K-5 Mathematics Program Assessment

September, 2005

Needham Public Schools
K-5 Math Program Review
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Background

During the during the 2002-03 school year, after extensive discussions and review, the mathematics program, *Investigations in Number, Data and Space* was introduced in all elementary classrooms across the district. This was done to insure that students were receiving a consistent approach to mathematics instruction; that there was a program in place that was aligned to the Massachusetts Curriculum Frameworks and that encouraged teachers to use research based practices instructional practices.

Over the course of the intervening years, a great deal of feedback was received from teachers and parents about how mathematics instruction was occurring in the district, how children were learning mathematics, and how teachers were feeling about the new curriculum and instructional practices. Although the informal feedback was generally positive, there were aspects of the program that were raising some concerns.

Now three years into the program, we felt it was time to review how well the *Investigations* program was meeting expectations. The intent of this review was to learn more about teachers', parents', and principals' perceptions of the K-5 mathematics program and to identify areas in which we need to channel future efforts to insure that the mathematics program meets the needs of all students.

Program Review Strategy

We approached the assessment of the *Investigations* program by examining it with respect to student achievement, in conjunction with the instructional systems (i.e. curriculum, instruction, assessment) and organizational systems (leadership, professional development and communication) that are currently in place to support student learning. In a standards-based environment, instructional and organizational systems collectively influence the effects of any academic program on student achievement. To carry out the assessment, we examined student work via the district's annual mathematics assessment and student MCAS scores, surveyed elementary classroom teachers, hosted focus groups for K-2 and grade 3-5 parents, and interviewed each principal individually. The following pages in this report outline our major findings.

Elementary Teacher Profile

Since all of the K-5 classroom teachers (n=105) responded to the survey, we are able to determine that a majority of elementary teachers have been teaching in the district during the implementation phase of the *Investigations* program.

It is interesting to note the distribution of the years of experience among our elementary school faculty:

Years Experience	Teaching*	Teaching in Needham
>20	22%	17%
16-20	7%	5%
11-15	18%	12%
6-10	17%	22%
1-5	32%	41%

*not all teachers responded to this question

About one-third of our elementary staff is relatively new to the profession, having five or fewer years of teaching experience and somewhat less than half have been in Needham for five or fewer years. With this many of our elementary classroom staff either new to teaching or new to Needham, how well the program is implemented may have a great deal to do with how effectively we are preparing our new staff to do so.

In the many areas we reviewed, teachers' responses varied according to the grade level taught or the number of years of experience he or she had rather than how long an individual had been teaching in Needham. Throughout the analysis, we considered this variation when it served to inform the matter at hand.

Instructional Systems

Curriculum

In this area of the study, we examined the extent to which there is an organized, articulated, up to date curriculum in place and how comfortable teachers feel in teaching it.

The K-5 mathematics curriculum is comprised of three key components: the math continuum, the *Investigations* program, and a set of supplementary materials for each grade level. We were interested in knowing the extent to which teachers were using each of these components in their classroom instruction and their perceptions of how well each was meeting curriculum and instructional needs.

The Math Continuum

Over the last two years, curriculum leadership has worked with teachers and principals to reconfigure the traditional mathematics scope and sequence into a document (the math continuum) designed to articulate the mathematical learning goals for students at each grade level. The continuum also conveys the degree to which the students are expected to demonstrate their understanding of specific skills and concepts. It is the primary guiding document for the horizontal and vertical articulation of the K-5 math curriculum.

Intuitively, we expected that experienced teachers, who have been teaching at a particular grade level for a while, would be likely to have internalized the math learning goals for their grade level and have less of a need to use or refer to the continuum. To our surprise, just the opposite was true. We found that the math continuum is used regularly by about two-thirds (63%) of the teachers to guide instruction. Our senior teachers use it the most (96%) and our less experienced teachers use it the least (18%).

Because students' successful experience with mathematics at each grade level is likely to depend on their mastery and exposure to particular concepts and skills at prior grade levels, it is important that all teachers consistently use the continuum to guide instruction. The horizontal and vertical articulation of the curriculum depends on this happening. It appears that we need to help our younger teachers to understand that the continuum is critical to help shape the mathematical experience of their students, to insure that their students have similar experiences as their peers at the same grade level, and to provide a foundation for their students' future mathematical learning.

The Investigations in Number, Data, and Space Program

Investigations in Number, Data, and Space, Needham's K-5 mathematics program, offers students meaningful mathematical problems while emphasizing depth in mathematical thinking rather than exposure to a series of fragmented topics. A major goal of the program is to expand the pool of mathematically literate students. The curriculum consists of a set of modules at each grade level. Each module offers a series of connected investigations of major mathematical ideas within the areas of number, data collection and analysis, geometry, and the mathematics of change. These investigations offer significant content and encourage students to develop flexibility and confidence in approaching mathematical problems, proficiency in evaluating solutions, and a repertoire of ways to communicate about their mathematical thinking. It presents a set of mathematics basics that is designed to enable students to compute fluently and to solve problems creatively and resourcefully. The program is built on the premise that students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge. The program also represents a new way for teachers to communicate mathematics content and requires a different, less traditional, instructional pedagogy.

We were interested in knowing the extent to which teachers were implementing this program and how comfortable they were in doing so. Although a vast majority of teachers (91%) feel confident about teaching the math content at their grade level, fewer (84%) feel confident about teaching the *Investigations* program.

Slightly more than half of all teachers (52%) felt the *Investigations* program was easy to teach. This view appeared to be concentrated among the primary grade teachers and was less prevalent among their colleagues at the intermediate grades where the mathematical concepts are more challenging and instruction becomes more complex. One reason for this difference may be that the constructivist approach, which is integral to teaching the *Investigations* program, is generally more difficult to implement. Additionally, the curriculum is very language-laden which makes it difficult for to provision for students with reading difficulties.

While the good news is that a majority of the teachers feel confident about teaching mathematics and the *Investigations* program in particular, it is important to recognize that there are also a number of teachers concentrated

at the intermediate grade levels, who are feeling differently about using the program to teach the math curriculum. We need to continue to find ways to support these teachers, to raise their comfort level with the program, and to insure that students are receiving the instruction necessary that enable them to better develop an understanding of the more complex mathematical concepts that are part of the curriculum at those grade levels.

Investigations Materials/Sequence

We were interested in knowing the extent to which teachers were using the *Investigations* materials and whether they were using them in the suggested sequence. About one-third of teachers (32%) reported that they usually use all the *Investigations* units designated for their grade level. More primary than intermediate level teachers reported doing so. This finding is in line with earlier results regarding teachers' perception of the ease with which the program can be taught. The inconsistent use of the program's materials at the intermediate grades may be due to the fact that a significant number of the teachers feel that the *Investigations* program is not easy to teach and therefore look to other sources for curriculum materials.

Fifty-seven percent of the teachers reported they usually taught the *Investigations* units according to the suggested sequence. K-3 teachers were more likely to adhere to the sequence than their colleagues at the upper grade levels. Some of this variation could be explained by new teachers, scattered across the grade levels, who are less likely to use the continuum and may therefore also be less likely to follow the suggested sequence. However, it is unlikely that this would explain all the variation and may be more closely related to earlier findings regarding the teachers' comfort level with teaching the program.

With about half of the teachers not following the suggested sequence, it will be difficult to implement specific instructional practices that have been shown to support student learning, such as looking at student work and the use of common benchmark assessments. Inconsistent use of the *Investigations* materials and the lack of adherence to a specified sequence in which the materials are taught at each grade level is an area of significant concern that merits our attention.

Supplementary Materials

There is a general consensus that the *Investigations* program materials alone are not sufficient to meet student needs. The summer after the program was implemented, teachers were provided with a range of supplementary materials that were intended to address this concern. We were interested in knowing more about how teachers were using theses materials and how useful they perceived them to be.

The supplementary materials are used on a regular basis by teachers for *extension* of math concepts (66%), *remediation* of math concepts (50%), and for *teaching skills not addressed in the Investigations program* (66%). Although 78% of the teachers indicated that a sufficient quantity of supplementary materials exists, 48% felt that these materials do not meet a variety of instructional and student learning needs. Informal conversations with a number of teachers across all grade levels supported this finding, but also revealed that the materials are not arranged in a way that makes them easily accessible for the purposes for which they are intended. Assessing the quality of the supplementary materials, their organization, and usefulness is critical. Because these materials are needed for extension and remediation and for teaching skills not addressed in the *Investigations* program, it is important that we insure that these materials are easily identified and readily accessible by teachers.

Summary-Curriculum

Overall we found that the curriculum was current and consistent with best practices. It is articulated vertically and horizontally. Relevant curriculum documents exist and have been recently updated. Areas needing attention center on the way the program is being implemented and include the following:

- Use of the math continuum to guide instruction
- Helping teachers, particularly those at intermediate levels, to feel comfortable teaching the program
- Insuring consistency in the sequence in which the program is taught
- Insuring that supplementary materials meet a variety of student learning needs and are readily identified and accessible by teachers.

Instruction

In this area of the study, we examined the extent to which teachers were using various strategies and techniques that are associated with effective mathematics instruction. We also looked at how comfortable teachers felt with using these practices to address student learning needs that ranged from remediation to extension and enhancement.

Differentiated Instruction

Brain research confirms what experienced teachers have always known:

- No two children are alike.
- No two children learn in the identical way.
- An enriched environment for one student is not necessarily enriched for another.
- In the classroom we should teach children to think for themselves.

Consequently, essential curricula goals may be similar for all students but methodologies employed in a classroom should be varied to suit to the individual needs of all children. Differentiating instruction means creating multiple paths so that students of different abilities, interests or learning needs experience equally appropriate ways to absorb, use, develop and present concepts as a part of the daily learning process. It allows students to take greater responsibility and ownership for their own learning, and provides opportunities for peer teaching and cooperative learning.

The ongoing focus within the district to increase teachers' ability to differentiate instruction appears to have had some positive effects. A significant number of teachers (86%) reported that they are comfortable differentiating mathematics instruction for students who are in need of remediation. This appeared to be true across most grades and teacher experience levels.

Slightly fewer teachers (77%) felt comfortable in differentiating instruction for students needing more challenging work in mathematics. Not surprisingly, teachers with less experience and those at the grade level with the most complex mathematics content were least comfortable with differentiating instruction for this group of students.

While this generally represents good news, we could be doing better. Although a small percentage of the teachers (12%) report that they are not comfortable with differentiating instruction for remediation and a slightly larger number (22%) report a similar level of discomfort with differentiating for students in need of more challenging mathematics, the students whose learning may be impacted as a result is likely to be significant.

We need to continue to provide opportunities for all teachers, particularly those new to the profession and those who teach at grade levels with the more complex mathematical content, to increase their ability to differentiate instruction for students of all ability levels within their classrooms.

Remediation

Nearly three-quarters of the teachers indicated that there are not enough support systems available for students who have difficulty learning mathematics. It appears that although a large percentage of teachers are able to differentiate instruction for students needing remediation, this technique alone is not sufficient to meet the learning needs of some students. Only about half of the teachers (49%) received training in strategies to gain understanding of students' mathematical thinking. A third of the teachers (33%) had participated in training related to teaching mathematics in a class including students with special needs. It seems that teachers' ability to support students in their classrooms who have significant difficulty learning mathematics is somewhat limited. How we support students in need of remediation in math continues to be an important matter that requires our attention.

Time Devoted to Teaching Math

For a number of years, the district has had a guideline that math be taught every day for at least 1 hour. Principals feel that some teachers are spending less than this amount of time on math instruction and responses from teachers verified this perception. Most teachers (70%) report they are teaching math 5 days a week and 75% of them report that it is happening from 45 to 90 minutes a day. Our most experienced teachers are more likely to adhere to this guideline (83%) and our least experienced teachers are less likely to do so (59%). Of particular note is that a quarter (27%) of our teachers are teaching math only three or four days per week. While some of this variation may be explained because of scheduling issues that cause teachers to extend the teaching time to more than an hour each day, it does not account for all of the variation in practice.

Thirty percent of the teachers felt that not enough time is allocated to the teaching of mathematics. Interestingly enough, this opinion was concentrated among teachers at grade levels where mathematics instruction was happening less than the recommended 5 days per week. We need to pay attention to the amount of time that teachers are devoting to mathematics instruction so that each student has an equal opportunity to achieve the curriculum learning goals for their respective grade level. Also, having math instruction occur during the morning hours at least two times per week would help to provide optimal conditions for student learning.

Computation Skills

One of the major drawbacks of the *Investigations* program is its lack of emphasis on having students develop proficiency with computational skills. This weakness is readily acknowledged and steps have been taken to insure that there is a balance between the emphasis on conceptual and skill development in the mathematics curriculum. An overwhelming majority of teachers (91%) report that they work hard to provide consistent review and practice so students can develop computation skills. Although this is good news, there are still a few teachers for whom this routine may not be in place. While indicative of the practices of only a small number of teachers, it nevertheless has the potential to impact the ability of a significant number of students to develop computational fluency. We need to maintain our focus on helping students to develop efficiency with their computation skills, to insure that all teachers are engaged in this practice, and that appropriate materials are readily available and easy for them to use.

Comfort with Mathematical Concepts/Pedagogy

This section of our assessment addressed teacher comfort level with mathematical content and their facility with using various strategies associated with effective instruction in mathematics.

In general, nearly all of the teachers reported that they enjoy teaching math and consider themselves to be strong math teachers. They reported feeling fairly to very confident about teaching the math content at their grade level and expressed similar confidence in using various standards-based instructional pedagogies such as:

Developing students' conceptual understanding of math	94%
Taking students' prior understanding into account	91%
Listening/asking questions to gauge student mathematical understanding	91%
Make connections between mathematics and other disciplines	90%
Leading a class using investigative strategies	88%

This is indeed a positive picture of teachers' understanding of the mathematics content at their grade levels and their confidence in using various standards-based instructional practices. However, we need to remember that there are still a number of teachers who are not as comfortable with the content at their grade level or some of the pedagogies associated with teaching it. When responses are examined across grade levels, and across years of experience, we found that anywhere from 5%-20% of our teachers are still unsure of themselves with respect to one or more of these practices. With the number of students potentially impacted by this group of teachers and our need to insure that teachers are using practices that enable all students to succeed, we have to continue to provide ways for every teacher to become very comfortable with mathematical content and a range of associated instructional pedagogies.

Summary-Instruction

In general, we found that teachers are feeling confident using varied instructional strategies that are research-based and associated with effective mathematics instruction. Most teachers feel comfortable in differentiating instruction for their students, providing remediation to some extent for those having difficulty, and supplying extension opportunities for those needing more challenging work.

Areas needing attention center on continuing our efforts to insure that <u>all</u> teachers have facility with content and a wide range of instructional pedagogies for mathematics instruction. Specifically, our focus should be to:

- Provide support for less experienced teachers and those at grade levels where the mathematical content is more complex to enable them to feel more comfortable in differentiating instruction for students needing more challenging work in mathematics.
- Increase the available support systems/strategies for students who despite all classroom efforts still have difficulty in learning mathematics
- Insure that all teachers are teaching mathematics daily.
- Continue to emphasize the importance of helping students to develop facility with computation skills
- Continue to insure that instruction is aligned with the curriculum

Assessment

In this area of the study, we examined the extent to which varied assessment practices are employed, are aligned with the curriculum, and are used to provide information to support instruction for all students.

Assessments to Inform Instruction

In a standards-based environment, assessments are an important way for teachers to gain understanding of how students are progressing with respect to specific learning goals. Data from a variety of assessments enable teachers to make adjustments to instruction that, in turn, promote increased student learning. Teachers reported that they are assessing learning in a number of ways and most (98%) provide students with multiple opportunities to demonstrate understanding of math concepts. The survey provided a snapshot of assessment practices that are currently occurring in classrooms across the district. The table below summarizes the assessment strategies and their use in elementary classrooms across the district.

Assessment Practices	Use
Formative/Informal assessments	95%
End of unit assessments	93%
Investigations assessment combined with teacher created assessments	83%
Pre-assessments	78%
End of year assessment data	65%
Investigations program assessments from the Source Book	60%
Looking at student work-LASW	48%
MCAS data	35%
Teacher created assessments (usually)	14%

The data driven standards based environment creates a renewed focus on how we assess what students are learning, how we use the resulting data to inform instruction, and how we report student progress. Although the data indicates that various assessment practices are occurring in classrooms throughout the district, conclusions could not be drawn as to whether any groups of teachers were using these assessment practices in common across a particular grade level in a school. The challenge we face is insuring that students at the same grade level are assessed by consistent standards across different classrooms and schools.

Aside from fourth grade MCAS test, the district's *End of Year Math Assessment* is the only instrument that we have that provides a common measurement of student progress. The purpose of this test is to determine if our students in grades 1-5 have achieved the learning goals outlined in the mathematics continuum for their grade level. Teachers often use the results to inform instruction for the subsequent year. In depth analysis of the results enables classroom teachers to address specific areas of weaknesses at their respective grade levels and to identify struggling students and their specific learning needs. Student performance on the *End of Year Math Assessment* has been found to be consistent with their performance on the MCAS test. You will see more detailed information about the test results in the *Quality of Student Work* section later in this report.

Conversations with teachers over the last year have revealed some dissatisfaction with the time of the year when the end of year assessment is administered, the manner in which it is corrected, and the delayed results. The test is usually given in the spring after students have completed the MCAS test and are feeling somewhat "test weary." Weeks were spent in hand correcting the test. Consequently, teachers were not receiving data about their students' progress until the following September, when their students were not longer with them. Principals raised similar concerns about the timing and the ability of the test to inform instruction. While the district *End of Year Math Assessment* has served a useful purpose for a number of years, we are now at a point of needing a system that provides a more timely flow of information about student progress, that makes it possible for teachers to use data to inform instruction on a regular basis, and that enables us to insure that progress in student learning is regularly being measured against agreed upon benchmarks throughout the school year.

Summary-Assessment

Overall we found that teachers reported using a variety of assessment strategies to gain an understanding of how students are progressing. They are providing students with multiple ways to demonstrate understanding. Common assessments consist of primarily the district's *End of Year Assessment* and fourth grade MCAS testing. Both of these instruments have helped to provide us with reliable (but not necessarily timely) information regarding students' achievement. Areas needing attention include:

- Developing more opportunities for common assessments at each grade level
- Providing an assessment system that insures a more timely flow of information about student progress, that makes it possible for teachers to use data to inform instruction on a regular basis, and that enables us to insure that progress in student learning is being measured and reported at multiple points during the school year against agreed upon benchmarks.
- Continue to support teachers in using data from assessments to inform instruction

Organizational Systems

Leadership

In this part of the study, we examined the extent to which there is an organizational capacity to support student learning. Specifically, we looked at program leadership, professional development, and conditions that promote support for student learning.

Leadership

A critical element in the success of any curriculum initiative is the support that leadership provides and the quality of the feedback that teachers receive about their implementation practices. Leadership for the elementary mathematics program lies primarily with principals, the K-5 Math Instructional Leader, and the Director of Program Development.

A majority of teachers (70%) felt that leadership encouraged and supported current math curriculum and instructional practices. Principals believe that the curriculum is highly engaging. They are seeing that students enjoy and learn from problem-solving, manipulatives, games, working with peers, explaining their answers, and are much more motivated and confident as a result. They are seeing that the approach teaches kids to think mathematically, to solve problems, and to be creative.

Principals are of the opinion that there needs to be more emphasis placed on math instruction in general. Over the last several years, they have focused much of their attention on literacy and they recognize that a shift in emphasis is important at this point. However, principals have remained very aware of the areas of concern with the *Investigations* program that have emerged. The recommendations that developed from our conversations with them are closely aligned with those that resulted from the teachers and parents who participated in this program review. Specifically, principals told us that:

- The program needs to be made easier for teachers to use.
- The program is not being implemented consistently across the district.
- Staff development is necessary
- New teachers need to be "brought up to speed."
- Remediation for some students is an issue
- A new approach to assessment is needed

More than half of the teachers indicated that they would like to receive more feedback from leadership to help them to improve instructional practice. This was true across all grade levels and among teachers of all years of experience. Nearly three-quarters of the teachers felt that individual consultations with the math curriculum leader provided useful information about instructional practice. This was particularly true for our least experienced teachers and for teachers at the intermediate grade levels where the mathematics content is more challenging. If we are to insure that teachers are able to provide instruction that promotes successful math learning experiences for all students, we need to find ways to increase opportunities for them to discuss and to receive constructive feedback on their practices. Our challenge is to find innovative ways to make this possible.

Summary-Leadership

Overall, we found that once the decision had been made several years ago to adopt the *Investigations* program and initial efforts to put the program in place had been completed, attention within the district turned to literacy. During the intervening years, as teachers worked to implement the program, areas of concern emerged. Simultaneously, the district had a significant influx of new teachers who were either new to teaching, new to the *Investigations* program, or both. Although the curriculum leader met regularly with teachers to address these matters and to offer assistance, there was no overall plan in place to remedy the identified concerns or to provide regular support for existing teachers or for the ones who would subsequently follow. Consequently, the overall implementation of the program is inconsistent across the district. While teachers feel that leadership encourages and supports the math program and

that their meetings with the curriculum leader provide helpful feedback on classroom instruction, they are in need of further opportunities for guidance to help improve practice and to insure consistent implementation of the *Investigations* curriculum.

Professional Development

This section of the review looked at the extent to which there is a focus on improving teacher skills and capacity to implement the articulated curriculum. We examined teachers' feelings about the support structures for teaching mathematics that are in place, the degree to which teachers have taken advantage of the professional development opportunities that are available, and the areas in which they would like to pursue for their own professional growth.

Support Structures for Teaching Mathematics

Teachers are better able to help their students to learn mathematics when they have opportunities to work together to improve their practice, time for personal reflection, and strong support from colleagues and other qualified professionals. [1] Teachers in Needham are provided with a variety of opportunities to collaborate with colleagues and to receive direct support from the Curriculum Leader in matters of instructional practice. We asked teachers to rate the support structures that are currently in place for teaching mathematics. Their responses are categorized as follows:

Support Structures	Helpful	No Response
School-based grade level meetings	89%	1%
Courses or workshops offered by the district	80%	8%
Grade level meetings with the curriculum leader to prepare for upcoming units	76%	8%
Individual meetings with curriculum leader	72%	8%
Classroom demonstration lessons	71%	14%

There were a number of categories listed above in which teachers chose not to respond. The likelihood is that these teachers had no opinion on the matter because they may not have had any experience with that particular support mechanism. For the most part, teachers felt that the various venues in place were helpful in providing support for math instruction. The variation in teachers' responses to the usefulness of these structures appears to be due more to the differences among the schools than to differences in the level of teachers' years of experience or grade. Teachers appear to view our practice of providing grade level meeting time, courses, meeting time with the curriculum leader, and classroom demonstrations to help improve their knowledge of mathematics content and pedagogy as being helpful to them. The results of this part of the survey provide us with ample reason to continue with practices that teachers tell us are working.

Professional Development in Mathematics

The most powerful way to have a positive impact on mathematics achievement for all students is by substantially investing in teacher professional development.[2] Needham provides a rich array of professional development opportunities for its teachers. 93% of the teachers reported that they had participated in some type of math related professional development in *the last 3 years*. This included time spent with the curriculum leader either individually or in grade level groups and participation in courses or workshops offered outside of the school day. The amount of time that teachers were engaged in learning more about mathematics or the teaching of mathematics in the *last three years* ranged from fewer than 6 hours to more than 35 hours, with most of the teachers spending from 6 to 15 hours in activities designed to develop their knowledge of mathematical content or pedagogy. Teachers with 16-20 years experience were our most active participants. The following table illustrates the extent to which teachers of varying years of experience participated in professional development opportunities.

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[1] Mirra, Amy J. (2003), Administrators Guide: How to Support and Improve Mathematics Education in Your School. Reston, VA: ASCD

[2] Ibid, p.22.

	All (n=105)	1-5 yrs (n=34)	6-10 yrs (n=18)	11-15 yrs (n=19)	16-20 yrs (n=7)	>20 yrs (n=24)
< 6 hrs.	17%	29%	17%	11%		13%
6 to 15 hrs.	44%	38%	56%	42%	71%	42%
16 to 35 hrs.	25%	21%	22%	21%	29%	29%
> 35 hrs.	7%	6%		11%		13%
Total	93%	94%	95%	85%	100%	97%

At first glance, participation in mathematics related professional development appears to be significant. However, when considered on a yearly basis, just over 60% of the teachers participated in less than 5 hours of professional development each year. Given that this time might have consisted in one or two grade level meetings with the curriculum leader, perhaps an individual classroom consultation or a one day summer course, we can see how little time has actually been spent on helping teachers to develop their comfort level with mathematical content and/or the pedagogy associated with the *Investigations* program.

Within the last three years 66% (64 teachers) of those who participated in math related professional development said that their work emphasized learning how to teach the *Investigations* units. Given that only two-thirds of the teachers have spent time learning to teach the units from the program, it is understandable as to why there is inconsistency in how the *Investigations* program is being implemented.

Summary-Professional Development

Overall we found that the data confirmed what we intuitively already knew. Support structures that we have in place, (i.e. school-based grade level meetings, professional development offerings, grade level meetings with the Curriculum Leader, classroom demonstration lessons, and individual consultations with the Curriculum Leader) are professional development opportunities for teachers that are working well and that are positively received. We have ample reason to continue with practices that teachers tell us are working and that support productive change and continuous improvement.

Teachers are participating in mathematics professional development opportunities but not as frequently as we would like. The dilemma regarding professional development facing all districts is the need for teachers to develop expertise in both content and pedagogy in mathematics and the lack of time or resources that are available that enable them to do so. During the 2005-06 school year we have begun to weave early release days, faculty meeting time and a few precious hours of substitute time to provide teachers with the professional development needed to implement the mathematics program. Insuring that these experiences happen each year so that the significant numbers of new staff will have the expertise to teach the curriculum remains a persistent challenge.

Areas needing attention include:

- Insuring that all teachers, particularly our least experienced and those teaching at the grades where the curriculum is more complex, have the content and pedagogical knowledge to implement the *Investigations* program
- Insuring that all teachers have an understanding of and facility with instructional strategies that would help students needing remediation to become more proficient math learners.

Parent Communication

Forming close relationships with families is important to a successful mathematics program. A strong mathematics program that provides for the successful learning experience of all students requires a commitment not only from teachers, curriculum leaders, and administrators, but also from parents. As part of this assessment of the K-5 mathematics program, we examined how teachers are helping parents to understand the *Investigations* program and how the parent community perceives the impact the program is having on their child's mathematical learning experience.

Over the last decade, there has been a conscious national shift in the philosophical underpinnings of how mathematics should be taught. The emphasis is now more on conceptual understanding and less on the repetition of algorithmic processes. Helping parents (who see the mathematics their children are learning bears little resemblance to the mathematics they learned when they were in school) to understand this change is one of the challenges each teacher faces. It becomes especially difficult when teachers are trying to make sense of the changes themselves.

Teacher/Parent Communication
Teachers indicated that they were generally comfortable in communicating with parents about the mathematics skills for their grade level. This was true across all grades and years of experience.

How they communicated with parents about the *units of study* that regularly occur in their classrooms varied. The table below provides an overall picture of the ways that were most frequently used:

Parent Conferences	96%
Newsletters	71%
Parent Volunteers	30%
Student Presentations	23%

Teachers also told us that they communicated with parents about mathematics is a variety of other ways that included:

- E-mail and telephone conversations
- The parent letters that are included in the *Investigations* units
- Report card comments

The fact that at least three-quarters of the teachers are feeling comfortable in communicating with parents about the various aspects of the mathematics program is encouraging. However, it is important that we also examine the regularity with which this happens and the effectiveness of the vehicles that we are using. The most popular means of communication is parent conferences but these only occur twice a year—not frequently enough to keep parents abreast of what is regularly happening in the classroom. Newsletters are also popular communication vehicles. However, parents told us that paper newsletters often get misplaced in transit and consequently do not often result in the communication that the teacher intended. Communication that occurs through electronic means was one suggestion that was frequently mentioned in each of the parent focus groups.

We rely heavily on parents supporting classroom teachers in their efforts to develop children's mathematical competency. Parents are eager to get a better understanding of the strategies and approaches that are used in the *Investigations* program and are searching for guidance on materials that they could use to support their child's learning at home. We need to review the ways in which we communicate our expectations to them, the frequency with which we do it, and the nature of the information that we provide them if we are to insure that parents' efforts to support their child's learning are in sync with what children are experiencing in the classroom.

It is the best interests of every child's mathematical development that we maintain a strong partnership with the adults in their lives. Insuring that communication is informative, instructive, useful, and regular is an important aspect of maintaining parents' trust and support.

Parent Perceptions

During the spring of 2005, as part of the assessment of the *Investigations* program, we held two focus groups for parents of children in the elementary schools. One group was composed of parents of children in grades K-2 and the other one for parents of children in grades 3-5. We were interested in knowing more about how they felt about their child's learning experience in mathematics; their familiarity with the *Investigations* program; how the program was working for their child; and how effectively we were communicating with them about their child's mathematical learning.

Children's Experience with Math:
Parents of *primary grade* students felt that many children are acquiring mathematical skills that were once part of the Kindergarten experience in pre-school programs and through quality "edutainment" (e.g. PBS: Cyberchase) that is geared specifically to children in this age group. Consequently, they told us that their children were not being challenged in math in the earlier grades. Parents said that they work hard to supplement with math experiences at home to keep their children engaged and commented that the math program in the primary grades appears to be less challenging now than when older siblings experienced it in previous years.
Parents of *intermediate grade* students represented a balanced distribution of children who either enjoyed math and did well with it or who found it difficult and struggled with it. A number of parents talked about how their children's understanding of mathematical concepts developed and deepened over time and credited the instructional approach

associated with the *Investigations* program. Children who were struggling with mathematical concepts at the earlier grades were acquiring more skills and displaying more confidence in the later grades.

Parents of *intermediate grade* students also felt that children were not given enough homework and that the homework was sometimes not challenging enough. A number of parents commented that the homework often reiterated concepts that the children had already mastered rather than reinforcing newly introduced ideas.

The *Investigations* Program

With respect to the *Investigations* program, parents confirmed many things we already knew. They told us that the program appeals to children who can articulate their thinking. "Children who get the answer and can't explain it get frustrated." The shift in the underpinnings of how mathematics is now taught (regardless of which program is used) has made mathematical learning more language dependent.

Parents of *primary grade* students were quick to point out that teachers are not all using the *Investigations* program in the same way and that some teachers are using more of the program materials than others. They emphasized the need for more consistency in the way the program materials are used, how they are supplemented, and in the way the program is taught.

These parents sensed that the program may not be "teacher friendly." They felt that it should "work" regardless of who is teaching it. Parents pointed out that the difference in how teachers implement the program causes difficulties for children as they move from teacher to teacher when they advance from one grade to the next. This difference can also be problematic when a teacher changes grade levels.

Parents of primary grade students told us that they would like to see math homework on a regular basis. Many take it upon themselves to "do math" with their children at home to support the classroom teacher and to insure that their child's math learning continues to progress.

At the *intermediate grade* level, parents indicated that they liked the program's approach to math. They appreciated that the curriculum asked children to discover or "figure out" how to solve a problem rather than being told how to do it. They also liked that the program supported the notion that there is more than one way to arrive at a solution to a problem. These parents were divided on the program's expectation that children be able to explain their thought processes in writing. They felt that it worked well for children who liked to write but it was difficult for children for whom mathematics was more intuitive.

Parents appreciated the fact that the program gave them the opportunities to have more family conversations about math related things. At this grade level, parents have had more experience with the *Investigations* program and have had opportunities to see their child's learning develop over time. Their exposure to the program is likely to have contributed towards their general understanding of its objectives and led to their generally positive perception of its effects.

Parent Recommendations

Across both groups, parents expressed a need for regular communication (preferably electronic) from the classroom teacher about the math curriculum and about the learning activities that were happening in the classrooms. They asked for more guidance on how to help their children to be successful math learners. As one person commented, "A parent needs something concrete to turn to. We grew up in a different time. We need to assist our children but don't know what's going on in the classroom and can't help." They suggested email distribution lists, distributing information about the curriculum via the web, and websites that would prove problems that parents and children could work on together at home.

There was a general sense that they liked the *Investigations* approach to mathematics but that children were not as facile with math facts as they should be. Parents would like to see more emphasis placed on skill development in this area of the curriculum to insure that children not only have a conceptual understanding of mathematics but also have the fluency needed to handle everyday calculations.

A third theme that emerged within each of the groups was consistency. Parents reiterated how important it was that the mathematics program be implemented consistently among teachers at the same grade level to insure a smooth transition for their children from one grade level to the next.

Quality of the Work of Students

Perhaps the most important aspect of this review of the K-5 mathematics program is the impact that curriculum, instruction, assessment, leadership, professional development and communication have on student learning. Every aspect of what we do to insure that these instructional and organizational systems are in place and functioning is done in the service of increasing our capacity to support mathematical learning for all students.

To examine the extent to which elementary school students are meeting benchmark expectations of curriculum essentials, we used the results of the grade 4 MCAS test and the results of the end of year mathematics assessment that has been in place in the district since 2003. Students' skills and conceptual understanding of the five major strands of the mathematics curriculum--Number and Operations, Algebra, Geometry, Measurement, and Data--were assessed as part of the annual end of year test and used to inform this review of the *Investigations* program. While the overall trends of student performance over the last several years remained fairly consistent, we were able to identify particular content strands at each grade level that are in need of further attention. A complete analysis of the results of the test and recommendations appear in the appendix of this report.

Next Steps

The purpose of this curriculum review was to learn more about teachers', parents', and principals' perceptions of the K-5 mathematics program and to identify areas in which we need to channel future efforts to insure that the program is meeting the needs of all students. The intent was to use this information to develop an action plan that would direct our efforts to address the issues that emerged. Principals are currently reviewing the data with the Director of Program Development and the mathematics instructional leader and are in the process of developing an overall plan for the district as well as for their individual schools. However, we have identified and have already taken a number of immediate steps to address two issues--the matter of consistency in how the mathematics program is being implemented and the availability and alignment of supplementary materials to the curriculum at each grade level.

To attend to these concerns, we have done the following:

- During the spring we piloted some organized supplementary materials, published by Scott Foresman, in classrooms at each grade level across the district. Feedback we received from teachers indicated that these materials were designed to complement the *Investigations* program in ways that addressed the concerns that teachers had raised. Because of the strong positive response that we had from teachers who had piloted these materials, we have purchased a set of materials for each elementary school classroom. Teachers received the materials when they returned to school this fall.

- We worked during the summer to organize the curriculum into a "teacher friendly format." In the process we aligned/organized the curriculum frameworks, the K-5 math continuum, the Scott Foresman materials, and existing supplementary materials to the *Investigations* units. Teams of teachers met for three days to do this work and developed a curriculum handbook for each grade level that they introduced to their grade level colleagues in September. The teams consisted of teachers from grades 1 through 5 and represented the views of each of the elementary schools. Teachers are very excited about having a curriculum pacing guide, and a weekly outline of curriculum objectives that are aligned with the *Investigations* units and supplementary materials. Participants in the project along with the K-5 mathematics instructional leader are reviewing the handbook with colleagues and soliciting their comments/feedback through a series of grade level meetings at each school that are scheduled throughout this school year.

- We have shared this work with special education staff to insure that their efforts to support children's mathematical learning are aligned with those of classroom teachers.

Overall, there are a number of concerns that were identified in this curriculum review that are in need of our attention. The leadership team is currently in the process of formulating a detailed plan for how to address them. However, we are optimistic that the steps we have taken thus far will have a positive impact on the consistency of how the curriculum is taught; the resources that the teachers have available to meet the learning needs of all their students; and most importantly, the mathematical achievement of our children.

Quality of the Work of Students

End of Year Math Assessment

Background
The foundation of Needham's elementary math curriculum is the Elementary Mathematics Continuum that outlines learner expectations for each grade level. This continuum includes learner outcomes for each grade level in the areas of number and operations, algebra, geometry, measurement, and data analysis and probability. The learning goals delineate three different stages in the development of student understanding. These three stages are as follows:

I=Introduce--Teachers should provide instructional opportunities to expose students to these learning goals; proficiency is not necessary.
P=Practice-- Teachers should provide instructional opportunities for students to practice these learning goals. Teachers may need to provide students with learning opportunities for the same learning goal at more than one grade level.
A=Achieve-- Students should achieve proficiency of these learning goals.

These learning goals are based on the Mathematics Curriculum Framework provided by the Massachusetts Department of Education, the National Council of Teachers of Mathematics standards, and teacher recommendations.

Investigations in Number, Data, and Space, adopted in September 2001, is the elementary mathematics program used in all schools, kindergarten through grade five. Supplementary materials have been provided for teachers to support and enhance math instruction at all grade levels.

Rationale of Assessments
The purpose of this assessment, administered for the last three years, is to determine if our students in grades one through five have achieved the goals for each content strand included in the elementary mathematics continuum.

Development of Assessments
For the past few years, the correction process involved the allocation of monies for a group of teachers to correct the tests and complete data entry during several days at the end of June. The Superintendent felt the money could be spent in a manner that would have greater impact on teaching and learning. As a result, a few proposals were discussed, and the final decision was to make all the assessment questions multiple choice for grades three through five and to maintain the basic format of the grades one and two assessments. Given this change in grades three through five, in which open response and short answer questions were eliminated, the number of points assigned to test items was, in some cases, significantly different from the previous years. The following tables illustrate the number of points per strand for over the last three years.

Grade 1-Points Per Strand

Strand	Points		
	2003	2004	2005
Number and Operations	35	35	36
Algebra	3	3	2
Geometry	20	21	22
Measurement	3	3	3
Data	2	2	2
Total	63	64	65

Grade 2-Points Per Strand

Strand	Points		
	2003	2004	2005
Number and Operations	27	24	17
Algebra	5	5	6
Geometry	10	7	6
Measurement	3	11	13
Data	5	4	7
Total	50	51	49

Grade 3-Points Per Strand

Strand	Points		
	2003	2004	2005
Number and Operations	28	21	14
Algebra	5	4	4
Geometry	NA	4	2
Measurement	12	11	8
Data	3	3	2
Total	48	43	30

Grade 4-Points Per Strand

Strand	Points		
	2003	2004	2005
Number and Operations	12	20	17
Algebra	5	10	5
Geometry	4	13	8
Measurement	4	11	2
Data	5	6	4
Total	30	60	36

Grade 5-Points Per Strand

Strand	Points		
	2003	2004	2005
Number and Operations	14	24	18
Algebra	8	8	5
Geometry	6	14	4
Measurement	3	3	4
Data	7	7	7
Total	38	56	38

Test Correction

With regard to test correction, the principals agreed to have teachers correct their class assessments. Four high school students were hired to enter the data into spreadsheets in order to analyze the results as we have done previously.

Use of Test Results

The test results are being used for multiple purposes. First, every teacher received a corrected test for each incoming student. Second, teachers received composite data regarding test results specific to their former class. Third, general system wide trends and school trends were established from the analysis. In addition, the 2003, 2004 and 2005 assessment results were compared to determine the progress in each grade level, keeping in mind changes were made in the test composition. Finally, the resulting information extrapolated from the recent assessments will be used to inform instruction for the continuing improvement of our mathematics curriculum.

Data Analysis

A spreadsheet was used to analyze the data. Individual student results were entered and data was aggregated for each item number. A composite was used to summarize each student's test results according to each of the five mathematical strands. Each student also received an overall percentage score.

The data was also analyzed by class. Each teacher was provided a mean class percentage score for each of the five mathematical strands. An average percentage score for the class was also calculated.

In addition, data was organized by grade levels across the district to calculate the percentage of students performing in each of the five intervals shown in the tables. The data included in the tables compare the results of the assessments administered in 2003, 2004, and 2005.

Grade 1:

360 Students/2003
389 Students/2004
398 Students/2005

	Number and Operations			Algebra			Geometry			Measurement			Data		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
90-100%	27%	51%	66%	60%	77%	76%	67%	87%	69%	91%	86%	91%	97%	98%	97%
80-89%	36%	24%	18%	0%	0%	0%	22%	7%	21%	0%	0%	0%	0%	0%	0%
70-79%	21%	12%	8%	0%	0%	0%	8%	2%	5%	0%	0%	0%	0%	0%	0%
60-69%	13%	10%	4%	14%	0%	0%	2%	1%	2%	8%	12%	7%	0%	0%	0%
0-59%	4%	2%	5%	26%	23%	24%	2%	3%	3%	2%	2%	2%	3%	2%	3%

Overall, first grade performance has been fairly consistent the past three years in most strands, with the majority of students receiving a score of 80% or higher. In Number and Operations, there has been a steady increase in scores, with two-thirds of the population scoring in the 90-100% range on the 2005 assessment. The successful performance of the students indicates that they are overwhelmingly achieving the learning goals outlined in the Continuum.

Grade 2:

345 Students/2003
360 Students/2004
404 Students/2005

	Number and Operations			Algebra			Geometry			Measurement			Data		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
90-100%	10%	34%	41%	42%	53%	48%	63%	75%	81%	59%	70%	70%	34%	64%	70%
80-89%	21%	32%	31%	26%	22%	20%	14%	16%	11%	0%	0%	15%	33%	0%	17%
70-79%	28%	18%	17%	0%	1%	1%	12%	7%	0%	0%	0%	7%	0%	21%	0%
60-69%	14%	11%	5%	12%	10%	11%	5%	0%	6%	32%	23%	5%	14%	0%	5%
0-59%	26%	5%	6%	19%	14%	20%	5%	2%	2%	9%	8%	4%	19%	14%	8%

In the content areas of Number and Operations, Geometry, and Data, steady progress has been demonstrated by students over the last three years. The area of Measurement indicates a decrease in the percentage of students performing below 69%. Over two-thirds of the students received a score of 80% or higher in the area of Algebra, which is consistent with the performance for over the last two years. Although this is positive, attention must be given to the 20% of the students who received a score of 59% or lower in this strand.

Grade 3:
351 Students/2003
351 Students/2004
369 Students/2005

	Number and Operations			Algebra			Geometry			Measurement			Data		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
90-100%	16%	8%	42%	40%	41%	55%	NA	50%	55%	28%	39%	30%	64%	62%	79%
80-89%	22%	25%	20%	23%	0%	0%	NA	35%	0%	19%	21%	48%	0%	0%	0%
70-79%	20%	17%	24%	0%	33%	32%	NA	0%	0%	17%	16%	13%	0%	0%	0%
60-69%	18%	25%	5%	20%	0%	0%	NA	0%	0%	18%	11%	4%	28%	31%	0%
0-59%	24%	26%	10%	18%	26%	13%	NA	16%	45%	18%	13%	5%	8%	7%	21%

In the content areas of Number and Operations, Algebra, Measurement, and Data there has been an increase in the percentage of students who received a score of 80% or above. In addition, there has been a decrease in the number of students receiving a score below 59% in the areas of Number and Operations and Algebra. In the areas of Geometry and Data, an increase in the percentage of students who received a score of 59% or lower was noted. In both cases, this increase in lower scores could be attributed to the limited number of questions (only 2).

Grade 4:
334 Students/2003
353 Students/2004
359 Students/2005

	Number and Operations			Algebra			Geometry			Measurement			Data		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
90-100%	23%	31%	31%	36%	54%	35%	24%	62%	41%	14%	18%	80%	55%	41%	81%
80-89%	19%	21%	36%	35%	8%	33%	22%	12%	30%	17%	25%	0%	21%	33%	0%
70-79%	18%	14%	17%	0%	16%	0%	22%	6%	17%	10%	23%	0%	12%	1%	17%
60-69%	16%	16%	6%	18%	11%	19%	13%	15%	7%	18%	18%	0%	7%	16%	0%
0-59%	25%	17%	10%	11%	10%	13%	20%	6%	5%	40%	16%	20%	6%	9%	2%

Over the past three years, a steady increase can be seen in the area of Number and Operations for the percentage of students who received a score of 80% or higher. At the same time, the percentage of students who received a score of 69% or lower in this area has decreased. Although more than two-thirds of the students received a score in Algebra of 80% or higher, one-third scored below 69%. The scores for

Geometry are fairly consistent with last year's scores, though the percentage of students scoring below 69% has decreased. The strong performance in the areas of Measurement and Data indicates an increase in student understanding, however, it is important to note there were only 2 questions and 4 questions respectively, in these content strands.

Grade 5:
363 Students/2003
332 Students/2004
361 Students/2005

	Number and Operations			Algebra			Geometry			Measurement			Data		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
90-100%	27%	40%	47%	6%	18%	43%	39%	23%	48%	34%	30%	59%	28%	30%	40%
80-89%	24%	22%	22%	17%	27%	0%	18%	11%	0%	0%	0%	0%	30%	27%	28%
70-79%	15%	12%	15%	25%	28%	35%	13%	18%	35%	0%	0%	0%	19%	19%	18%
60-69%	12%	12%	9%	23%	13%	0%	15%	14%	0%	33%	36%	28%	0%	0%	0%
0-59%	21%	14%	7%	29%	14%	22%	14%	34%	17%	33%	34%	13%	23%	24%	13%

Results show a steady increase in student understanding in the area of Number and Operations, Measurement, Geometry, and Data over the last three years, with a greater percentage of students scoring above 80%, and a lower percentage of students scoring below 69% in each of these strands. Performance in the area of Algebra remains consistent with the results in 2004, though improvement is noted since 2003.

Recommendations
The following recommendations are provided to maximize mathematical learning for all elementary students.

Teachers must know and understand grade level learning goals. These goals are outlined in the elementary mathematics continuum to guide teaching practices.

Teachers must follow the sequence of units of study for their grade level. This year teachers received a math curriculum binder that contains a pacing guide for teachers which clearly delineates the expectations for grade levels one through five, and builds consistency in content. Two teachers from each grade level developed a framework that was modeled after the literacy units of study. This design was in response to the teachers' request to efficiently organize the components of the math curriculum, and provide teachers new to Needham with a coherent math curriculum that can be easily used.

Teachers must use the Curriculum Materials provided. In addition to the binder, resources published by Scott Foresman were purchased to complement the math curriculum and provide materials for differentiating instruction as well as for homework purposes. They developed a framework that was modeled after the literacy units of study and they shared this work at an Elementary Cabinet meeting in May. Everyone agreed that their design advanced the teachers' request to efficiently organize the components of our math curriculum and provide teachers new to Needham with a coherent curriculum that can be easily used.

Take the time needed to teach mathematics effectively. The *Investigations* program requires 45 minutes for kindergarten and one hour for grades one through five. In addition, students must spend 10 minutes on Daily Routines or Ten Minute Math activities. It is imperative for students to have consistent opportunities for vocabulary development, writing in math, and problem solving experiences that incorporate mathematics from each of the five content strands.

Grade levels should focus on particular content strands. Content strands that necessitate improved performance must be examined to effect changes in instructional practice. The June 2005 results indicate grade one teachers should review the area of geometry; grade two teachers should examine the teaching of algebra; grade three teachers should focus on their teaching of geometry and data; grade four teachers should emphasize algebra and geometry; and grade five teachers should examine instructional practices in algebra, geometry, and measurement.

Provide appropriate homework and support. Homework assignments are provided in the Investigations unit guides, and can be supplemented with the Scott Foresman materials as well as activities from previously purchased supplementary resources. Homework is an appropriate opportunity to provide parents with materials to reinforce math skills such as fluency with math facts. When assigning homework from *Investigations*, it is important to be clear about the task.

Continue professional development. Teachers have opportunities to meet regularly with grade level colleagues, attend content institutes provided by the Department of Education, and take courses through The Education Cooperative. In addition staff development is provided through workshops and courses presented by Needham teachers. Sustained learning by educators will have positive effects on the teaching and learning process. As we deepen our understanding about mathematics, we will improve our teaching.