

Rationale

Background

Over the past three years, component districts have invested numerous resources in the professional development of their math teachers. Math Solutions has provided the primary vehicle for that professional development. The courses, as designed, provide math teachers with content and pedagogy that promises to engage all students in the learning of meaningful mathematics. With the first group of teachers attending Math Solutions in the summer of 2000, we would anticipate seeing improved student results beginning with the 2001 test administrations. The purpose of this study is to measure the impact of this investment on student achievement.

The Evaluation Model¹

Effective professional development evaluations require the collection and analysis of five critical levels of information. With each succeeding level, the process of gathering evaluation information gets a bit more complex. And because each level builds on those that come before, success at one level is usually necessary for success at higher levels.

Level 1: Participants' Reaction

¹ Guskey, Thomas. R. Does it make a difference? Evaluating Professional Development. *Education Leadership*. March 2002. Vol 59: 6: 45-51.

The first level of evaluation looks at participants' reactions to the professional development experience. This is the most common form of professional development evaluation, and the easiest type of information to gather and analyze. While we have regional Math Solutions evaluations compiled, we will also gather specific information from teachers in districts that have been selected as part of a more in-depth analysis.

Level 2: Participants' Learning

In addition to liking their professional development experience, we also hope that participants learn something from it. Level 2 focuses on measuring the knowledge and skills that participants gained. Although you can often gather Level 2 evaluation information at the completion of a professional development activity (and we did this with the regional math solutions evaluation form), it requires more than a standardized form. Measures must show attainment of specific learning goals. Moving forward at this level, therefore, will also require gathering additional and specific information from teachers in districts selected as part of a more in-depth analysis.

Level 3: Organizational Support and Change

At Level 3, the focus shifts to the organization. Lack of organizational support and change can sabotage any professional development effort, even when all the individual aspects of professional development are done right. At level 3, you need to focus on questions about the organization characteristics and attributes necessary for success. Interviews with teaching staff and administrators can help identify the organization characteristics and attributes contributing to math success.

Level 4: Participants' Use of New Knowledge and Skills

At Level 4 we ask, did the new knowledge and skills that participants learned make a difference in their professional practice? The key to gathering relevant information at this level is specifying clear indicators of both the degree and quality of implementation. Unlike Levels 1 and 2, this information cannot be gathered at the end of a professional development session. Enough time must pass to allow participants to adapt the new ideas and practices to their settings. Because implementation is often a gradual and uneven process, you may also need to measure progress at several time intervals. Interviews with teachers and direct observation of math instruction might provide the needed data for this research effort.

Level 5: Student Learning Outcomes

Level 5 addresses “the bottom line”: How did the professional development activity affect students? Did it benefit them in any way? Evaluations should always include multiple measures of student learning. Analyzing State and local math assessment data, teaching artifacts, and student work would help us to answer these questions.

For more information on each of these levels, please refer to the attached chart. We believe that, by using these five levels of information in our evaluation of the Math Solutions initiative, we can collect good evidence about whether this professional development program has contributed to specific gains in student learning.

The Criteria for District Selection

We have used the following criteria to select districts for participation in this study.

These criteria include:

- 45% or more of teacher participation in Math Solutions (1 or more courses)
- Increased scores on State math assessment from 2000 to 2002

Six districts met the above criteria, three at each level, thereby ensuring a broad representation of component schools. The districts participating in the study are as follows:

Elementary Level

- Frankin
- Otselic Valley
- Oxford

Middle School

- Franklin
- Greene
- Walton

The Process

1. Contact superintendents and principals and request participation.
2. Collect and ensure accuracy of Math Solutions participation in selected districts
3. Develop data collection instruments
4. Visit districts to:
 - a. Survey Math Solutions participants regarding reaction to, and learning and application of, new knowledge and skills

- b. Interview Math Solutions participants and administrators on organization support change mechanisms
 - c. Observe classroom math practices
- 5. Collect and analyze student outcomes measures, including but not limited to:
 - a. Key Idea analysis
 - b. Item analysis
 - c. Collection of teaching artifacts
 - d. Student work analysis
 - e. Analysis of local, “off year” math assessments
 - f. AIS data
- 6. Analyze all district data to:
 - a. Identify any potential correlations between participation in Math Solutions initiative and student success
 - b. identify district practices that support the application of math solutions to teachers’ classroom practice
 - c. inform the future development of professional development in the area of mathematics
 - d. identify “next steps” for this research
- 7. Share, disseminate and discuss research findings and recommendations

Data Collection Tools

Quantitative Data

Walk-Through Summary

A Walk-Through was completed for each of the participating districts. Twelve classrooms were witnessed; three being elementary level classrooms and the rest of the classrooms consisting of grades 6 through 8. Observations and conversations were recorded using a checklist. (Appendix ???)

The first item examined was the availability of manipulative materials for student use. Math Solutions encourages the use of manipulative materials to build and reinforce conceptual understanding of mathematics. Typically, the elementary classrooms observed exhibited more availability and access to manipulative materials than the middle school classrooms did. All three of the elementary classrooms offered manipulative materials and had stations set up with student activities. While manipulative materials were in storage in many middle school classrooms, they were not readily accessible to students. For two of the five districts observed there was no evidence that manipulative materials were offered in middle school classrooms for student use.

The arrangement of student seats was also observed. Math Solutions encourages cooperative work among students, therefore seating should complement their ability to work in groups. In the elementary classrooms observed, the students' seats were arranged in small groups of three or four, with the exception of one classroom where student seats were arranged in a large rectangle in the center of the room to facilitate easy movement to the centers on the outskirts of the room. In two middle level classrooms observed, the card method for grouping students (as modeled at the Math Solutions training) was utilized. Many of the middle school classrooms had student seats arranged in triads or clusters of four desks. One classroom had seats arranged in rows, but had students working with a partner. This teacher commented that she often had

students move desks from the rows into groups, but that rows were necessary for instruction and testing.

Math Solutions suggests some “permanent” work stations devoted to hands-on math choices for students which they call menus. While these work station activities may change depending on the concepts being explored, the design of student choice and constructivism learning philosophy should be customary. In examining elementary classrooms, evidence of a variety of work stations or centers existed, but they were not necessarily devoted solely to the study of mathematical concepts. They encompassed all content areas. At the middle school level three of the nine classrooms observed offered some variation of menus. One classroom offered a Problem of the Week (POW) station which offered a choice between two similar problems as well as an Enrichment Center offered for students who finished work early.

Another item common to Math Solutions is that the math charts displayed are student-developed, based on their conceptual understanding. Ten of the twelve classrooms viewed displayed charts relating to math. None of these charts at either elementary or middle level were student made. While one classroom had teacher-made charts displayed, the other eight offered commercially manufactured charts for display.

Engaged and participating students are ubiquitous in a Math Solutions classroom. For the most part, students showed evidence of being actively engaged and participating positively throughout the lessons observed. This was not dependent upon the lesson being of a constructivist nature. In the elementary classrooms, it was noticed that students were very comfortable with the routines developed for group and station work and listening intently during the reading of a math-related picture book. Middle school students who were involved in center or group work demonstrated similar behaviors as those who were observed doing rote tasks. In

one 7th grade classroom, during homework review during the first fifteen minutes, about 50 percent of the students were disengaged. When the same class of students moved into a hands-on exploration of various 3-dimensional figures, engagement and participation increased significantly. In another middle level classroom, students were practicing solving algebraic equations on the blackboard with no hands-on exploration involved and these students were also very engaged and participatory in a positive manner.

Central to Math Solutions is problem-solving. Reference to a problem-solving list of strategies posted in the classroom is an integral part of helping students think and reason mathematically. In the elementary classrooms, charts witnessed referred to basic operations. None of the elementary classrooms observed displayed the problem-solving strategies. Only one of the nine middle level classrooms displayed charts listing the problem-solving strategies. The sixth grade classroom that did display the manufactured “Steps for Problem-Solving” addressed the process of problem-solving and not the various strategies available for students to use in solving problems.

The use of calculators is extensive in a Math Solutions program and the availability and accessibility of calculators was considered necessary in our analysis. In the elementary classrooms there was no evidence of calculators being available to students. In the middle level classrooms observed, one classroom had calculators easily on hand and students used them as needed without teacher direction to do so. Three other middle level teachers made calculators available, either on student request, or as they determined when they could be used by students. These teachers retained control over when and how the students could utilize the calculators. None of the other five middle level classrooms offered or made calculators available during the observations.

Evidence that writing relating to math occurred in these classrooms was also looked for. There was not an opportunity to witness math-related writing in any of the three elementary classrooms visited. The degrees to which students must explain their mathematical reasoning in middle level classrooms varied. One of the teachers had students verbally explain their math reasoning aloud so that other students could hear that student's reasoning. Two classrooms from differing districts opened with two "Bell Ringers" on the blackboard. For each problem presented the students were required to write a one sentence explanation of how they solved each problem. Sharing of various solutions and processes was then facilitated by each teacher. Math journals were present in two other middle level classrooms, but not utilized during this observation.

The use of literature books relating to mathematical concepts should be evident in a Math Solutions program. One of the three elementary classroom teachers opened the lesson with a picture book read aloud to the students. There was no evidence in either of the other two elementary classrooms that books were integrated into math to build or reinforce concepts. One sixth grade teacher had literature books in her classroom which could be related to math. One seventh grade teacher mentioned that she introduced a math-related book each unit, but not until after the unit test. None of the other middle level teachers utilized literature throughout math instruction.

Elementary scheduling allows for much flexibility in the amount of time allotted to math on any given day. Lessons observed ranged from 20 minutes to an hour. Eight of the nine middle level classes had traditional schedules allowing a range of 30 minutes to 40 minutes per day of math instruction. One middle level class consisted of 76 minutes of math instruction every other day because of an alternating block schedule.

There are varying levels of collaboration among the teachers in classrooms observed. Many of the middle level teachers share the same prep time. Some teachers purposefully establish collaborative meetings during this time; while with other teachers collaboration happens by chance during this time. Some of the middle school teams meet daily and some meet weekly. Some complain that the meeting time is not structured while other district teachers feel it is too structured. Two of the districts are working to meet and establish vertical alignment of the material covered at each grade levels. In some situations, the teachers work in full isolation from their colleagues.

Teacher Survey and Comments

Prior to the visit and during the walk-through, teachers answered a variety of questions designed to measure the frequency of the use of various components of Math Solutions. Some of the teachers who participated took time to fill out the interview questionnaire developed for this evaluation. All were willing to take time to discuss the questions in the Teacher Interview as well as other questions which arose as a result of the evidence witnessed during the walk-through. Of the teachers interviewed, one had completed both level 1 and level 2 of the Math Solutions Course. Nine teachers had completed level 1 of the Math Solutions Course. One teacher had received no Math Solutions training, but felt that she was knowledgeable enough in the constructivist philosophy and utilized the methods, referring to resources from Marilyn Burns. One teacher did not indicate which level of Math Solutions training, bringing the total number of teachers interviewed to 12.

Teacher practices from Math Solutions examined to help students learn mathematics were: use of questioning techniques to stimulate a variety of solutions, student collaboration and interaction, writing activities incorporated into math instruction and assessment, use of literature to enhance math instruction, use of true problem-solving, use of menus and student choice, connections with other disciplines, and collaboration with other teachers.

While all teachers responding indicated some degree of incorporating questioning techniques, student collaboration, and integrating math with other disciplines, 50% of the total teacher interviewees indicated that they did not use menus as a way to offer student choices. Two-thirds indicated they occasionally included writing activities into math. One-third utilized literature to enhance math instruction. Also, only one-third differentiated between problem-solving and basic word problems. One teacher indicated no collaboration with other teachers, while 50% indicated collaborating frequently or to a great extent with other teachers. Teachers who commented indicated that as remedial math teachers they felt limited as to the possibilities of doing these activities with students because of the nature of their job. Many felt that as a push-in instructor in a regular classroom it was their role to help students with the regular classroom instruction, rather than to facilitate hands-on choices for students. They felt this would intrude on the regular classroom teacher's method of instruction.

Teacher perception of administrative support in the implementation of Math Solutions was assessed through asking about: administrator's availability for providing guidance, administrator's response to barriers to implementation, provision of adequate planning time with colleagues in scheduling, and provision of resources for the implementation of Math Solutions.

About 50% of the teachers indicated that the administration occasionally was available to provide guidance on the implementation and instruction of Math Solutions. One third of the

teachers felt administration was available frequently or to a great extent, with one teacher indicating administration was not at all available to provide guidance. All but one teacher felt administration at least occasionally responded promptly to barriers to the implementation of Math Solutions. Two-thirds of teachers believe administration has provided adequate planning time with colleagues, but one-fourth deem administration has not accomplished this at all. All teachers felt administration has at least occasionally provided resources to access math manipulative materials. Teachers commented that manipulative materials were in vast supply and utilized often. For further administrative support, teachers would like to see time (suggested $\frac{1}{2}$ conference day) to work with colleagues on creating menus and sharing successes with the implementation of Math Solutions.

Evidence was examined which indicates conditions where student learning has been impacted as a result of Math Solutions training. Seventy percent of the teachers responding to the question felt that students demonstrated successful application of key concepts as a result of Math Solutions being incorporated into the classroom. Nearly 50% believes student scores on local or state assessments increased occasionally while one teacher felt they did not increase at all on either local or state assessments. All teachers felt at least occasionally or frequently students ability to think critically and analytically were increased as a result of implementing Math Solutions pedagogy in the classroom. All but one teacher felt students demonstrated the ability to connect math to other disciplines. One teacher responded that she was waiting for the state assessment results since her first attempt at implementing Math Solutions and could not respond fairly to this particular section of the survey. One teacher identified time as a barrier to full implementation of Math Solutions pedagogy and felt that it was unrealistic to teach using this method all the time. "Students still don't make connections from one situation to another,

recognizing the use of a math concept in many situations,” was the perception presented by one teacher.

Teachers also shared their perceptions about student behavior and attitude toward math as a result of the implementation of Math Solutions, including: increased engagement in math lessons and activities, increased motivation for learning, conversations among peers about math, increased attendance, decreased discipline referrals, increased confidence in math ability, risk-taking in discovering solutions to problems, and spending time on math outside of class.

All teachers reported at least occasional increase in engagement and motivation, with one teacher indicating these occurred to a great extent. All but one teacher witnessed the occurrence of conversations among peers about math and its use in various aspects of life and learning. One third of the teachers did not evidence an increase in attendance. There was also no significant evidence demonstrating major decreases in discipline referrals. More than 50% of all teachers indicated an increase in math confidence and risk-taking among their students and nearly 50% indicated evidence of students spending time on math outside of the classroom.

Many of the teachers responding indicated that their instructional practices have changed as a result of the Math Solutions training. The focus of these changes appears to be an increase in the use of math manipulatives to teach and reinforce concepts. Several teachers commented on using more effective questioning techniques and considering multiple solutions and representations of solutions by students rather than focusing on one right answer. It seemed that the younger the students, the more difficult the teachers found adapting the ideas.

Utilizing the Math Solutions approach to instruction is perceived by the teachers to have an impact on student learning. Increases in collaboration between students and students teaching other students are noted. Students appear to be more willing to try various methods or strategies

for solving problems as well as demonstrating a greater interest and enthusiasm for mathematics. One teacher felt that while there was more reasoning occurring with her students, rote memorization had been sacrificed.

The greatest continual need for support teachers requested is the time necessary for adapting curriculum, creating activities, gathering materials, preparing menu activities, and more support for interaction with other teachers. Several teachers commented on their desire to continue by completing the level 2 of the Math Solutions Course.

During the course of the walk through observations, many teachers commented and expanded on ideas discussed.

Resources

Guskey, Thomas. R. Does it make a difference? Evaluating Professional Development. *Education Leadership*. March 2002. Vol 59: 6: 45-51.