

MATHEMATICS TEACHER SPECIALISTS—MAKING A DIFFERENCE FOR STUDENT LEARNING

T. ROWAN

*University of Maryland, College Park
College Park, MD 20742*

Introduction

Mathematics is generally considered the second most important subject for students to gain competency in, reading and language arts having a solid hold on first place. Having said this, there is also general agreement that many elementary teachers are much less prepared to teach mathematics than they are to teach reading. My experience teaching a mathematics methods course for elementary teachers supports this view, both with respect to content knowledge and confidence about knowing and teaching the subject. However, many elementary schools have Reading/Language Arts Specialists because of the high level importance of reading. Schools generally do not have Mathematics Specialists, though teachers are better prepared and more confident with reading. Reading/Language Arts Specialists are often classroom teachers who have had additional preparation and experience. They often do not have responsibility for a classroom of children, but rather are responsible for supporting their fellow teachers who do have classrooms.

Despite the acknowledged importance of mathematics and less well-prepared teachers, there are relatively few elementary schools that have Specialists for mathematics. While the reason for this is often given as budget constraints, those budget constraints do not prevent the employment of Reading Specialists. It could be argued that, *if* mathematics is important in our society, and *if* Mathematics Specialists can make a difference in student learning, then money or ways of organizing teacher personnel should be found to provide Specialists, just as they are for reading/language arts. This paper is intended to support the view that Mathematics Specialists do make a difference—and this difference can be seen in many ways, including student learning.

Two school systems that have endeavored to provide some level of Mathematics Specialist support will be discussed to informally describe the positive changes that Mathematics Specialists can help to bring about. One of these school systems is in Phoenix, Arizona and the other is near Richmond, Virginia. These districts are similar in size, but dissimilar in other characteristics, including the way in which the Mathematics Specialist positions were implemented.

The Madison District

The Madison School District is located in Phoenix, Arizona which is separated into a number of elementary/middle school districts. It is a small K-8 district with seven schools. The District received two National Science Foundation (NSF) grants. The first (1998-99) was a planning grant. That was followed by a grant for a three-year project (2000-2003) that enabled the District to provide half-time release for two teachers for six of its seven schools and one Teacher Leader for the seventh school. Thirteen teachers were released half-time to serve as mathematics leaders for the 329 teachers in the seven schools. These teachers were selected by a relatively informal process that involved self-nomination, principal nomination, and prior participation in mathematics planning activities that preceded application for NSF support. The District had over 5,200 students in the 2002-2003 school year.

Madison District—Mathematics Teacher Leaders

Prior to receiving NSF support, the District had adopted two reformed mathematics programs, *Investigations in Number, Data, and Space* and *Connected Mathematics* [1,2]. The District curriculum was developed with these two programs as its basis (1995-96). The Mathematics Teacher Leaders (MTL) were initially established (1996-97) and were given half-time release with the support of the planning grant. The progress made during the planning grant led to the funding of the larger grant for the 2000-2003 school years. The MTL participated in extensive professional development through workshops conducted by consultants and college mathematics courses from Arizona State University (ASU) during both NSF grants. Professional development workshops were usually single days used to focus on the concept of reflective teaching—teaching that is based on first gaining a deeper understanding of the background knowledge of the students, then planning instruction that reflects that background knowledge. As might be expected, exploring this instructional concept included some simultaneous exploration of content. The college-level courses focused specifically on content understanding, and developed and extended understanding of algebra and geometry. These courses were designed specifically to develop this content using, to the extent possible, instructional strategies that were supportive of the reflective teaching goal of the project. This was important because of the variation in content background of the MTL and because it was essential for the MTL to have consistent reinforcement of the instructional strategies they were to provide training on and to use. Much of the content of the workshops and the design of the content courses used the ideas of the Cognitively Guided Instruction Project [3]. The college courses were open to both the Mathematics Teacher Leaders and to the other teachers in the District. It was understood that

there would be turnover in the MTL program, and teachers who were seen as possible future Teacher Leaders were especially encouraged to take the courses. To enhance their leadership skills, the MTL were sometimes used as instructors' assistants in presenting some parts of the courses.

Each Specialist was released for half of the school day and had a class to teach the other half. The reason for this arrangement was not primarily a budgeting issue, but rather a belief that maintaining close contact with children and teaching would enhance the Specialist's performance and increase credibility with the teachers served by the Specialist.

While the MTL in the Madison District had relatively well-defined responsibilities, as indicated in Table 1, the District administrators recognized that there were many differences among the schools that required a flexible approach to the implementation of the MTL position at the school level. The building principals participated in many of the training sessions for teachers and familiarized themselves with the philosophy and goals of the Mathematics Teacher Leaders program. The principals and the MTL were thus able to work together in very cooperative ways to adjust the implementation process to meet the needs of the local schools. In some cases, the teaching staff was stronger and needed less frequent individual support by the MTL. The MTL worked to establish schoolwide activities to support children, teachers, and parents. In other cases, the dominant role was cooperatively working with teachers.

The NSF grant proposal that led to initial funding of the half-time release of the MTL included an overall plan to provide professional development to all teachers in the District, with the MTL leading workshops for the other teachers, in addition to the opportunity to enroll in the content courses from ASU. Training for classroom teachers was provided primarily through released time or summer workshops paying stipends for attendance. College courses that were offered either paid a stipend or gave teachers who took them college credit without having to pay tuition. The MTL participated in teacher workshops (either as participants or leaders), attended additional workshops once a month, and took the college courses. While the half-day release time was used in a variety of ways, depending on the needs of a particular school, a typical schedule was described in the NSF proposal as shown in Table 1.

The MTL found that the reading/research days and the flexible use days included in the original proposal plan were often taken up with other tasks, such as follow-up meetings with

teachers or providing support by organizing and facilitating access to instructional materials, including manipulatives.

Table 1
Typical MTL Two-Week Half-Time Release Schedule

Day 1 – Grade-level meeting	Day 6 – Grade-level meeting
Day 2 – Grade-level meeting	Day 7 – Grade-level meeting and classroom support
Day 3 – Classroom support	Day 8 – Classroom support
Day 4 – Reading and research	Day 9 – Districtwide meetings
Day 5 – Work with partner MTL to strengthen reflective teaching/leadership skills	Day 10 – Flexible use

The MTL were originally selected because of the excellence of their teaching, their interest in mathematics teaching in particular, and their demonstrated leadership qualities at their schools and on District committees. Given that informal selection process, one might expect that the MTL would feel very comfortable with their knowledge of mathematics and pedagogy related to the subject. As a part of data collection during the planning grant, MTL were asked to estimate their comfort level with mathematics content and pedagogy. The results are shown in Table 2.

These self-report data seem to indicate that, even with teachers who had been selected for their leadership roles based upon excellent teaching of mathematics and content backgrounds that exceeded that of their peers, the percentage that indicated a “very comfortable” level with mathematics content was less than half of the group. Only slightly more than half were “very comfortable” with the pedagogy. The need for support and additional training in content **and** pedagogy were supported by the data.

Table 2
Mathematics Teacher Leaders

	Uncomfortable	Somewhat comfortable	Comfortable	Very comfortable
Mathematics content		14%	43%	43%
Teaching mathematics			43%	57%

From my experience as a college methods instructor and district supervisor, I know that teachers of the early elementary grades are often uncomfortable with mathematics content and pedagogy. The Madison District MTL included teachers whose classrooms ranged from first through eighth grade. The survey result can be interpreted as further emphasizing the need to support classroom teachers with mathematics content and pedagogy training. It is simply too much to expect that a classroom teacher who teaches all subjects should be an expert in each of those subjects. The teaching of mathematics is further complicated by the diverse strands that must be addressed (number/operation, geometry/measurement, statistics/probability) and the need to develop the processes of problem solving, reasoning and proof, communication, connections, and representation within those strands [4]. Even though many middle school teachers may teach only mathematics, they too are often uncomfortable at some level with all or part of the content and/or pedagogy that integrates these processes.

Madison District—The Move Toward Reflective Teaching

The goal of the NSF project in the Madison District was to help all teachers in the District move toward *reflective teaching*, the definition of which was adopted from a proposal submitted to the NSF by the Madison School District entitled, “Teaching Reflectively: Extending and Sustaining use of Reforms in Mathematics Classrooms.” This goal was chosen based upon research into how children learn mathematics. In our view, to be a reflective teacher means to adopt the following practices and views of teaching.

- A critical part of teaching is observing and listening to students, and then making educated judgments about the understanding that those students have about the mathematics.
- Judgments about the level of understanding of individual students are used to plan instruction that will move students forward in their mathematical understanding.
- An important dimension of teaching is that of constantly refining and improving one’s knowledge of how students think and develop mathematically in order to build strong background knowledge by: 1) continually learning more about research into how children learn mathematics; 2) observing students and thinking about what they say and do; 3) sharing ideas with colleagues about each other’s observations and the judgments that may apply to them, as well as discussing the interpretation of research; and, 4) refining one’s questioning skills—an important element in getting improved feedback

from students about their understanding of mathematics, as well as an important tool in helping students develop strategies for learning mathematics.

- Instructional materials, such as texts, are tools that are to be used as a part of planning and implementing instruction that builds on the background knowledge of students; they should not drive the instructional program.
- Much of mathematics instruction can be based on having students solve challenging problems for which they have the background knowledge to create procedures leading to solutions, then moving students toward more efficient procedures that build on those they created.

This definition focuses on pedagogy and does not explicitly mention content. It is important to note that mathematics content was the substance on which this pedagogical perspective was developed. Content knowledge was embedded in every phase of the project implementation.

Madison District—Student Performance Data

With the goals that were set for the project, the flexible leadership to address local needs, and having the benefit of half-time release for the MTL, how did student learning fare? While the project was not a research project, data routinely collected by the District provide a reasonably good estimate of student achievement over the years following the initiation of MTL. The following charts give an indication of student performance.

The Stanford 9 scores from 1997–2002 for each tested grade level are shown in Figure 1.

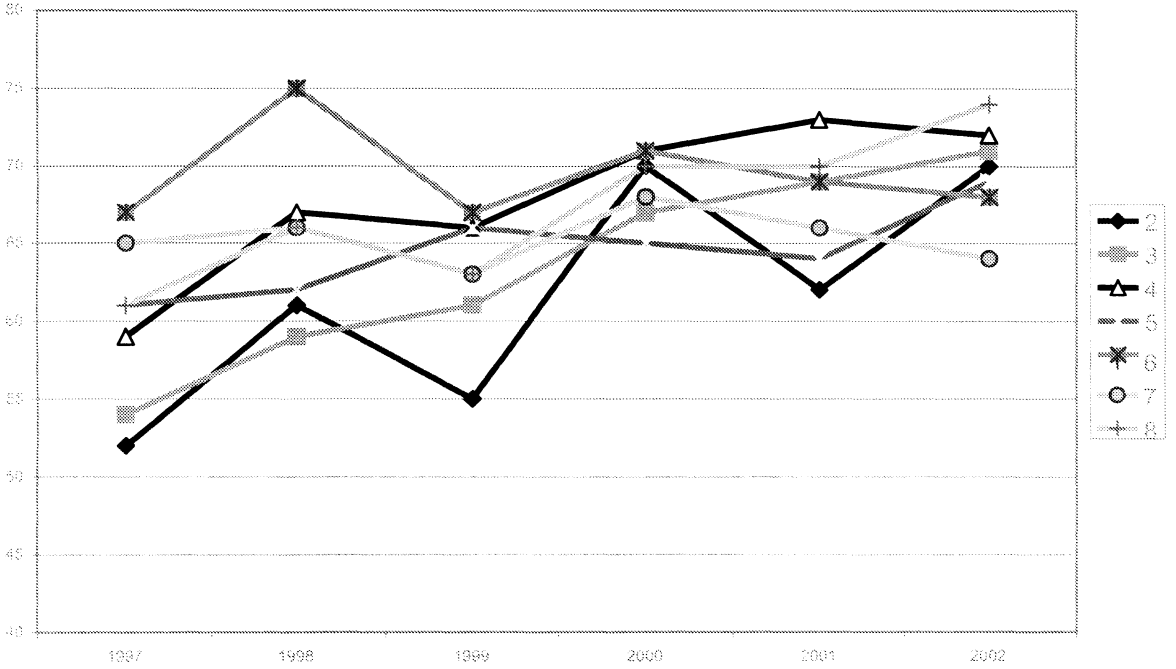


Figure 1. Stanford 9 mathematics scores by grade (1997-2002).

While there are fluctuations of the scores from year to year, Figure 1 shows the overall trend for most grades is in a strong upward direction. The exception is in grade 7, where there was resistance from some teachers to the pedagogical ideas of the project. Also, as indicated by Figure 2, during these same years (1997–2002), the student population became increasingly diverse. While this trend is often accompanied by falling test scores, the Madison District scores trended in an upward direction for most grade levels. Of course, it should be kept in mind that each year’s data came from a different group of students.

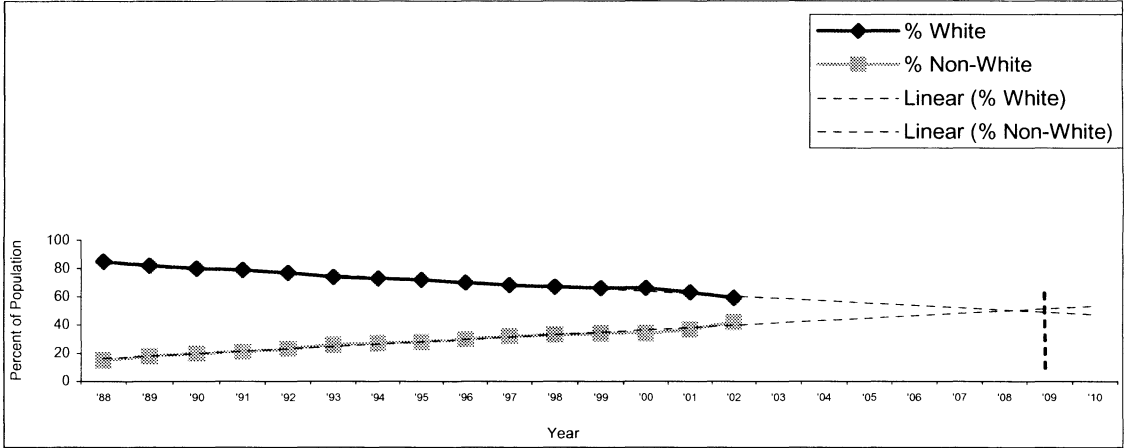


Figure 2. Ethnicity trends (long range).

The results on the Arizona State Mathematics Test (AIMS) also indicated high performance during the project (Figures 3–5).

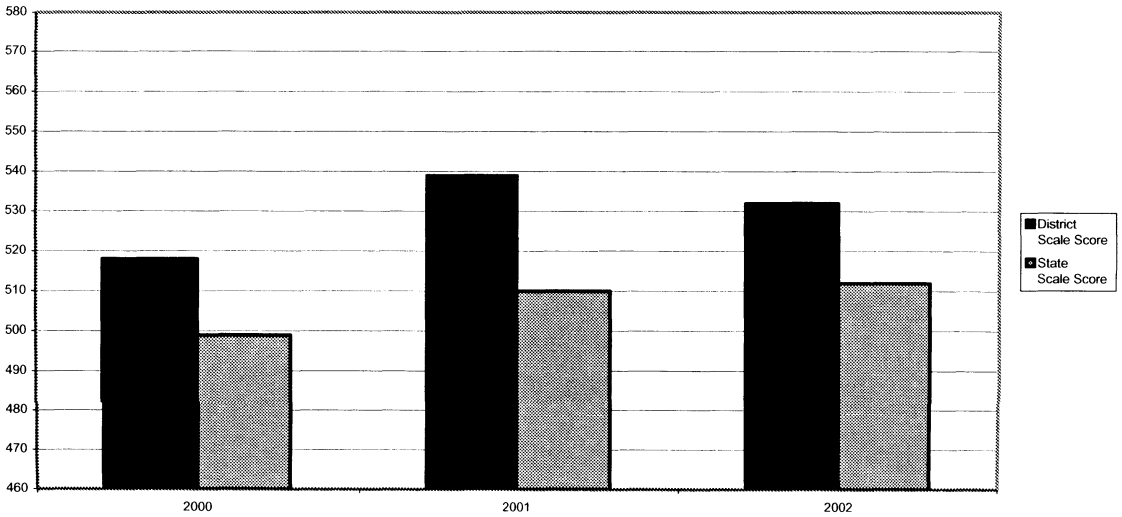


Figure 3. Grade 3 AIMS mathematics scale scores by year.

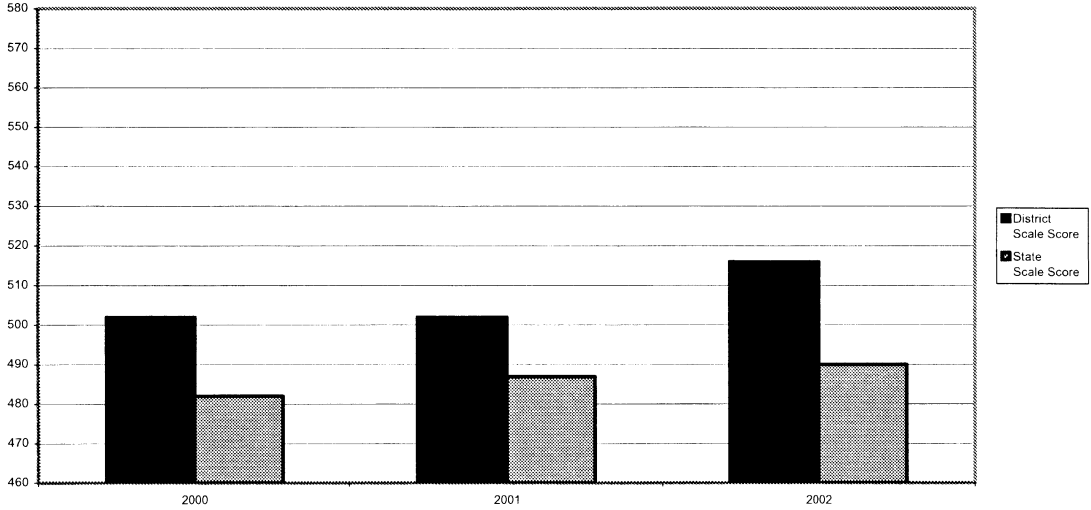


Figure 4. Grade 5 AIMS mathematics scale scores by year.

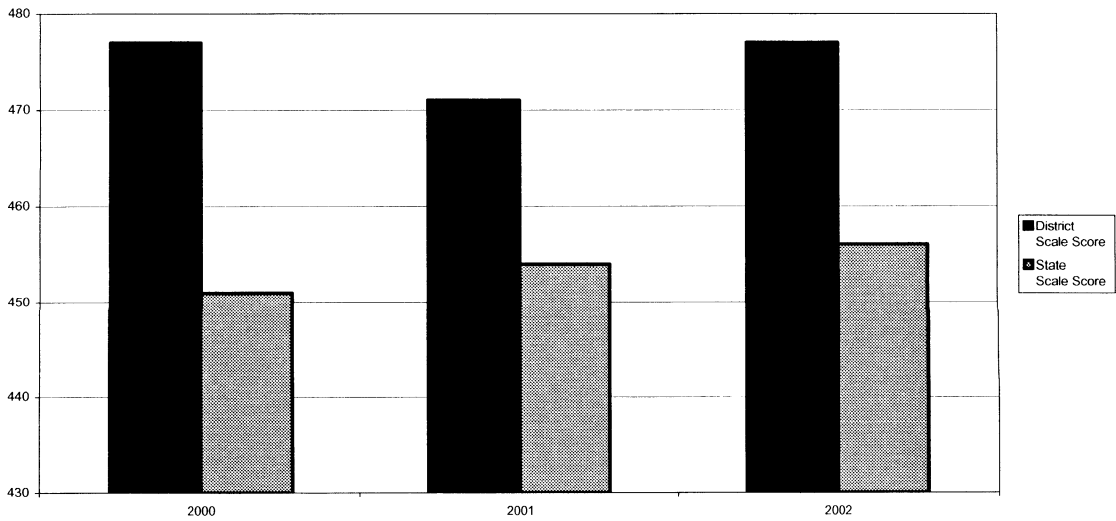


Figure 5. Grade 8 AIMS mathematics scale scores by year.

As another indication of progress, it can be noted that, over the years of the project, the percentage of students going into advanced mathematics classes on entering high school from the Madison District increased dramatically.

Madison District—Summary

While none of the preceding data are presented as a formal analysis, they do seem to indicate that the introduction of Mathematics Teacher Leaders to work with their colleagues and give thoughtful attention to ways of improving mathematics instruction was a positive move on the part of this school district. The emphasis on understanding and using student thinking as a fundamental component of teaching and learning mathematics, as fostered by the MTL, is a difficult change for classroom teachers to make. Their own experience as students, as well as their previous teaching, has almost always been based on a direct instruction model. The use of the MTL to assist teachers in making this transition seems to have been justified by the excellent student test performance, as well as the general feeling among teachers and administrators in the Madison District that students understand mathematics better and enjoy the learning of mathematics more. Mathematics Teacher Leaders, working in close cooperation with building principals who understood the pedagogical goals, seem to have contributed to excellent results for students in the Madison School District of Phoenix, Arizona.

It should be noted also that the Madison School District has elected to continue the Mathematics Specialist positions since NSF funding has ended. It was felt that the MTL program was value added to the instructional program.

The Hanover District

This Hanover district is in a suburb of Richmond, Virginia. It is a K-12 district and has both typical suburban schools and rural schools. Hanover County Public School district (HCPS) is a mixture of rural, small town, and suburban neighborhoods. The population has increased almost 50% over the past ten years and is projected to continue to grow. The HCPS currently has approximately 17,000 students in three high schools, five middle schools, and thirteen elementary schools.

Hanover County has received financial support from the ExxonMobil Foundation to implement a program of mathematics leaders in its elementary schools. Foundation funding *began in 1997* and has continued as HCPS has worked to maintain its mathematics leader

program by combining local funds with those received from the Foundation. While the outside funds have been relatively low, enabling the ExxonMobil Foundation to provide assistance to more school districts, they still have made a very large difference for Hanover County. Without this support, the program would not likely have been possible. Seed money such as this helped HCPS to initiate and maintain a Teacher Leader program in spite of the budget constraints that accompany relatively rapid growth of the student population. In turn, the Foundation has been able to gather information from HCPS that has been useful to other districts that have received funds.

Hanover District—Teacher Leaders

There are currently fifteen Teacher Leaders (TL) supporting classroom teachers in the Hanover district. Because of the budget limitations, these TL must work with their peers at times other than regular school hours; they do not have release time. Teacher Leaders are released for professional development workshops and meetings, but provide most of their in-school leadership through activities after school, individual contacts with their fellow teachers, and other activities. Teacher Leaders are called on to conduct professional development for other teachers on County professional development days when all teachers are released. The support they provide includes development and implementation of the HCPS curriculum, coordination of instruction and assessment with the Virginia *Standards of Learning (SOL)*, offering mathematics study groups for their peers after school, heading up preparation and delivery of mathematics programs for parents, and assistance with selection and organization of instructional materials to support the teaching of mathematics at the local school level [5]. The Teacher Leaders have been provided professional development through local workshops funded by ExxonMobil Foundation grants and through attendance at national meetings and workshops. The school district has supplemented grant funds to extend the training opportunities and to utilize the Leaders as curriculum developers during the summer. Several of the TL have entered graduate programs at a nearby university to specialize in elementary mathematics teaching. Some have completed this program while others are currently attending classes.

Professional development for the Hanover County TL has been provided primarily through workshops delivered by consultants. These workshops have generally occurred on six release days each school year. In addition, there has usually been a four-day summer workshop that combined curriculum development work with professional development activities. Mathematics content background and pedagogy have been integrated into the presentations of

these workshops. The pedagogical philosophy has been that of reflective teaching and modified constructivist strategies, much the same as that used in the Phoenix project. Teacher Leaders have often taken ideas from the workshops, tried them out with their students, and shared the results with their colleagues during the workshops. Often, the TL have given presentations at annual and regional meetings of the National Council of Teachers of Mathematics, here again sharing the ideas and understanding they have gained as a result of the ExxonMobil funding.

Certainly, this is a much less intense level of implementation and professional development than that described for the Madison District with its NSF funding. However, the goal in HCPS was the same as in the Madison District: to support Teacher Leaders who could encourage peer teachers to use reflective teaching strategies to increase and deepen the mathematical understandings of their students. In Hanover County, the high-stakes nature of the Virginia *SOL* testing program also required emphasis to be placed on enabling teachers to see how this way of teaching would move students to high achievement on the *SOL* tests. While this focus on testing was also an issue in Arizona, it didn't carry with it the same level of urgency. This pressure to succeed on the Virginia *SOL* tests was very significant for the school principals in Hanover County and, to some extent, complicated TL efforts in the early years of implementation. Principals did not have the opportunity to participate in any professional development activities initially. As a result, in some locations, the potential effectiveness of the reformed teaching strategies for producing excellent results on the *SOL* tests was not accepted. The flexibility with which the local schools implemented the mathematics Teacher Leader program was considerable. Partially because the building principals did not initially participate in professional development with the TL, there was more emphasis on teaching directly to the *SOL* tests in some schools. During the 2002-2003 school year, the elementary principals participated in the *Lenses on Learning* program conducted by the district-level mathematics Teacher Leader [6]. This provided the opportunity for greater understanding, acceptance, and implementation of reflective teaching.

The Teacher Leaders in HCPS provide a variety of types of support for their fellow teachers. As indicated above, they conduct district-level workshops on professional development days. These have generally been grade-level specific. Since the members of the TL are representatives from all grade levels except fourth, this has allowed them to comfortably divide the responsibilities for these workshops. At their local schools, many TL conduct after-school mathematics study groups for teachers who are interested in learning more about mathematics

content and the reflective teaching of mathematics. These study groups focus on a variety of topics which are often determined by the teachers who participate. Communication with parents is facilitated through family math nights and other meetings for parents. While the current district adopted textbook is traditional, the NSF-supported reform program, *Investigations in Number, Data, and Space*, has been made available to teachers as a supplement [1]. Teacher Leaders support their colleagues who want to implement this program in whole or in part. The TL, working together with fellow teachers, select for school purchase manipulative materials that support the mathematics program. Ideas for the effective use of these materials are shared through workshops and individual interactions. Fellow teachers are sometimes invited to observe in the classrooms of the TL.

Hanover District—TL Activities

Study groups are used by most of the TL. An example of this is the Teacher Leader whose study group decided to explore the teaching of geometry. Five teachers met for six weeks, once each week for two hours after school. They explored the formation of open-ended problems for students to solve in geometry. Some of their activities included:

- Looking at examples of student thinking;
- Audiotaping their own lessons and analyzing the questions they were asking students;
- Sharing ideas and research information about reflective teaching; and,
- Implementing similar lessons in their various classrooms and bringing back student work to share and discuss.

Teacher Leaders reported using a variety of other activities:

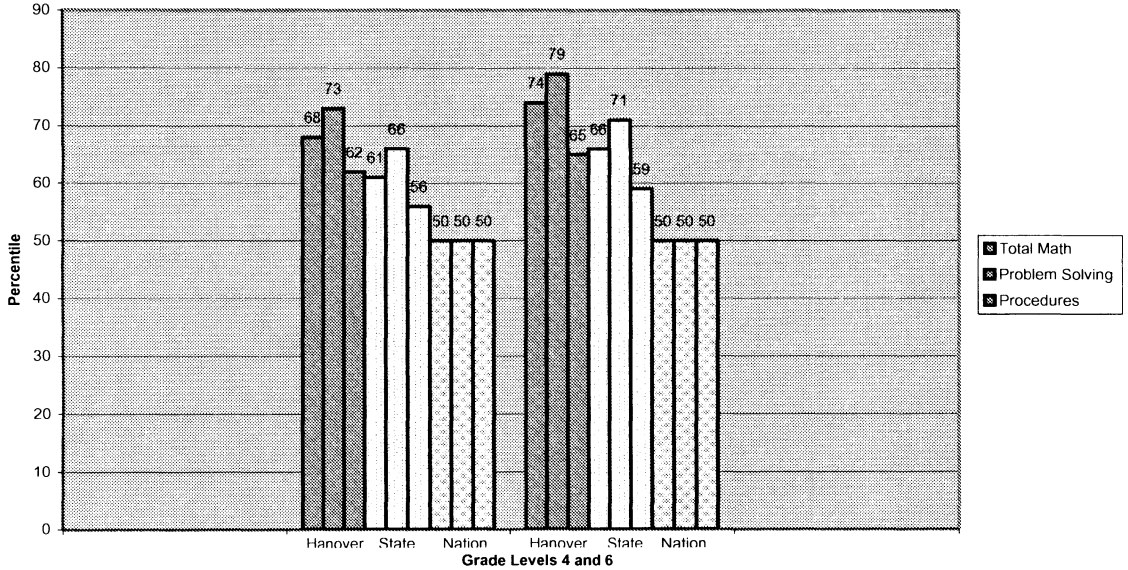
- Formed a math committee with a representative of each grade level for the school;
- With the committee, planned a family math night;
- Provided leadership for a “Math-a-lon” to raise funds from the community for the purchase of manipulative materials;
- Provided information and demonstration lessons for school board members;
- Mentored a new teacher;
- Inventoried and relocated the “math closet” that houses manipulatives;
- Presented at faculty meetings;
- Led in-service sessions for countywide groups of teachers; and,

- Worked in the summer week-long workshop to write instructional guidelines to assist teachers, whether using the traditional text or the reformed text, to be more reflective in their teaching.

Hanover District—Student Performance Data

Given the less intensive implementation of Teacher Leaders for mathematics in the Hanover district, has there been a positive result for students? As with the Madison District, there has been no formal evaluation of student progress that can be directly attributed to the TL program. As mentioned previously, the nature of this district is quite different from the Madison District. The assessment tools used by the district are also quite different. Clearly, the nature and implementation of the TL program is also very different from the MTL program in Madison. It is not really appropriate to compare the informal results between these two districts. However, treating them as completely separate examples with extremely different characteristics may make their separate results even more interesting. The student performance data for grades 4 and 6 from the Hanover system indicate strong performance on mathematics achievement assessments when compared to the statewide results. The chart below shows the scores on the Stanford 9 test for the 2001 school year. The TL professional development program had been in place since 1997. The highest achievement is in the area of problem solving, an area of particular importance and emphasis in the TL professional development activities.

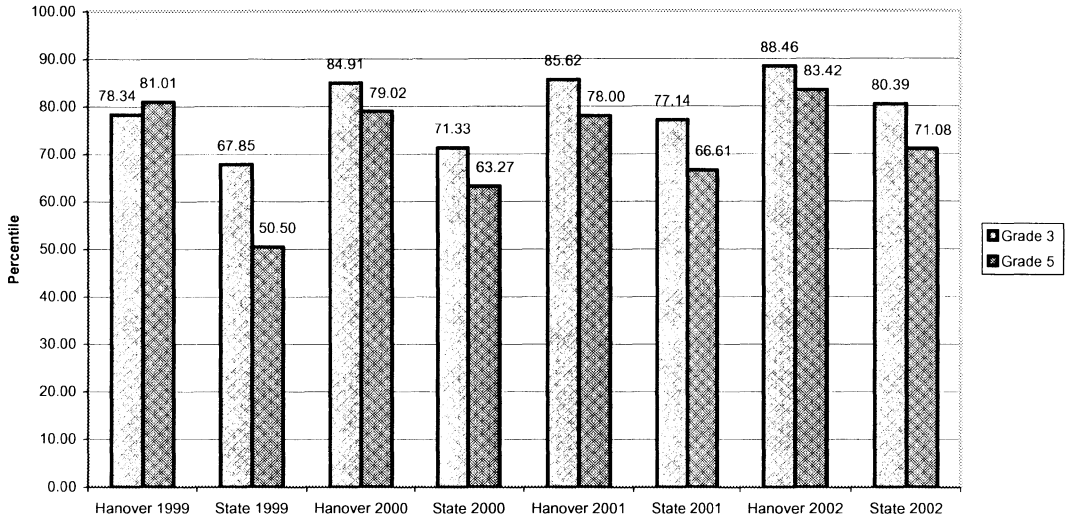
**Table 1
Stanford 9 TA 2001**



Both the state results and those of the Hanover district exceed the national average for the tested elementary school grade levels, 4 and 6. The Hanover scores are above the statewide performance at both grade levels and in all three of the subscores.

The *SOL* achievement tests are the tests of primary interest in Virginia. Table 2 indicates the performance of the Hanover County district and the statewide results for four school years and two grade levels, 3 and 5. As with the Stanford results, the Hanover district exceeds statewide performance in every school year for each of the grade levels. Note also that the trend for each grade level is upward, both for Hanover and the Commonwealth of Virginia. The results in each of the years represent the performance of a different group of students, so fluctuations would be expected. Each new group can be seen as demonstrating higher scores than the preceding one.

Table 2
Virginia Standards of Learning Test



The scores at grade 5 for the year 2001 would represent the performance of many of the same students who were tested in grade 3 during the 1999 school year. While the data indicate a drop of slightly more than 1 percentile from grade 3 to 5 for the state, the Hanover students essentially kept their achievement level, dropping by only about 1/3 of a percentile. Grades 3 through 5 maintained about the same trend as the Commonwealth from 2000 to 2002, the scores in both for those years were very nearly holding steady. Given the high level of the Hanover scores, one might conjecture that they may have been experiencing what is called a “ceiling effect.” Given a diverse population, what is the highest performance one might expect on the *SOL* test?

Do the data from these two tests tell anything about the effectiveness of the TL program? There is no basis for claiming that. The scores for both Hanover County and the Commonwealth trended upward over the years displayed for grade 3. For grade 5, Hanover scores stayed relatively level, with a slight upward jump in 2002. Overall state scores had an upward trend for grade 5 across all four years. Hanover scores have stayed considerably above the statewide averages each year. It is generally accepted that improving scores that are low is easier than getting the same improvement in scores that are already high. The TL program may or may not have played a role in the increases and high performance by Hanover County students. However,

it can be noted that the problem solving scores stood out well above the other subtests on the Stanford, and seeing this continual high performance on the *SOL* test, accompanied by generally positive responses from students, parents, and administrators provides a combination of results that are supportive.

Because the emphasis in the TL program has been on problem solving and encouraging students to make sense of the mathematics, rather than on focusing only on the *SOL* test, it could be argued that students are gaining a perspective on mathematics that would not be gotten by focusing directly on the content of the tests. The fact that the scores were high and trended upward is a plus. It is often argued that making significant changes in the way a subject is taught will cause an initial decrease in student performance. It would certainly seem that such is not the case in Hanover.

Moving to a nontraditional approach for teaching mathematics is not easy for teachers at any level. For elementary teachers, it is challenging because many of them do not have a great deal of confidence with respect to mathematics and its teaching. Having a Teacher Leader in the building can help make the transition easier and alleviate some of the anxiety about mathematics content. The activities used by the TL in their local buildings have the potential to do that.

Closing Remarks

My experiences in working with these two school districts as they designed and implemented the MTL and the TL programs have convinced me that Teacher Leaders are virtually essential to maximizing the potential of classroom teachers for getting the best from their students. Schools and school districts should find ways, either through budget additions or resource allotments, to implement such programs. The gains are more valuable than the costs. This is particularly important in the typical school setting where classroom teachers often lack strong mathematics backgrounds. The structure of our schools is such that the classroom teacher is isolated and has sole control over the content and pedagogy that is experienced by the students. There are those who would argue that imposing particular assessments takes away that control, but it really doesn't. What each teacher does to move students to achieve on the assessments is governed by the teacher. If "drill and kill" is the only thing that seems available to a teacher, then that is what will happen. A Teacher Leader can help teachers see better options. Many school administrators have as little background in mathematics content and pedagogy as their teachers. At best, they cannot provide the support that would be provided by a Teacher Leader. At worst,

they may actually promote rote learning of test items. If we are to have mathematics programs that help students achieve good results in today's atmosphere of heavy emphasis on tests, **and** make sense of the mathematics they are learning so that they can use that mathematics effectively in future mathematics courses and daily life, then we need to provide the kind of support that Teacher Leaders can provide.

What are some things that seem to be essential for an effective Teacher Leader program? A few suggestions are outlined below.

- Provide a professional development program for Teacher Leaders and classroom teachers that integrates content knowledge with pedagogy that enables students to make sense of mathematics.
- Help building administrators gain enough understanding of the pedagogy to effectively support the program implementation as they observe and evaluate teachers.
- Recognize that getting teachers to make significant changes in their pedagogical approaches is a long-term task.
- Provide support in the way of release time and resources so that leaders and teachers will not be frustrated. This includes manipulative materials, but these need not be unreasonably extensive or expensive. Once teachers focus on the “big ideas” of mathematics and see that the manipulatives are only one of the possible ways to represent those ideas, this expense can be controlled and/or spread out over a reasonable time frame.
- If at all possible, provide time during the school day for the Teacher Leaders to carry out their responsibilities. This can shorten the time for successful implementation and minimize the resistance of teachers who are reluctant to make changes in practices they have used for years.
- Recognize that high achievement on the part of some students using current traditional methods does not necessarily indicate that those methods are truly effective. Such achievement may occur *in spite* of those practices. In my experience, many high achievers who got there because they memorized what the teacher or text said, later dropped out of mathematics when they could not succeed in higher mathematics courses through that strategy. All students, high and low achievers, can benefit from mathematics

classes that emphasize the fact that what is done with mathematics should make sense, rather than just getting an answer that pleases a teacher or test developer.

References

- [1] *Investigations in Number, Data, and Space*, TERC, Cambridge, MA, 1998, Internet: <http://investigations.terc.edu>.
- [2] *Connected Mathematics*, TERC, Cambridge, MA, 1998, Internet: <http://investigations.terc.edu>.
- [3] T.P. Carpenter, E. Fennema, P.L. Peterson, C.P. Chiang, and M. Lof, "Using Children's Mathematics Thinking in Classroom Teaching: An Experimental Study," *American Educational Research Journal*, **26**(4) (1989) 499-531.
- [4] *Principles and Standards for School Mathematics*, National Council of Teachers of Mathematics, Reston, VA, 2000.
- [5] *Standards of Learning for Virginia Public Schools*, Board of Education, Commonwealth of Virginia, Richmond, VA, 1995.
- [6] C.M. Grant, B.S. Nelson, E. Davidson, A. Sassi, A.S. Weinberg, and J. Bleiman, *Lenses on Learning: A New Focus on Mathematics and School Leadership*, Dale Seymour Publications, Parsippany, NJ, 2002.