were more likely to change their math textbook than were teachers at other schools but were not more likely to supplement their text with other material. Moreover, IPAW teachers were more likely to spend class time addressing student weaknesses by remediation, but not by re-teaching Grade 8 content. Other ways of spending class time that IPAW teachers were unlikely to find productive were generating estimates, generating hypotheses, and making inferences from data.

Teachers at IPAW schools were, in general, more likely to use MCAS results to determine what they taught than were teachers at other schools. In particular, IPAW teachers were more likely to have reported that MCAS results influenced the math assessments used, the expectations for learning, the subject matter emphasized, and the use of materials.

How's It Taught?

Grade 8 math classes in IPAW schools were less likely to be scheduled daily than they were at non-IPAW schools. IPAW schools were less likely to use calculators and computers in their classrooms than were other schools but, paradoxically, teachers at IPAW schools were more likely to supplement the math text with computers than were teachers at non-IPAW schools.

Teachers at IPAW schools were more likely to spend more than 7 hours (of class time) reviewing MCAS results than were teachers at non-IPAW schools. MCAS also has a greater influence on what was taught at IPAW schools than at other schools. In particular, teachers at IPAW schools were more likely to report that MCAS results influenced how they prepared students to take MCAS and their homework assignments.

MCAS was also more likely used in assessment at IPAW schools than at non-IPAW schools. Teachers at IPAW schools were also more likely than teachers at non-IPAW schools to use MCAS results to identify the *Patterns, Relations and Algebra* math strand as major area of student weakness. IPAW teachers also reported using grades to identify this strand weakness. IPAW teachers were less likely to use individual presentations as a strategy to assess learning, but were more likely to assess students with a test or quiz at least once a week.

IPAW administrators were more likely than non-IPAW administrators to have identified more remediation as a solution to a general skill weakness in students. Teachers at IPAW schools also generally treated student needs and weaknesses differently than their colleagues at non-IPAW schools. Pedagogical change was more likely to be identified by IPAW teachers as an important

means to identify strand weaknesses. Accelerated classes were also more like to be identified by IPAW teachers as an important means to address the needs of above grade students. On the other hand, IPAW teachers were less likely than non-IPAW teachers to identify more "hands-on approaches", and more practice and homework as ways to increase a student's math learning.

To Whom Is It Taught?

IPAW schools were more likely than were non-IPAW schools to be grouped homogeneously in math classes. Unlike non-IPAW schools, administrators and counselors at IPAW schools were identified as having a major influence on student placement in math classes. Grades and placement tests were also likely to be considered in student placement in math classes at IPAW schools, but parental selection was not an important factor.

A final word of caution is in order. While all of the factors identified in this study could make a difference in MCAS test scores, none of these factors are as important in determining MCAS test scores as are socioeconomic factors.

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APPENDIX A:
SCHOOLS INCLUDED IN THE STUDY

School	School Name	District	Size of District	2002 Grade 8 Enrollment	IPAW School?	Change in Percent of Students Testing As	
						Proficient & Advanced	Warning
1.	Boston Latin	Boston	Large	385	No	-9%	1%
2.	Boston Latin Academy	Boston	Large	299	No	17%	-5%
3.	Boston Renaissance Charter	Boston Renaissance	Small	71	No	2%	-18%
4.	Carlisle	Carlisle	Small	83	No	11%	1%
5.	Central Middle	Quincy	Large	194	No	-3%	2%
6.	Charles E. Brown Middle	Newton	Large	261	No	3%	-2%
7.	Chestnut Street Middle	Springfield	Large	454	No	1%	-6%
8.	Clinton Middle	Clinton	Small	151	No	4%	2%
9.	Cyril K. Brennan Middle	Attleboro	Small	185	No	7%	-6%
10.	Dr. William R. Peck Middle	Holyoke	Large	281	No	0%	1%
11.	E. N. Rogers	Lowell	Large	173	Yes	13%	-27%
12.	East Somerville Community	Somerville	Large	71	Yes	7%	-23%
13.	Edward Devotion	Brookline	Large	88	No	-11%	1%
14.	F. A. Day Middle	Newton	Large	300	No	-3%	-1%
15.	Forest Grove Middle	Worcester	Large	438	No	-5%	9%
16.	Great Falls Middle	Gill-Montague	Small	142	No	-8%	14%
17.	Hanover Middle	Hanover	Small	222	Yes	13%	-9%
18.	Hastings Middle	Fairhaven	Small	208	Yes	16%	-15%
19.	Henry K. Oliver	Lawrence	Large	146	No	3%	-22%
20.	Henry Lord Middle	Fall River	Large	277	No	-4%	8%
21.	James L. Mulcahey	Taunton	Large	102	Yes	6%	-11%
22.	James P. Timilty Middle	Boston	Large	173	Yes	13%	-21%
23.	John F. Kennedy	Somerville	Largel	85	No	1%	-6%
24.	John F. Parker Middle	Taunton	Large	65	No	-9%	-17%
25.	Jonas Clarke Middle	Lexington	Small	234	No	1%	-5%
26.	Joseph Case Junior High	Swansea	Small	170	Yes	24%	-25%
27.	Lincoln	Lincoln	Small	64	No	-7%	-7%

School	School Name	District	Size of District	2002 Grade 8 Enrollment	IPAW School?	Change in Percent of Students Testing As	
						Proficient & Advanced	Warning
28.	Locke Middle	Billerica	Small	237	Yes	25%	-24%
29.	Lura A. White	Shirley	Small	61	No	0%	6%
30.	M. Marcus Kiley Middle	Springfield	Large	378	No	-2%	-4%
31.	Marstons Mills Middle	Barnstable	Small	234	No	14%	-3%
32.	Mashpee High	Mashpee	Small	172	Yes	13%	-11%
33.	Medway Middle	Medway	Small	200	No	11%	-1%
34.	Milford Middle East	Milford	Small	294	No	-1%	-8%
35.	Morton Middle	Fall River	Large	254	Yes	9%	-9%
36.	Mountview Middle	Wachusett	Large	240	Yes	6%	-8%
37.	Nauset Regional Middle	Nauset	Small	257	Yes	30%	-19%
38.	Nessacus Regional Middle	Central Berkshire	Small	196	Yes	19%	-19%
39.	North Brookfield High	North Brookfield	Small	63	No	0%	-4%
40.	North Junior High	Brockton	Large	334	Yes	12%	-24%
41.	Oak Ridge	Sandwich	Small	130	No	11%	-2%
42.	O'Bryant Math-Science	Boston	Large	127	No	-4%	-3%
43.	O'Donnell Middle	Stoughton	Small	368	No	7%	-2%
44.	Paul R. Baird Middle	Ludlow	Small	273	No	-10%	6%
45.	Phyllis Wheatley Middle	Boston	Large	90	Yes	5%	-26%
46.	Pickering Middle	Lynn	Large	224	Yes	9%	-15%
47.	Plymouth Community Intermed.	Plymouth	Small	410	Yes	5%	-9%
48.	Robert Frost	Lawrence	Large	183	No	1%	2%
49.	Roosevelt Junior High	New Bedford	Large	337	Yes	6%	-22%
50.	Rupert A. Nock Middle	Newburyport	Small	226	No	-3%	2%
51.	Samoset	Leominster	Small	213	Yes	15%	-16%
52.	Silvio O. Conte Middle	North Adams	Small	164	No	3%	-4%
53.	South Lawrence East	Lawrence	Large	171	No	0%	-11%
54.	Sullivan Middle	Worcester	Large	505	No	0%	-9%

School	School Name	District	Size of District	2002 Grade 8 Enrollment	IPAW School?	Change in Percent of Students Testing As	
						Proficient & Advanced	Warning
55.	Thomas Prince	Wachusett	Large	50	No	1%	2%
56.	Umana-Barnes Middle	Boston	Large	313	No	3%	-14%
57.	Wamsutta Middle	Attleboro	Small	201	Yes	11%	-10%
58.	Wellesley Middle	Wellesley	Small	301	No	2%	3%
59.	West Springfield Middle	West Springfield	Small	319	No	1%	-3%
60.	Whitman Middle	Whitman-Hanson	Small	198	No	-4%	6%