The Journal of Mathematics and Science: COLLABORATIVE EXPLORATIONS

Volume 14, Fall 2014

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Principals and Mathematics Specialists Partnering to Support High Quality Mathematics Instruction

PART II: REGULAR JOURNAL FEATURES

Virginia Mathematics and Science Coalition
The Journal of Mathematics and Science:

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SPECIAL ISSUE
Principals and Mathematics Specialists Partnering to Support High Quality Mathematics Instruction

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Today more than ever principals and teachers are called upon to provide a rigorous mathematics program so that every student reaches mathematical proficiency. Schools in Virginia, as well as nationally, need support to increase their capacity in order to provide every student with mathematics learning experiences to attain the five strands of mathematics proficiency: 1) understanding, 2) computing, 3) applying, 4) reasoning, and 5) engaging [1]. The Virginia Mathematics Specialist Initiative (VMSI) began over fifteen years ago and continues today under the auspices of the Virginia Mathematics and Science Coalition (VMSC) and with endorsements from the Virginia Council of Teachers of Mathematics (VCTM) and the Virginia Council of Mathematics Supervisors (VCMS). The VMSI efforts have included securing funding from the State Council of Higher Education (SCHEY) and four National Science Foundation (NSF) grants to create, among other things, a model preparation program for Mathematics Specialists to enable them to provide school-based support for schools to improve their mathematics program. This article presents key events within the VMSI that revealed the critical role a principal plays in leading the school's mathematics program, and the need for a principal to engage in professional learning opportunities to increase his/her capacity to provide effective leadership for mathematics education. In addition, a description is shared of the subsequent evolution to a well-defined Principals Partnering Institute in order to develop principals' capacity to lead and share leadership for a rigorous mathematics program that prepares mathematically proficient students. Lastly, a description of curriculum that supports the Principals’ Institutes and the efforts to take the Institutes statewide is presented.
Setting the Stage: Early Grant Work

In 2002, the VMSC appointed a task force to investigate how a Mathematics Specialist embedded in a school could impact mathematics teaching and learning. The Mathematics Specialist Task Force was charged with making recommendations for the potential roles and responsibilities a Specialist might assume and about the preparation a Specialist would need to effectively support teachers and administrators in their efforts to improve student learning. The Mathematics Specialist Task Force recommended that well-prepared Mathematics Specialists be placed in elementary and middle schools to support teachers in developing stronger mathematics knowledge and instructional practices for teaching so that every Virginia student could reach higher levels of mathematics achievement.

More specifically, the Task Force report asserts the importance of the Mathematics Specialists “working with the building-level administrator” since classroom teachers “must make changes in their instructional program and practices” [2]. The need for the principal to provide effective leadership for improving mathematics instruction became increasingly clear when Virginia Commonwealth University (VCU), University of Virginia (UVA), Norfolk State University (NSU), University of Maryland (UM), and the VMSC, along with the school divisions, partnered in two National Science Foundation (NSF) grants: the “Mathematics Specialist: Research Study and Pilot Study” (2004-2009) supported by the Teacher Professional Continuum (TPC) program; and, the “Preparing Virginia's Mathematics Specialist,” supported by the Mathematics and Science Partnership (MSP) program.

The NSF-TPC grant supported a comprehensive research study on the impact of two cohorts of twelve well-prepared Mathematics Specialists on student learning in the twenty-four treatment schools they served. To prepare for the roles of Mathematics Specialists, the teachers completed five mathematics content and three mathematics education leadership graduate courses that were collaboratively designed through partnership among six universities (University of Virginia, Virginia Commonwealth University, Norfolk State University, Longwood University, George Mason University, and Virginia Tech) and school division mathematics leaders. The first cohort (Cohort I) of twelve Mathematics Specialists assumed roles in the treatment schools in Fall 2005. A one-day seminar was provided in Spring 2005 for principals and their Specialists to raise principals' awareness about how a Mathematics Specialist was prepared to support teachers and
how they as principals could support their Specialist. Cohort II and their principals participated in a similar seminar in Spring 2006.

As Cohort I Specialists began working in the schools, the grant management team systematically solicited suggestions about additional support the Specialists needed to be successful. The management team was intentional about listening to central office mathematics leaders from the school divisions, as well as the Specialists themselves, when formal and informal opportunities arose to have conversations and collect data about what supports and assistance seemed to contribute to the effectiveness of the Mathematics Specialists in carrying out their roles and responsibilities. Virginia has agreed upon a statement concerning the work of full-time, school-based Mathematics Specialists:

Mathematics Specialists are teacher leaders with strong preparation and background in mathematics content, instructional strategies, and school leadership…. Mathematics Specialists are former classroom teachers who are responsible for supporting the professional growth of their colleagues and promoting enhanced mathematics instruction and student learning throughout their schools. They are responsible for strengthening classroom teachers’ understanding of mathematics content, and helping teachers develop more effective mathematics teaching practices that allow all students to reach high standards as well as sharing research addressing how students learn mathematics.

The statement then concludes with the specific responsibilities of all Mathematics Specialists.

The novice Mathematics Specialist received support through two-day, grant-supported workshops each semester of their first two years, and each Specialist was concurrently enrolled in the last of three leadership courses during their first year. A member of the grant management team and one of the authors of this article served as an instructor for the course and purposefully designed course projects, reflection journal prompts, and in-class activities to provide ongoing support for the novice Specialists.

The discussions during the workshops and the leadership course and, in particular the reflection journals, illuminated the Specialists’ opinions that the principal was instrumental in
how effective they were in providing support for teachers and also impacting change in the school's mathematics program. For example, they believed that teachers more readily allowed the Specialist to come into their classrooms and accepted the Specialist's help with planning when the principal made public a clear vision for the school's mathematics program. In addition, when both the principal and the Specialist were advocating for a mathematics program that balanced understanding concepts with developing skills, the teachers were more open to moving away from a teacher-centered classroom to a more student-centered classroom. An emerging realization for the management team was that not every principal was proactive in letting teachers know his/her expectations for the mathematics program and ways the Specialist would support teachers. In some cases, teachers were receiving conflicting messages. The principal was directing teachers to concentrate on procedures and a narrow curriculum to prepare students for state assessments and the Specialist was encouraging teachers to use more tasks and engage students in inquiry learning. The information shared from central office leaders on the grant management team reflected what was shared by the Mathematics Specialists.

The feedback from principals of the NSF-TPC Cohort I Mathematics Specialists was positive and also provided information about what professional learning opportunities could be helpful for them. For example, a principal reported that having a Mathematics Specialist enabled her to gain valuable insight into how students process mathematics concepts. She attended grade-level meetings as often as she could to support the Specialist and to stay abreast of mathematics instruction. The principal also met regularly with her Specialist to discuss best practices in mathematics instruction. The principal believed her interactions with the Specialist increased her own confidence to provide instructional guidance for teachers to effectively differentiate instruction so that more students were becoming successful in mathematics. The lesson here was that a Specialist and principal with a robust collaborative partnership are better able to provide leadership for the school's mathematics program. Additional data provided insights into what the principal needed to know and do to support the Specialist.

A more formal gathering of information was facilitated through VCU's Commonwealth Educational Policy Institute (CEPI) as part of the NSF-TPC grant's policy component. Six of the twelve principals in treatment schools were interviewed at the end of their first year with a Specialist. According to policy analysts, the interviews revealed that one of the predominant factors that strongly influenced the “nature and quality of school-site implementation” was
whether the principal held a vision and demonstrated force to carry out the vision [3]. One of the principals shared, “The positive and active role of the principal is critical to the Specialist’s acceptance and success. I was visible in supporting her, attending the grade-level planning meetings she held with the mathematics teachers, and meeting with her regularly.” This substantiated the Specialists’ feedback about what principal support increased their feelings of efficacy.

Continuing the Grant Work

As the first two NSF grants were ending, VCU, UVA, and NSU were joined by Longwood University (LU) in a partnership with VMSC and eleven school divisions in a new NSF Discover Research (DRK12) grant project (2009-2014), “Researching the Expansion of K-5 Mathematics Specialist Program into Rural School Systems.” Based on the knowledge gained about how instrumental the principal is to the success of a well-prepared Mathematics Specialist during the two previous grants, this new grant included a component to provide professional development for the principals of the treatment schools where the twenty Specialists prepared through the grant would be placed.

The validation on the decision to include the principal support component in the new NSF-DRK12 Rural grant came in Spring 2009. The impending conclusion of the NSF-TPC and NSF-MSP grant activities provided an opportune time to bring together all of the stakeholders: the grant management teams, the Specialists and their principals, and the researchers from the various studies conducted as part of the grant for a two-day “What We Have Learned Symposium.” The rapporteur’s report echoed earlier realizations: the role of building principal to the work of his/her Mathematics Specialist emerged as one of the five themes of the Symposium [4]. Furthermore, an analysis of individual participants’ written reflections during the Symposium identified the need for principals and school divisions to increase their awareness of the research and need for Specialists, and increase their knowledge about what support is vital for effective Mathematics Specialists. The Symposium launched an investigation into what specific knowledge and experiences would increase a principal’s capacity to provide leadership for a rigorous mathematics program and develop his/her understanding about how to partner and share leadership with a Mathematics Specialist.
Leadership Knowledge and Skills to Support the Schools’ Mathematics Programs

A review of the literature and further consideration of the data gathered as part of the NSF-TPC and NSF-MSP grant project activities had made clear the importance of the principal’s active leadership and supportive collaboration with his Mathematics Specialist in how effectively the Specialist could work with teachers to transform their practice. The question was, however, what specific knowledge and skills do principals believe are necessary to provide leadership for a mathematics program and support to a Mathematics Specialist to transform a school’s mathematics program? A recognition luncheon in Fall 2009 for the principals and Specialists who were research participants in the two grants provided an opportunity to gather additional information from principals. Several members of the grant management team met with a focus group of principals to learn how they thought a principal should support a Mathematics Specialist. The meeting with the principals inspired the VMSC to support the creation of an advisory council, to include school division principals and central office administrators.

In Spring 2010, members for the Administrators' Advisory Council (AAC), fifteen middle and elementary school administrators who had Mathematics Specialists in their schools and three central office leaders, were identified. The Council meetings were facilitated by two VMSC board members (one had been a co-PI for the NSF grants and is also one of the authors of this article). The AAC members examined available information and research about Mathematics Specialists and their impact on instruction, as well as mathematics teaching and learning from an administrator's perspective. These activities served as a basis for informative discussions about their own leadership practices and how they worked with their Specialists. The VMSC facilitators analyzed the meeting discussion notes and artifacts in order to gain an understanding of principals' beliefs about effective mathematics teaching and learning. The meeting notes with the analysis were shared and discussed with VMSC and with grant management team leaders.

Planning for the First Professional Development Opportunities for Principals

As late as 2012 Lochmiller, Huggins, and Acker-Hocevar documented the importance of the principal’s leadership; however, they also acknowledged that little had been presented about ways to prepare a principal with effective strategies to lead improvement efforts in mathematics instruction [5]. Indeed, in 2004 the authors of this article found sparse information available when they began to plan the professional development for principals in the NSF-DRK12 Rural grant project. They did learn about a curriculum developed at the Educational Development
Center (EDC) for working with principals, *Lenses-on-Learning: A New Focus on Mathematics and School Leadership*, that proved to be very helpful [6-8]. In addition, research conducted through EDC regarding administrators and the knowledge they need to lead a mathematics program was also informative [9]. Two additional publications—*Adding it Up: Helping Children Learn Mathematics* and *Administrator's Guide: How to Support and Improve Mathematics Education in Your School*—provided insights about how students need to know mathematics and what a principal should think about in building and supporting a successful mathematics program [1, 10].

The documents and information mentioned above, along with suggestions for support identified in previous grants regarding the knowledge and skills that enable principals to lead effective mathematics programs and support the work of Mathematics Specialists, informed the design of the professional development component for principals as part of the NSF-DRK12 Rural project. Consultations with the partner school divisions led to planning a series of five 1-day professional development sessions for the principals. The central office liaison committed to attend the third day. Activities were designed to give principals the following opportunities: 1) address the need for change; 2) think about what makes a good lesson in mathematics; and, 3) consider further their role as an instructional leader and how to partner with their Mathematics Specialist. This series of professional development sessions was offered for principals in the treatment schools prior to the Mathematics Specialists assuming their roles in the schools. The sessions were held over the course of two days in the fall, one day in March, and finally, two days in June to allow principals time between sessions to integrate what they were learning into their practice. The work with the principals included the following guiding questions:

- What should good mathematics instruction look like?
- What supports are needed for high-quality mathematics instruction?
- What is the connection between high-quality mathematics instruction and student performance?
- How can a school-based mathematics Teacher Leader or Mathematics Specialist support teachers to improve instruction and student learning?
Between the sessions, principals were given specific assignments to help them reflect on the mathematics instruction in their own schools. They used an observation protocol based on the Virginia Process Goals identified in the *Mathematics Standards of Learning for Virginia Public Schools* to observe several teachers [11]. The principals were asked to identify action goals for improving their schools' mathematics programs. Principals, with their Mathematics Specialists-to-be, began to develop a vision for their schools' mathematics programs. This vision was to include what students should be doing and what teachers, Mathematics Specialists, principals, and central office representatives needed to do so that the students would be successful. One of the principals in the grant shared the following in an e-mail after the final workshop session for the NSF-DRK12 principals in the treatment schools:

I just wanted to thank you for all the wonderful guidance you and your team have provided. I am truly excited about having Janice as a Mathematics Specialist in my school and know she will help us improve instruction...! I have truly enjoyed participating in all of the workshops provided and feel I am ready to guide Janice and help make the Specialist’s position in my school what it was truly intended to be. ..... I’m thankful to be a part of this journey!

Students in the three NSF-DRK12 grant leadership courses were also given assignments that involved collaborating with the principal of the treatment school to which they would be assigned. During the first two leadership courses, they were still classroom teachers but not necessarily in the schools where they would be eventually assigned as Specialists. They began their role as Specialists while enrolled in the third leadership course. The first course required students to interview the principal they would later be working with so they could learn his/her philosophy about teaching mathematics, perception of the school’s mathematics program, and what s/he believed was necessary to strengthen the school's mathematics instruction. The second leadership course required the student to use a particular protocol to analyze the various types of assessment reports for the grades 3-5 performance on the state assessments. The student and principal met to discuss the findings and to delve into what was happening in the instructional program that might lead to the assessment results. By the third leadership course, the students had assumed their role as Specialists. During the course, they completed a lesson study cycle and invited the principal to be a part of the lesson study process. They also collaborated with the...
principal to determine a focus for professional development for teachers during their grade-level meetings. These opportunities helped make the first year of the principal and Specialist partnership a more productive year.

During the first year that the principal and Mathematics Specialist worked together, the principals requested a follow-up to the previous year’s professional development sessions that they and their Specialists could attend together. So, a sixth session was held in Spring 2011 and provided an opportunity for each principal with his/her Mathematics Specialist to participate in more professional development, as well as share successes and challenges they encountered during their first year working together. In addition, they began developing an action plan for the next school year. This time, however, the sessions were held in two locations to decrease travel time. Following the session, both principals and Specialists shared that they missed having the entire group together.

**Middle School Mathematics Specialists Task Force: Preparation Program and Principals’ Work**

In 2008, the VMSC appointed “The Middle School Task Force” to consider how the current K-5 Mathematics Specialist Preparation Program might be modified to better address the needs of middle school Mathematics Specialists so they, in turn, could better help middle school teachers and students. The Task Force research found significant differences in the needs of middle school students and teachers, as well as in their structure. They noted that in comparison to elementary schools, middle schools have students with a wider range of academic needs, learning gaps are deeper, the scheduling and organizational constraints are more involved, and student motivation and social pressures are greater issues. Furthermore, teachers assigned to mathematics classes are more likely to consider themselves “mathematically proficient” and principals are more likely to feel the need to delegate responsibilities specific to the mathematics program. The Task Force concluded that well-prepared middle school Mathematics Specialists could help schools address these concerns. Based on their findings the VMSC, in partnership with VCU, UVA and NSU, pursued and received a NSF-MSP grant, “Preparing Virginia's Middle School Mathematics Specialist” (2009-2014). The focus of the grant was to work with eighteen school divisions and prepare fifty middle school teachers to become Mathematics Specialists, and to study the impact of full-time Mathematics Specialists assigned to twelve treatment schools.
As with the elementary Mathematics Specialist program, the question remained as to how best support the work of the Specialists. Since the principal’s role was a critical component of this support, it was recommended that the highly successful program initiated with the elementary principals through the NSF-DRK12 Rural grant be emulated. The model of a five-day series was replicated, and principals of the teachers enrolled in the NSF-MSP Middle School grant program were invited to participate during the year prior to the teachers entering their schools as Specialists. Adjustments were made to the professional development agendas to address the needs of middle school principals and their staffs. Appropriate articles and tasks were selected, and the duties of the Mathematics Specialists were identified in the context of middle school structures. Again, the feedback was extremely positive, and the principals requested a sixth day be held the following year with principals and Specialists in attendance.

Goals for the professional development sessions included fostering the principals’ understanding of good mathematics instruction, enlarging their capacity as instructional leaders in mathematics, and increasing their understanding of the role of the Mathematics Specialist. The activities engaged the principals in relevant professional learning activities. Videos, panel discussions by practitioners, and presentations provided opportunity for large- and small-group discussions involving instruction, the Mathematics Specialists’ role, and supportive strategies principals could implement. Horizon Research, Inc (HRI) completed a study on the principal professional development sessions and developed a report, MSP Institute: Mathematics Specialists in Middle Schools, Impact of Workshops for Middle School Principals: Summary of Interviews [12]. During their research, HRI observed sessions, studied the exit slips, and interviewed principals. The report shared the principals’ perceptions of their role in leading the mathematics programs in their buildings and their ability to carry out their role based on participation in this program. The report also shared numerous principal reflections, such as this one on instruction:

It’s more about getting students to struggle with the math. What I discovered through the workshop is that we as educators, for the sake of time, of planning, of staying on the pacing chart, we tend to give our students too much information to work with instead of helping them think through [the problem]. We need to let the kids struggle a bit. It’s okay. Give them the skills and the foundation to
work with, but we don’t have to make it too easy for them. It’s okay for them to think. For me, that was the biggest message, the major take-away.

In terms of supporting the Mathematics Specialist in their school, another principal said:

Everything in my ten years of being a principal has told me that if I’m for it, it’s going to happen, and if I’m not for it, it’s not going to happen. So if I buy in, then I’ve got to get the school to buy in, and [the Specialist] needs my support for this buy-in. She needs my support to know that we set these goals and I’m meeting with the teachers to emphasize this.

The administrators consistently described the workshop activities as informative, practical, collegial, challenging, and highly engaging. As illustrated in the excerpts above, the interviews revealed that the school leaders were applying what they had learned. There seemed to be a high level of commitment among the participants to implement what they had learned [12]. Based on this success and the previous success of the NSF-DRK12 Rural grant professional development sessions, a decision was made to begin sharing these opportunities with a larger audience.

Expanding to Principals Partnering Institutes through Statewide Partnerships

Due to the positive feedback from the NSF-DRK12 Rural grant and NSF-MSP Middle School grant work with principals, the VMSC established an advisory committee of principals, mathematics supervisors, Mathematics Specialists, and university researchers to meet in Summer 2012 to determine next steps. The committee strongly recommended that the principal professional development series continue with enrollment open to all elementary and middle school principals across Virginia. The content in the five days was organized into a 3-day Institute, with a two-day session and then a one-day session two months later. The statewide Institutes were designed for principals who may or may not have a Mathematics Specialist assigned to their schools. They were designed to allow principals to achieve the following goals:

- Refine their own understanding of standards-based mathematics;
• Become more aware of what they should see students and teachers doing in classrooms that promote proficiency and understanding in mathematics; and,

• Develop a vision for their schools’ mathematics programs.

With support from the VMSC, and endorsement from the VCTM and the VCMS, a series of 3-day Principals Partnering Institutes were advertised in Fall 2012, one in Roanoke and two in Richmond. Within forty-eight hours, all three Institutes were filled! Prior feedback from principals was very positive and the demand was obviously great, so VDOE contributed support allowing three additional 3-day Institutes to be scheduled in Spring and Summer 2013 in Roanoke and Richmond.

Continuing the expansion into Summer 2013, the VMSC and the Virginia Department of Education (VDOE) collaborated to offer three Principals Partnering Institutes in Roanoke, Newport News and Falls Church, and opened the registration up to all elementary and middle school principals from across the Commonwealth. The Institutes met for two days in July and a third day in October. After the first two days of the first round of statewide Principal Institutes, the VMSC requested that Horizon Research prepare a preliminary report on what resonated with the principals, what they planned to take back to their schools to improve instruction, and what questions they still had. A HRI communication stated that there was evidence of a positive impact on principals after just the first two days of the Institute. An overarching theme for principals’ responses to a questionnaire was that the Institute engaged them in thinking deeply about mathematics instruction and their role in it:

• Principals left the Institute with a clear focus on effective mathematics instruction.

• Principals were focused on their role in promoting effective mathematics instruction.
• Principals have questions about how to implement changes in mathematics instruction in their schools and what resources may be available to help them make those changes.

With regard to the principals’ questions in the last statement, Day 3 of their Institute was designed to help answer some of these questions.

In Spring 2013, due to the continuing demand for the Principal Institutes, the VMSC approached the Virginia Association for Supervision and Curriculum Development (VASCĐ) about partnering to offer more Institutes with the continued endorsement of the VCMS, VCTM, and VDOE. With the VASCĐ joining the partnership, along with the VMSC and VDOE, to make additional Institutes available, three more 3-day Principals Partnering Institutes were planned for Fall and Winter 2013-2014 in Newport News, Roanoke, and Harrisonburg. A registration cost was imposed for the first time to help cover expenses. Despite this new requirement, the three Institutes filled quickly, and plans were made to offer more Institutes in Spring 2014. At the conclusion of the workshops in Fall 2013, over 350 principals had been served statewide.

Partnerships continued to expand. A series of three Principals Partnering Institutes in schools identified by the VDOE Office of School Improvement were planned for them. Those Institutes took place in Chesterfield, Norfolk, and Lynchburg by meeting two days in January and the third day in March. The content of the Principals Partnering Institute curriculum was revised to bring particular attention to the state accountability requirements specified in the essential actions for the lesson planning category included in the “Essential Actions for School-Level Reviews.” Emphasis was placed on making explicit the alignment between the Institute activities and the research-based strategies in planning and implementing instruction in schools identified by the VDOE Office of School Improvement.

With the growing interest among principals to attend a Principals Partnering Institute, the need emerged to have additional well-prepared facilitators. In conjunction with the VDOE partnership, a train-the-trainer, multi-day academy is planned for Summer 2014 to prepare additional facilitators. At least two participants per Superintendent’s Region will be invited to learn the curriculum and develop strategies to effectively lead discussions and facilitate a
Principals Partnering Institute in their region. The goal of the facilitator academy is to build a cadre of leaders who can help sustain and support this work across Virginia.

Factors Contributing to the Demand for and Success of the Principals Partnering Institutes

The move to take the Principal Institutes statewide was timely because they focused on the new rigor in the state revised 2009 *Mathematics Standards of Learning* and resulting rigor in the revised 2012 state assessments, as well as on the national attention on the importance of preparing all students for STEM-related career opportunities. Others from outside Virginia can appreciate this new pressure through the Common Core State Standards (CCSS). Planning for the statewide Principals’ Institute also included consulting with the Virginia Association of Elementary School Principals (VAESP), and the Virginia Association of Secondary School Principals (VASSP), as well as a careful review of the curriculum from feedback from previous Principal Institutes.

The review of the written feedback from previous Institutes had been very positive; principals noted that they found the activities and discussions enlightening, and they appreciated the time to network and learn from their peers. Some curriculum adjustments were necessary since expansion of the audience opened participation to principals who might or might not have a Mathematics Specialist embedded in their school. However, the intention of the professional development was the same: to build principals’ capacity to effectively lead a rigorous mathematics program where every student could become mathematically proficient.

Along with confirmation about what experiences the principals valued in the grant-supported Institutes, a review of the literature provided additional validation for what was important to consider in establishing the goals and curriculum for the statewide Principals Partnering Institutes. Nelson and Sassi reported that a principal needs to know how to make sense of what s/he observes in a mathematics classroom, and form an opinion about the quality of instruction [13, 14]. However in an earlier work, they had cautioned, “...the principal's belief about what constitutes mathematics as a field of study and how mathematics should be learned” [9]. These beliefs influence the opinions they draw about the teaching and the learning they observe in classrooms, as well as the judgments they make about how to support teachers. Since a principal is responsible for creating and making public a shared vision for the mathematics
program that makes transparent the expectations for every student the beliefs the principal holds carries great potential for shaping the vision [15].

If the expectations to “raise the floor and the ceiling” for mathematics learning is to be realized, it requires a more rigorous mathematics program for all students while also closing the achievement gaps between various student populations. How can a lone principal provide the school-based leadership necessary? Elmore asserts that, in organizations such as schools, “There is no way to perform these complex tasks without widely distributing the responsibility for leadership” [16]. The expertise and leadership capacity to improve teaching and learning requires a leadership mix: principals, formal Teacher Leaders, and informal teacher leaders [17]. Considering these ideals, the goals of the statewide Principal Institutes, entitled “Principals Partnering to Raise the Floor and the Ceiling in the New Era of Mathematics Standards,” were defined:

- Understand the need for a more rigorous mathematics program and ways to effectively support school staff in moving toward a more rigorous mathematics program;

- Recognize instructional practices that increase rigor for all students in order to increase mathematics proficiency and to close the achievement gap; and,

- Recognize the importance in collaboratively developing an action plan for the school mathematics program that shares leadership to increase rigor and to increase mathematics proficiency for every student.

These goals provided standards to guide the selection of mathematics tasks so principals could do mathematics together, and to identify articles and books to bring expert voices to the principals’ discussions. All activities encouraged principals to examine their beliefs about mathematics teaching and learning. Videos of classrooms provided the context for rich discussions. These videos also allowed principals to simulate observing students and teachers using a protocol based on the Virginia process goals in order to become more aware of what they should see students and teachers doing in classrooms that promote instructional rigor and mathematical proficiency for students [11]. The Institute activities allowed opportunities for principals to reflect on how more rigorous and effective instruction can also increase student achievement on the revised assessments for the state assessments in mathematics since student
achievement determines how schools fare under the state accountability system. Principals learned about the many resources for teachers' professional development and for developing classroom lessons available at the VDOE website.

The Institute goals also influenced the scope and sequence of the activities that took place during the Institute, and served as connecting threads running through each of the three days of activities. Facilitation for the Institute activities mirrored best instructional practices for mathematics classrooms to further develop the principals’ mental model of effective mathematics; inquiry learning took place around completing rich tasks and discussions in small groups, and in whole groups using videos of classroom practice. Throughout each day’s activities, various protocols were used that allowed the principals to reflect on their own schools’ mathematics programs and on their own leadership: to share, raise questions in a secure environment, and network with colleagues from across the Commonwealth.

Table 1 shows each of the Institute goals and identifies the main activities and resources employed to address each goal during the three days of the Institute. For clarity in the presentation of this information, each entry in the table is associated with one goal; however in many cases, an entry supports multiple goals of the Institute.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3 (2-3 months after Day 2)</th>
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Recognize instructional practices that increase rigor for all students in order to increase mathematics proficiency and to close the achievement gap.

<table>
<thead>
<tr>
<th>Recognize the importance in collaboratively developing an action plan for the school mathematics program that shares leadership to increase rigor and to increase mathematics proficiency for every student.</th>
</tr>
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<tbody>
<tr>
<td>Doing Math: Make explicit the different kinds of mathematical thinking in a computation problem.</td>
</tr>
<tr>
<td>Lesson Planning Tools: Identify mathematical content and reasoning in a rich task.</td>
</tr>
<tr>
<td>Video Of Classroom Practice: Lenses on Learning Module 1 Session 3: Discuss their own teacher observations in relationship to the Virginia Process Goals.</td>
</tr>
<tr>
<td>Bridging to Practice: Review and discuss the VDOE Essential Actions for Lesson Planning. Revisit and revise throughout the workshop.</td>
</tr>
<tr>
<td>Bridging to Practice: Develop individual action plans with no more than two steps to foster instruction for developing mathematical proficiency; include the drivers and challenges for taking the steps.</td>
</tr>
<tr>
<td>Bridging to Practice: Use a backward design to map out a vision for the school's mathematics program: 1. What are students doing? 2. What do teachers have to do to enable students to engage in that way? 3. What does the school mathematics leadership team need to do with teachers in order for them to have the knowledge/skills to do this? 4. What support does the mathematics leadership team need from the principal to accomplish this? 5. What support does the mathematics leadership team and the principal need from central office to accomplish this?</td>
</tr>
</tbody>
</table>

Recognize the Teacher Effectiveness Continuum: Individually, principals reflect and locate classrooms/teachers on a continuum from least to most effective in teaching for deep understanding.

**Characteristics of a Highly Effective Classroom:** Whole group – Develop a set of descriptors for an effective mathematics classroom - what will teachers be doing, what will students be doing? Revisit and revise throughout the Institute.
At the end of each day, facilitators would carefully read and reflect on the exit slips so that adjustments could be made to the following day's activities in response to the feedback. Facilitators would be explicit in sharing any adjustments with participants, and appreciative of suggestions to make the program more effective. As in previous Institutes, the intent was that this responsiveness and respect of the principal's role would add to the collegial atmosphere.

**Vision for Principals Partnering Institutes**

As of today, more than 500 principals have participated in the Institutes. The vision is that, through the support of the Coalition, VCTM, VCMS, VDOE and VASCD, the statewide "Principals Partnering to Raise the Floor and the Ceiling" will continue being offered to support these leaders in providing leadership for a rigorous mathematic program that ensures mathematical proficiency for every student. In addition, the Institutes will continue to encourage principals to nurture additional leadership in their schools, such as Mathematics Specialists or mathematics Teacher Leaders. Steps are also being taken to make the detailed workshop materials available nationwide to mathematics leaders who would like to develop comparable workshops for their principals.

**References**


Abstract

After being part of a week-long math institute, both the principal and the Mathematics Specialist from an urban school district partnered to develop a professional development plan. It incorporated a Lesson Study Model that supported collaborative learning teams, focused on the instructional process, and incorporated reflection and feedback. Although the faculty had engaged in other forms of professional development, the lesson study process was seen as a powerful vehicle that invited a level of coaching and cross-collaboration. This article focuses on the shared viewpoints of the principal and the Mathematics Specialist who worked together to build a mechanism for professional learning for improved mathematical proficiency and understanding.

Introduction

The creation of a collaborative learning community requires shared leadership, reflection, feedback and mutual commitment to build capacity from all parties. It also involves trying different ways of developing capacity that may not be typical to what schools experience. Given week-long training on lesson study, the school’s Mathematics Specialist and I agreed to use this practice to build teacher proficiency in the area of mathematics. To further the commitment, we agreed that using action research would be the best approach for implementing and analyzing the effects of the lesson study process. Action research allowed us to carefully examine the process through self-reflection as leaders and learners.
At the time of the action research, Willard Model Elementary consisted of approximately five hundred students with 58% of the students being part of the free and reduced lunch program. The principal and Mathematics Specialist designed an action research plan where surveys were developed to ask specific questions to measure what was learned during the lesson study process. We attended weekly grade-level meetings to listen to teacher discussions, reflections, and feedback as they worked together to develop lessons. We asked many questions, such as what type of student misconceptions were expected, to help gain a deeper understanding of what the teachers were thinking as they developed their lessons.

Overall, the lesson study process involved twenty-seven teachers from K-5. The process allowed teachers to unwrap the Mathematics Standards of Learning for Virginia Public Schools (SOL) carefully, and plan and develop a lesson while anticipating student misconceptions in conjunction with the Mathematics Specialist [1]. Once the lesson was developed, the team decided who should teach the lesson while the rest of the team committed to collect data by observing the lesson. The team met shortly thereafter to discuss what was observed about student learning and the implications behind the lesson for future revisions. Each time the team met, the principal and Mathematics Specialist joined them to discuss and capture the thoughts and ideas of the teachers, while building a perspective on the ideas of lesson study.

Principal's Perspective

Administrators must always be aware of the positive and negative impacts that change can have on individuals. The goal is not to add one more thing to the plate, but to arrange the plate for greater appeal. Lesson study was a transformative process that engaged many emotions which typically accompany change. Excitement, uneasiness, and relief are a few of the emotions I experienced as I moved along the continuum of this project. I found myself mustering up the courage to move ahead with something that would be perceived as “one more thing.” I was able to outline a professional development structure that would take the staff to a different level of collaboration by transforming how teachers think about their lessons. I presented the lesson study process as a concept where “teachers are learning together,” and I took the time to explain the components of lesson study to the whole staff. I then provided grade-level teams release time for a half-day to help them design a unit, while mapping out a lesson that they planned to observe together. Watching the teachers co-plan as a grade level, and openly discuss and exchange ideas gave powerful insight into their learning. Each discussion was a learning opportunity to clarify, extend, or simply to bring awareness to the curriculum, instruction, and assessments.
After collecting and analyzing teacher feedback, I collaborated with the Mathematics Specialist to plan year two of the project, maintaining some key structures while changing other pieces for better planning and motivation. For example, organizing the timeline at an earlier point to give teachers greater lead time with the schedule helped to reduce their anxiety. The collective efforts created deep positive changes as evidenced by teacher feedback. Many teachers understood the power of lesson study once they experienced the process, while others asked questions, such as “How do you expect us to plan like this for every lesson?” not realizing that the expectation was to experience the reflective learning process. I was seeking the type of instructional reflection that would change how the teachers anticipate student responses prior to designing the lesson.

**Perspective from the Mathematics Specialist**

The lesson study planning, though awkward at first for some grade levels, allowed the teachers to enter another level of collaboration. As a coach, I asked questions that “lead from behind,” meaning that I used questions to guide their exploration of student thinking in the context of mathematics. It appeared that as a side effect of the lesson study process, a higher level of respect among colleagues developed as teachers began to submit ideas without fear of any undue criticism from their peers. Many of the teachers enjoyed anticipating and then addressing possible student misconceptions. In addition, they began to grapple with choosing the best teacher moves to address each component of the lesson. They began to think: “If I do this ‘teacher move,’ then how will the students respond, and how will ‘I move’ on to the next step?” This was growth in pedagogical content knowledge for many individuals on our instructional team; again, one that was not the result of a direction delivered by any one person, but a consequence of the lesson study process. No longer did they view preparing lesson plans as a requirement for compliance. Looking back, I distinctly remember one teacher stating that if this was something they were to do just one time, then she was interested in it. However, by the end of the lesson study process, she admitted how it changed how she planned. In fact, teachers began to value the collaborative planning of a blueprint to frame the thinking pathways for our learners. Even more, teachers began to analyze the effects that we can create with our choices with regard to student growth.

The observation of the lesson was another powerful part of the process. It was like a scientific experiment. As the lessons were implemented, our collaborative plan came to life. We could see how close we were to planning success, how each move that we planned would either
create a path to understanding or create a possible roadblock for the learners. It was important
during the observations to remain focused on the students, and this was stressed so that the host
teacher did not perceive this time as an evaluation of her teaching by the teacher observers. It
was, instead, an evaluation of the plan itself and how it affected students. Furthermore, it was
beneficial to have multiple pairs of eyes purposefully watching the lesson.

The post-lesson discussions were valuable professional learning opportunities for the
teachers. During these discussions, not only the effectiveness of the lesson was analyzed, but also
the conceptual thinking of the students. Such discussions deepen teachers’ understanding of how
students really learn mathematics. In addition, this post-discussion also took place in a non­
threatening environment where I could introduce specific content knowledge on the mathematical
concepts covered in the lesson that might not otherwise have been easily shared in a typical
planning meeting.

What Was Learned Together?

Many lessons were learned about our leadership roles as principal and Mathematics
Specialist. Time was spent discussing and reflecting on the whole idea of lesson study and how it
enhanced a learning culture. Although the collaboration was successful, several challenges
presented themselves and provided an opportunity for improvement. The teachers reminded
everyone how ideas can be good in theory, but given the time constraints and job demands, the
ideas may not always be practical. For this school, completing a lesson study during the second
or third school year quarters would have been better than during the first quarter. The principal
and Mathematics Specialist realized that the teachers needed that first quarter to focus on building
relationships, establishing routines, and setting the instructional pace. We also learned that a key
component of each lesson study experience included a reflection on the lesson. It became evident
that, when possible, a lesson reflection on the same day allowed the observed teacher to make
adjustments to the lesson, as well as the teachers who would be replicating it in their own
classrooms.

Conclusion

Overall, this experience allowed for teacher growth not only in pedagogical knowledge,
but also in mathematical content knowledge. This is extremely important, especially for
elementary teachers who may not specialize in one content area. Using lesson study as
professional development invites teachers to think and act differently about planning,
understanding the curriculum, and delivering instruction as they become researchers of their own
craft. As the principal and the Mathematics Specialist, it was rewarding to serve as collaborative facilitators and mentors throughout this lesson study process. We both feel that we learned important instructional and leadership skills that have served us well as we moved on to new positions within our district, and we recommend the process to others.

Reference

PARTNERING WITH PRINCIPALS THROUGH FORMAL AND INFORMAL PROFESSIONAL DEVELOPMENT

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Abstract
Mathematics Specialists and administrators need to define what they should see students and teachers doing in classrooms that promote proficiency and understanding in mathematics. Formal, divisionwide professional development on this topic can quickly guide and inform a large group of administrators in one setting. However, potentially more powerful professional development can occur on a small scale one building at a time through mathematics department learning walks.

Introduction
Dennis Sparks describes one role of principals as being expected to create learning communities in their schools and to engage the broader school community in creating and achieving a compelling vision for schools which typically serve increasingly diverse student populations [1]. Principals are asked to give up “command-and-control” views of leadership, choosing instead to be instructional leaders steeped in curriculum, instruction, and assessment who can coach, teach, and develop and distribute leadership to those in their charge.

This is a daunting task, as administrators are spread thin with day-to-day building responsibilities. They are required to be experts in not just general instructional best practices, but to be able to offer guidance on instruction in multiple subject areas. Collaboration between administration and instructional coaches is crucial because no one can be an expert in everything. In addition, administrators need formal and informal professional development to support them in their role as instructional leader.

Formal Professional Development, Countywide Workshop
The Chesterfield County Public Schools (CCPS) mathematics department formalized their mathematics instructional model in September 2012, explicitly laying out expectations for each part of the mathematics lesson. This instructional model was shared with all building-level administrators through an all-day professional development session that focused on mathematics instruction. Throughout the day, administrators had the opportunity to hear from representatives...
from the Virginia Department of Education (VDOE), explore the mathematical process standards, and look closely at each component of the instructional model. The day began with a representative from the VDOE sharing mathematics updates and a brief overview of the mathematics process standards. The CCPS mathematics department then shared their philosophy of mathematics.

We believe that all students can learn mathematics with understanding. Learning mathematics with understanding involves thinking, reasoning, and applying knowledge and skills to problem-solving situations, not just memorizing facts and procedures to get an answer. Mathematics is a sense-making discipline that requires both conceptual understanding and procedural fluency. In building mathematical concepts, students explore multiple representations and make connections between ideas. Students then make connections between concepts and procedures. Reflective thought and reasoning is required throughout this process.

Mathematics classrooms should be student-centered. Teachers are facilitators who design instruction to provide opportunities for students to use and build on their pre-existing knowledge and skills. Students at all levels should be engaged in rich discourse—questioning, explaining and justifying their reasoning, and clarifying their misconceptions—as they are learning and applying mathematics. Students should also learn to appreciate that there are multiple ways of approaching problems and finding solutions, even to basic computation exercises. The process of finding a solution is as valued as having the correct answer.

Students become competent and confident problem solvers when they have developed conceptual understanding, efficient meaningful procedures, and useful problem-solving strategies and habits of mind.

Administrators were given the opportunity to discuss their interpretations of this philosophy and how it should manifest in classroom instruction. Specific focus was given to the idea of the instruction being student-centered with the teacher as a facilitator that provides many opportunities for rich discourse.

The instructional models for K-2 (see Appendix A) and grades 3-5 (see Appendix B) were shared next. These documents lay out a framework for what should happen in each component of a mathematics lesson. After discussing each part of the instructional model and detailing the “look-fors” in each part of the lesson, a video of a problem-solving lesson was
watched by the group. In this lesson from *Content Focused Coaching*, the teacher presents a problem-solving activity involving fractions [2]. Rich dialogue is prominent in both the whole-group introduction of the task as well as the small-group work completed by the students. This specific video was selected because student discourse is prominent in both the CCPS mathematics department belief statement and in each component of the instructional model.

As administrators viewed each part of the problem-solving lesson video, they were asked to focus on a series of guiding questions. Some of the questions were as simple as noting what the teacher was doing and what the students were doing. It quickly becomes clear in the video that the classroom is student-centered and mathematical talk is encouraged and valued. Many of the guiding questions focused on how the teacher keeps the focus on mathematical understanding. Administrators were continually encouraged to note how students were demonstrating their understanding by sharing their reasoning, explaining what they are thinking, and justifying why their answers make sense. Administrators were seated with their peers, and there were many opportunities for small-group discussions at their tables, as well as sharing out important ideas with the whole group.

Later in the day, an additional video of classroom instruction was shared. This video was chosen to represent very traditional instruction in which the teacher was using the latest technology and the students were reasonably well behaved. However, in this video there was no student discourse. The teacher asked many rote or recall questions, and frequently elicited a choral or chant response from the class. A similar set of guiding questions were used while watching this video. It was especially powerful to see the deficiencies with regard to discourse as well as student understanding in this traditional lesson.

Administrators noted that the most beneficial parts of this staff development day were the in-depth look at the instructional model and viewing both videos with these “look-fors” in mind. Thoroughly understanding the CCPS instructional model for mathematics prepared the principals for supporting teachers with implementation of the model in their classrooms. Viewing the videos allowed the principals to reflect on how specific pieces of the model should look in action. One administrator noted that this type of professional development helped her to understand the process of teaching mathematics, and exactly what the use of research-based best practices look like in a mathematics classroom.
Informal Professional Development, Learning Walks

In Confer and Ramirez’ *Small Steps, Big Changes*, the principal states:

I honestly have always found myself in a bind when I observe math lessons and need to talk to teachers about what I saw or need to give them feedback. I’m much more comfortable with literacy lessons since I know more about decoding and comprehension strategies. I just don’t have the background in math. It’s a tough thing to admit as a principal, but it’s true—and really, it’s not possible for anyone to know everything [3].

Informal discussions with other administrators lead to similar statements. Routinely, administrators will share that their area of expertise is language arts instruction or special education. Very few building administrators have a significant background in mathematics instruction, which isn’t surprising as the Mathematics Specialist endorsement only came about in the past decade in the Commonwealth of Virginia. However, building-level administrators are expected to be instructional leaders that guide and support their staff in all content areas including mathematics.

In Fall 2012, the CCPS mathematics department began a series of learning walks. During a learning walk, a team from the county mathematics department consisting of the Instructional Specialist for Mathematics, the Elementary Math Teacher Consultant, and three Math Coaches join forces with the building-level administration to visit a school for an entire day. Additional support providers, including Special Education Liaisons and English as a Second Language Liaisons join the team depending on the demographics of each school. A schedule is developed so that pairs of observers can visit each classroom during mathematics instruction. Typically, a member of the mathematics department is paired with a building administrator or Special Education Liaison. Ideally when the schedule allows, the observation pairs stay for the entire mathematics class. When that isn’t possible due to mathematics class times that overlap or a large number of teachers at a grade level, some observation pairs observe the beginning of the lesson in one room and the second half of the lesson in another room.

The entire observation team sits down at the beginning of the day and discusses protocol for the observations. Administrators have an opportunity at this time to make the team aware of building-level initiatives that are in place that they would like to monitor, as well as any concerns
or general statements about classrooms that will be visited. Pairs use a form (see Appendix C) based on the mathematics instructional model while conducting their observations. Pairs observe together in each classroom with each person taking their own notes. When a break occurs, observers return to the meeting room and debrief together, noting their observations and comments on a large sheet of chart paper for each grade level (see Appendix D). These charts are left with building-level administrators for their own records or debriefing with teachers. All of the information recorded on these charts is also recorded in a Google Doc™ site that is shared with all members of the observation team. Special notes of commendation and recommendation for the school and individual grade-level teams are noted as well.

Frequently, principals asked questions of the math team about mathematics content or specific strategies being used while observing together in classrooms. Several principals had commented that the recommended structure of mathematics stations for grades K-2 had confused them when they initially observed the process. Having someone from the CCPS mathematics department observing with them allowed them to ask clarifying questions that solidified their understanding. Principals noted that they are much more secure in the feedback they are giving teachers after participating in a learning walk with the mathematics team. One principal shared that her understanding of number talks grew significantly by participating in the learning walk. Her initial thought was that a number talk should look the same at each grade level. After observing in each grade level and asking questions about what mental math was being demonstrated in the kindergarten and first grade classroom number talks, she was more comfortable with what she was seeing in the primary grades.

The powerful collaboration between administrators and the CCPS mathematics department continues after the observations are completed and the pairs have an opportunity to debrief with the entire observation team. Frequently, trends emerge when the data is compiled by grade levels. These trends not only help when providing feedback for teachers, but also help the administrators determine future needs for professional development at their own schools. One principal shared that, while she had observed growth among her staff in the areas she had focused on for professional development, she hadn’t realized the scale of this growth because she is embedded in the school. She sees it each day and notices the little changes, but because she’s there every day she had lost track of just how far her staff had come. Having a team of people from outside the building observe provided a new view of this success, and actually allowed her to tweak her plans for continued professional development to incorporate additional topics.
Conclusion

Professional development is most commonly thought of in terms of workshops and courses, yet learning also occurs through collaborative efforts. While learning walks were not originally intended to be a form of professional development for school administrators, the comments that they have shared demonstrate that this is the case:

- “Participating in the learning walks allowed me to make observations and ask questions of our coaches for feedback. This conversation and idea sharing about what we observed is very helpful. The discussion with the math department after the observation helped to validate what I was observing.”

- “I can see the strategies put into practice and discuss details of how they are being used effectively. This helps to guide in professional development in areas where they are not. Learning walks were seriously the greatest professional development days that I’ve attended. It is very powerful to walk with experts and compare my thinking. Now I know exactly what to look for and what feedback to provide.”

References


Appendix A

Instructional Model for K-2 Detailing All Lesson Components

Elementary Mathematics Instructional Model and “Look-Fors”

Grades K-2

The development of number sense is the major focus in K-2 mathematics. Opportunities for
developing number sense occur during calendar math / review, the mini-lesson, independent
stations, and closure.

Throughout all components of a lesson, it is critical that students demonstrate
understanding by sharing their reasoning, explaining what they are thinking, and justifying
why their answer makes sense.

Calendar Math / Review 10-15 Minutes
Use Every Day Counts Calendar math or a similar well-planned calendar math routine to explore patterns,
build number sense and provide a cumulative review and spiraling of mathematics concepts and skills.
This is also an opportunity for children to develop mathematical vocabulary and communication skills.
- Includes opportunities for students to share, explain and justify thinking
- Teachers are encouraged to include:
  - Word Problem of the Day (beginning in the second semester of kindergarten and
  continuing in first and second grades, a word problem of the day supports the conceptual
  understanding of addition and subtraction and the development of problem solving
  strategies; beginning in second grade problems can include two steps)
  - Questions addressing concepts across the strands that target specific student needs
    (number fact of the day, estimate of the day, term of the day, skill of the day, picture of
    the day, measurement of the day)
  - A number talk that involves subitizing with dot cards and ten frames, part-part-whole
    concepts, or a basic fact strategy (a number talk is a short whole class conversation where
    children share their reasoning and justify their answers to the question that has been
    posed)

Mini-Lesson 10-15 minutes
Mini-lessons are planned to address the current grade level big ideas found on the pacing guide. Refer to
the CCPS Curriculum Framework for planning resources. The instructional strategies listed in the
framework are sequenced to initially develop conceptual understanding and then connect and build to
efficient procedures.
- Most mini-lessons will focus on concept or skill development and build on pre-existing knowledge
  and skills
- Multiple methods and strategies should be used
- Manipulatives and pictorial models that support the understanding of mathematical concepts are
  used
- Opportunities to discover concepts using hands-on inquiry activities are provided
- Some mini-lessons will be built around understanding a complex problem or performance task. A
  complex problem allows students to apply their mathematical understanding to new, unfamiliar
  situations and leads to the development of problem solving habits of mind.
**Active Engagement** 25-30 minutes

<table>
<thead>
<tr>
<th>Independent Stations – 3 to 5 days per week</th>
<th>Shared Experience – 1 or 2 days per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Stations provide opportunities for students to have ongoing meaningful practice with important foundational number concepts*</td>
<td>- Allows all children to experience the same activity so that the teacher and students can use the activity for a whole class reflection</td>
</tr>
<tr>
<td>- May not be directly related to the mini lesson (i.e. mini lesson may be related to patterns, but stations are related to counting)</td>
<td>- Directly related to the mini-lesson (a continuation of the mini-lesson)</td>
</tr>
<tr>
<td>- A variety of stations are provided, all related to the same big idea – during most weeks the big idea is a foundational number concept</td>
<td>- Usually a way of providing practice for lessons focusing on the strands of geometry, probability and statistics, measurement, or patterns, functions, and algebra</td>
</tr>
<tr>
<td>- Students choose the station at which to work, often moving between two or three stations in one session</td>
<td>- Students may work in groups, with partners or independently</td>
</tr>
<tr>
<td>- Differentiation is provided through expandable activities that are easily leveled so that students at different levels can be working side by side at the same station</td>
<td>- If the mini-lesson focused on a complex problem or performance task, the shared experience focuses on solving the problem or completing the task</td>
</tr>
<tr>
<td>- Stations target individual student’s needs and levels of understanding – even if the student is below or above grade level</td>
<td>- Teachers observe students as they work and interact with them to target individual student’s levels of understanding and to nudge student thinking forward</td>
</tr>
<tr>
<td>- Students often record what they are doing in a journal or on a recording sheet</td>
<td>- Teacher may be able to meet with small flexible groups during this time</td>
</tr>
<tr>
<td>- Teachers observe students as they work and interact with them to target individual student’s levels of understanding and to nudge student thinking forward</td>
<td></td>
</tr>
<tr>
<td>- Small group instruction may take place during the first 10 minutes of this time if a group of students share similar needs and those needs are best met by teacher directed instruction</td>
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<tr>
<td>- The same stations stay in place for several weeks. This allows students to transition from learning how to do the activity to learning from the activity.</td>
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</tbody>
</table>

**Closure** 5 minutes

- Students reflect on new learning and make connections through discussion or journal writing
- Students reflect with the teacher on the learning environment (what went well and what could be improved)

*The foundational number concepts targeted at each grade level include:

K – counting objects, comparing quantities, subitizing (recognizing quantities without counting), and part-part-whole
Gr 1 – comparing quantities, developing strategies for addition and subtraction, and part-part whole (internalizing number combinations through 10)
Gr 2 – part-part-whole (internalizing number combinations through 10), developing strategies for addition and subtraction, place value, and applying addition and subtraction strategies to two-digit numbers
Basic Fact Fluency

A goal of the elementary math curriculum is that students master the basic addition, subtraction, multiplication, and division facts. According to Van de Walle (2006), demonstrating mastery of the basic facts typically means that you can produce the answer in about 3 seconds or less without resorting to inefficient methods such as counting. Van de Walle goes on to say that all children can master the facts if they construct efficient mental tools. An approach for mastering facts that is grounded in using relationships between numbers not only allows children to construct the mental tools that help them learn the facts, but also helps them develop number sense.

There are three important steps to mastering basic facts.
1) Help students develop a strong concept of the operation. (What does it mean to multiply 3 x 4?) Using models and story problems aid in developing the concept.
2) Develop efficient thinking strategies to find the answers.
3) Provide appropriate practice in using the strategies until the strategies become automatic. Also provide practice in selecting strategies that are appropriate for a given fact.

A 'traditional' fact mastery program based on memorization may appear to work for some children. However, students who memorize facts miss out on developing the number sense and reasoning inherent in a strategy approach. In addition, the strategies that are used to master the basic facts can be used as mental math strategies for bigger numbers.

The following strategies have been identified by CCPS as the core strategies that are part of our approach to developing fact fluency. These strategies are referenced in the CCPS Curriculum Frameworks along with supporting activities and resources. The strategies are listed in the order they are introduced. A full day lesson is usually used to introduce or discover a strategy with short follow up sessions on subsequent days to begin practicing the strategy. A strategy should be introduced and practiced for at least a week before a new strategy is introduced and practiced. Once two strategies have been introduced, strategy selection activities can occur. Learning facts should be spread out over time and cannot simply be a two-week unit.

<table>
<thead>
<tr>
<th>Addition:</th>
<th>Subtraction:</th>
<th>Multiplication:</th>
<th>Division:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counting On</td>
<td>Think Addition</td>
<td>Twos (doubles)</td>
<td>Think Multiplication</td>
</tr>
<tr>
<td>One More Than/ Two More</td>
<td>Counting Back</td>
<td>Tens (think place value)</td>
<td></td>
</tr>
<tr>
<td>Than Doubles</td>
<td>Counting Up</td>
<td>Fives (half of 10x)</td>
<td></td>
</tr>
<tr>
<td>Near Doubles</td>
<td>One Less Than, Two Less</td>
<td>Ones and Zeros (think</td>
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<tr>
<td>Than</td>
<td>Than</td>
<td>about the concept)</td>
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<tr>
<td>Terrific Tens</td>
<td>Bridging Through Tens</td>
<td>Nines (one set less than 10x or patterns)</td>
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<tr>
<td>Bridging Through Tens</td>
<td></td>
<td>Fours (double and double again)</td>
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<td></td>
<td></td>
<td>Threes (double and one more set)</td>
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<tr>
<td></td>
<td></td>
<td>Helping Facts (any unknown fact)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elevens (10x and one more set)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Twelves (10x + a double)</td>
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Monitoring Progress

An understanding of individual learning styles and a differentiated approach to instruction requires a rethinking of the idea that all students learn their facts in the same amount of time. Timing children before they have had the chance to develop efficient strategies can emphasize speed and guessing rather than number sense and accuracy. Timed activities should only be used occasionally (no more than every two weeks) to determine which facts a student already knows and to plan activities tailored to each student's needs. Alternative ways of assessing progress (like observation during a game or activity or a low key interview) can be used with all students, especially those that are anxious when timed. Ideally students will have mastered most addition and subtraction facts by the end of second grade and most multiplication and division facts by the end of fourth grade. Students who have not mastered the facts by fifth grade will need continued ongoing review and practice.
Appendix B

Instructional Model for Grades 3-5 Detailing All Lesson Components

Elementary Mathematics Instructional Model with "Look-Fors"
Grades 3 – 5

Throughout all components of a lesson, it is critical that students demonstrate understanding by sharing their reasoning, explaining what they are thinking, and justifying why their answer makes sense.

Check For Understanding and Review 20 Minutes
This portion of the lesson should ideally include all of the components listed below. It is difficult to address every component listed below in a 20 minute session. Within a week most of the activities listed should occur. Teachers will need to make decisions about what to include daily. If the main lesson is focused on developing a basic fact strategy then the basic fact fluency portion could be eliminated for that day. If the main lesson is from a unit focused on computation, the number talk or word problem could be eliminated if the lesson lends itself to a similar goal.

Cumulative Review
- A deliberate and carefully planned review of previously taught skills, concepts, and vocabulary unique to the needs of students in each classroom
- Keeps skills and understandings fresh, reinforces previously taught material, and gives students a chance to clarify their understandings
- Includes time for students to share, explain and justify thinking
- Every Day Counts Calendar Math (if available) or similar well planned calendar math routine can serve as cumulative review
- Could include:
  - Word Problem of the Day (single-step or multistep; if multistep – more time will need to be allowed and other components of the Check for Understanding and Review time will need to be eliminated)
  - 3-5 questions that address concepts across the strands and target specific student needs (number fact of the day, estimate of the day, term of the day, skill of the day, picture of the day, measurement of the day)
- Review skills should be included in ongoing assessment

Number Talks
- A 5-10 minute classroom conversation or discussion crafted around purposefully chosen computation problems
- Students learn to mentally solve problems accurately, efficiently, and flexibly
- Promotes number sense and computational fluency
- By sharing and defending their solutions and strategies students are provided with opportunities to collectively reason about numbers

Basic Fact Fluency (see Basic Fact Fluency page for more detail)
- Provides practice in the use of efficient mental strategies and the selection of strategies after they have been developed. These strategies are based on relationships which encourage the development of number sense.
- Provides opportunities to apply and demonstrate knowledge of basic facts
- Could include:
  - Strategy selection activities or sorts
  - Use of Origo Box of Facts materials (if available)
  - Fact fluency games

Homework Check for Understanding
- When homework is reviewed the focus is on explanation and understanding, not on checking for right answers
- Fewer assigned problems and a meaningful review enable the focus to be on "Why?" "How did you get that?" "Who has a different way?" "What do others think?" "Is that reasonable?"
- Homework review should take no longer than 5 minutes
**Instructional Unit** 35 minutes

Refer to the CCPS Curriculum Framework for planning resources. Most lessons will focus on concept or skill development. Some lessons will be built around a complex problem or performance task. A complex problem allows students to apply their mathematical understanding to new, unfamiliar situations and leads to the development of problem solving habits of mind.

<table>
<thead>
<tr>
<th>Concept/Skill Lesson</th>
<th>Complex Problem Solving Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the CCPS Curriculum Framework, instructional strategies for each big idea are sequenced to initially develop conceptual understanding and then connect and build to efficient procedures.</td>
<td>Students work through the steps for problem solving: Understand, Plan, Solve, and Look Back. Early in the year teachers may need to guide students through the four step process and gradually release responsibility to students.</td>
</tr>
<tr>
<td><strong>Concept/Skill Development</strong></td>
<td></td>
</tr>
<tr>
<td>- Build on pre-existing knowledge and skills</td>
<td>- Pose a complex problem that students can access in a variety of ways depending on their prior knowledge</td>
</tr>
<tr>
<td>- Use multiple methods and strategies</td>
<td>- Encourage reasoning through discourse</td>
</tr>
<tr>
<td>- Incorporate manipulatives and pictorial models that support the understanding of mathematical concepts</td>
<td>- Value the use of multiple representations</td>
</tr>
<tr>
<td>- Provide opportunities to discover concepts using hands-on inquiry activities</td>
<td>- Provide opportunities for students to share solutions and justify their answers</td>
</tr>
<tr>
<td>- Build conceptual understanding, then link to procedures</td>
<td>- Allow students to solve problems in a variety of class structures including whole class, small group, partners and individually</td>
</tr>
<tr>
<td>- Pose questions (both teachers and students) including higher order thinking questions</td>
<td>- Use a problem solving lesson at any point during a unit for formative assessment</td>
</tr>
<tr>
<td>- Include opportunities for discourse</td>
<td></td>
</tr>
<tr>
<td>- Provide a variety of instructional opportunities including whole class, partner, and small group activities</td>
<td></td>
</tr>
<tr>
<td><strong>Concept/Skill Practice</strong></td>
<td></td>
</tr>
<tr>
<td>- Use games, journal writing, taboos or paper pencil activities as practice opportunities</td>
<td></td>
</tr>
<tr>
<td>- Observe students as they work and interact with them to target individual student’s levels of understanding and to nudge student thinking forward</td>
<td></td>
</tr>
<tr>
<td>- Meet with small flexible groups as determined through observation and assessment data while other students practice independently or with partners</td>
<td></td>
</tr>
<tr>
<td>- Provide opportunities for practice in groups, pairs or independently</td>
<td></td>
</tr>
<tr>
<td>- Assign independent practice or homework only after checking for understanding</td>
<td></td>
</tr>
</tbody>
</table>

**Closure** 5 minutes

- Students reflect on new learning and make connections through discussion or journal writing.
Basic Fact Fluency

A goal of the elementary math curriculum is that students master the basic addition, subtraction, multiplication, and division facts. According to Van de Walle (2006), demonstrating mastery of the basic facts typically means that you can produce the answer in about 3 seconds or less without resorting to inefficient methods such as counting. Van de Walle goes on to say that all children can master the facts if they construct efficient mental tools. An approach for mastering facts that is grounded in using relationships between numbers not only allows children to construct the mental tools that help them learn the facts, but also helps them develop number sense.

There are three important steps to mastering basic facts.
1) Help students develop a strong concept of the operation. (What does it mean to multiply 3 x 4?) Using models and story problems aid in developing the concept.
2) Develop efficient thinking strategies to find the answers.
3) Provide appropriate practice in using the strategies until the strategies become automatic. Also provide practice in selecting strategies that are appropriate for a given fact.

A 'traditional' fact mastery program based on memorization may appear to work for some children. However, students who memorize facts miss out on developing the number sense and reasoning inherent in a strategy approach. In addition, the strategies that are used to master the basic facts can be used as mental math strategies for bigger numbers.

The following strategies have been identified by CCPS as the core strategies that are part of our approach to developing fact fluency. These strategies are referenced in the CCPS Curriculum Frameworks along with supporting activities and resources. The strategies are listed in the order they are introduced. A full day lesson is usually used to introduce or discover a strategy with short follow up sessions on subsequent days to begin practicing the strategy. A strategy should be introduced and practiced for at least a week before a new strategy is introduced and practiced. Once two strategies have been introduced, strategy selection activities can occur. Learning facts should be spread out over time and cannot simply be a two-week unit.

<table>
<thead>
<tr>
<th>Addition:</th>
<th>Subtraction:</th>
<th>Multiplication:</th>
<th>Division:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counting On</td>
<td>Counting On</td>
<td>Think Addition</td>
<td>Think Multiplication</td>
</tr>
<tr>
<td>One More Than/ Two More Than</td>
<td>Counting Back</td>
<td>Counting Back</td>
<td>Counting Back</td>
</tr>
<tr>
<td>Doubles</td>
<td>Counting Up</td>
<td>Counting Up</td>
<td>Counting Up</td>
</tr>
<tr>
<td>Near Doubles</td>
<td>One Less Than, Two Less Than</td>
<td>One Less Than, Two Less Than</td>
<td>One Less Than, Two Less Than</td>
</tr>
<tr>
<td>Terrific Tens</td>
<td>Bridging Through Tens</td>
<td>Bridging Through Tens</td>
<td>Bridging Through Tens</td>
</tr>
<tr>
<td>Bridging Through Tens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtraction:</td>
<td>Multiplication:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twos (doubles)</td>
<td>Tens (think place value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tens (think place value)</td>
<td>Fives (half of 10x)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fives (half of 10x)</td>
<td>Ones and Zeros (think about the concept)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ones and Zeros (think about the concept)</td>
<td>Nines (one set less than 10x or patterns)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nines (one set less than 10x or patterns)</td>
<td>Fours (double and double again)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fours (double and double again)</td>
<td>Threes (double and one more set)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threes (double and one more set)</td>
<td>Helping Facts (any unknown fact)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helping Facts (any unknown fact)</td>
<td>Elevens (10x and one more set)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevens (10x and one more set)</td>
<td>Twelves (10x + a double)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monitoring Progress

An understanding of individual learning styles and a differentiated approach to instruction requires a rethinking of the idea that all students learn their facts in the same amount of time. Timing children before they have had the chance to develop efficient strategies can emphasize speed and guessing rather than number sense and accuracy. Timed activities should only be used occasionally (no more than every two weeks) to determine which facts a student already knows and to plan activities tailored to each student's needs. Alternative ways of assessing progress (like observation during a game or activity or a low key interview) can be used with all students, especially those that are anxious when timed. Ideally students will have mastered most addition and subtraction facts by the end of second grade and most multiplication and division facts by the end of fourth grade. Students who have not mastered the facts by fifth grade will need continued ongoing review and practice.
Appendix C
“Learning Walk” Observation Form

CCPS Elementary Mathematics Learning Walk Form

<table>
<thead>
<tr>
<th>Time Observed</th>
<th>Instructional Components</th>
<th>Narrative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check For Understanding</td>
<td>Opportunities for students to share their thinking</td>
<td></td>
</tr>
<tr>
<td>- Cumulative Review</td>
<td>- Many</td>
<td>- Limited</td>
</tr>
<tr>
<td>- Calendar Math</td>
<td>- Some</td>
<td>-</td>
</tr>
<tr>
<td>- Problem of the Day</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Number Talk</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Basic Fact Review</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Homework Check</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Instructional Unit</td>
<td>Opportunities for students to share their thinking</td>
<td></td>
</tr>
<tr>
<td>Grades K-2</td>
<td>- Many</td>
<td>- Limited</td>
</tr>
<tr>
<td>- Mini Lesson</td>
<td>- Some</td>
<td>-</td>
</tr>
<tr>
<td>- Shared Experience</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Independent Stations</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Student Choice</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Focused on same big idea</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Differentiated within each station</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>- Teacher interaction</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Grades 3-5</td>
<td>- Concept/Skill Lesson</td>
<td></td>
</tr>
<tr>
<td>- Concept/Skill Practice</td>
<td>- Small Group</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>Instruction/Remediation</td>
<td></td>
</tr>
<tr>
<td>- Problem Solving Lesson</td>
<td>- Group Work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Partner Work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Independent Work</td>
<td></td>
</tr>
<tr>
<td>Closure</td>
<td>Opportunities for students to share their thinking</td>
<td></td>
</tr>
<tr>
<td>- Discussion</td>
<td>- Many</td>
<td>- Limited</td>
</tr>
<tr>
<td>- Written</td>
<td>- Some</td>
<td>-</td>
</tr>
</tbody>
</table>
## Appendix D

Combined Notes for Observations in a Series of Grade 4 Classrooms

<table>
<thead>
<tr>
<th></th>
<th>Fourth Discourse</th>
<th>Some</th>
<th>Limited</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>On Pace</th>
<th>Slightly Behind</th>
<th>Sig. Behind</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Model/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Comments**

- Glows
  - Math anchor charts on display
  - nice number-talk
  - came back to specific words of 
    "brain dump" chart
  - vocab cards posted
  - accepted student strategies
  - talk & neighbor
  - small groups enabled more discourse
  - turn and talk
  - checks for understanding
  - liked different colors for different strategies

- Grows
  - value all strategies in number talks
  - address student misconceptions
  - little differentiation: 9 adults
    each led a group doing some activity
  - lesson may have been too open ended to accomplish learning targets
  - check for understanding went long & sometimes took time away from instruction
  - need to maximize learning time
A COLLABORATIVE APPROACH: TWO PERSPECTIVES

B. CHONG and M. FARRELLY
Mark Twain Middle School
Alexandria, VA 22310

Abstract
This article is a story of collaboration between a principal, Baek Chong, and the mathematics coach, Megan Farrelly. This article shows both perspectives: Baek’s thoughts are written in regular typeface, whereas Megan’s perspective is italicized. Both educators work at Mark Twain Middle School in Fairfax County Public Schools in Virginia which has nearly 900 seventh- and eighth-grade students. Twain Middle School serves a diverse population, of which about 35% of the students are on free or reduced lunch, 15% receive special education services, 14% receive English language services, and 40% of the students are in the advanced academics program.

Principal and Mathematics Coach: A Collaborative Approach
When I first became the new principal in the middle of the school year at Mark Twain Middle School, I did not make working with the mathematics coach, Megan Farrelly, a priority. I felt as if I had more important things to take care of, and it did not occur to me that collaborating with Megan would help with our mathematics instruction, or make me a better instructional leader. I thought that Megan would do her job, and that meant we did not need to meet in order to discuss any specifics dealing with the mathematics department. It would take me a couple of months to see our collaboration as a positive force in raising mathematics student achievement at our school. I hope that our article about this collaboration will encourage other principals to set aside some time during their busy schedules to discuss instruction with their coaches, department chairs, team leaders, and assistant principals.

During my first year as a mathematics coach at Mark Twain Middle School, the principal (who I had worked with for five years) left in October. I did not know what to expect because I was in a new position and about to get a new principal. In the time between principals, I met weekly with one of our assistant principals because he oversaw the mathematics department. Throughout my Mathematics Specialist coursework I learned that, although I should have a good working relationship with the mathematics administrator, I should also meet and regularly communicate with the principal of the school. At the end of the day, the principal makes the decisions, and if I wanted him to support me and my department, then we needed to communicate regularly. When our new principal, Baek Chong, started in December, I made it a priority to
invite him to our weekly mathematics coach “touch base” meetings because I wanted him to see mathematics as a priority.

Not Another Meeting!

I want to stress before we get further into this story that no magic bullet exists in how Megan and I make our situation work. When reflecting on our collaboration, we agreed that meeting consistently on a weekly basis, for thirty to sixty minutes, in order to talk exclusively about mathematics instruction contributed the most to our successful working relationship. If we aren’t able to have our regular meeting, we always make sure that we reschedule for another time that week no matter how busy our schedules might be.

Once I made these weekly meetings a priority, I did not find it difficult to find time in my schedule. We have a thirty-minute block of time carved out once a week. We do not prep for these meetings, but bring talking points, so collaborating weekly goes from daunting to effortless. I spent most of my time as a new principal focused on getting the day-to-day management items addressed, but I gradually shifted my focus to becoming an instructional leader. This meant I devoted more time to discussing instruction. Putting this meeting on my calendar weekly has ensured that I did not push it aside, and has helped me to keep my focus on instruction.

These weekly meetings have helped ensure that I am able to complete my work within the school, and guarantees that I have the support of my principal. During these meetings, I have been able to share successes and the needs of the entire mathematics department. I have also used this time to share what I am reading, or what I have learned with respect to professional development. The key to our collaborative success stems from these regular meetings.

Ideas into Everyday Practice

We all got into education to make a difference with the students. As principals, our direct contact with students diminishes; so in order to make a significant impact, we must think more systematically. I look forward to meeting with Megan because our meetings give me time to talk about how we can take some of the ideas in educational research and make them a reality at our school. Megan and I frequently talk about how we can incorporate critical and creative thinking, writing, and other practices into our mathematics department. We debate the pros and cons of different ideas, and then discuss whether we should put the practice into place for the
whole department, one team, or one teacher’s class. I find it enjoyable to see ideas become reality as I watch students succeed and grow as individuals.

For example, at the beginning of the school year, I explained to our staff that we will have a multi-year focus on incorporating critical and creative thinking into our instruction, as well as the goal of becoming an International Baccalaureate Middle-Years Program (IBMYP). Megan immediately began researching how the mathematics department could implement IBMYP in addition to critical and creative thinking. She eventually brought some suggestions to me based on our school system’s focus on academic talk, and wanted to focus her monthly professional development on academic talk. She explained her ideas and how they could work for our mathematics department. Moreover, she also proposed a timeline on how we could implement them based on our school schedule. As we discussed her ideas, I could see how they fit in with our overall school focus, and then we agreed that she would start to put the specifics into action for the year. I agreed to this undertaking because of our collaboration and the trust we had built. If we had not met as frequently, I might not have seen the importance of her focus on academic talk.

Last year, I implemented monthly mathematics department work sessions that focused on needs within the schools, but these sessions did not always connect from month to month. After learning of Fairfax County’s and Baek’s instructional focus for the school, I decided that I wanted these monthly department work sessions to focus on improving classroom discussions. Twain Middle School has thirteen mathematics teachers, including special education mathematics teachers, who all attend these 45-minute monthly sessions. Before each session, I talk with Baek about the agenda for the upcoming professional development, and we discuss how we think teachers will react. An administrator always attends these work sessions; if Baek cannot attend, then another administrator will. This lets me know that I am supported and shows the mathematics teachers that our administration values their work and continued education. I also invite other staff members to these work sessions, such as Twain’s librarian, school-based technology specialist, and instructional coach. I facilitate the work session and design it to encourage everyone else to be engaged and to participate. This means our administration sits in the group with our mathematics teachers discussing, listening, sharing, and learning along with them. This one small but significant thing shows that our administration supports the teachers and their mathematics coach.
Information and Data (Is it Working?)

As a result of our weekly meetings, I am able to stay current with mathematics instruction and, more importantly, about the events in the mathematics department. I try to make as many of the Collaborative Learning Team (CLT) meetings and observe as many classes as I can; but I cannot see everything, so I count on Megan sharing her data and input from the mathematics department. Megan shares with me everything about the department because her responsibilities include the following duties:

- Attending all mathematics subject-level CLT meetings;
- Observing classes;
- Organizing the professional development sessions;
- Setting up colleague observations;
- Mentoring new teachers and CLT facilitators;
- Attending all county-level mathematics department chair meetings;
- Attending instructional leadership council meetings;
- Attending weekly administrative meetings; and,
- Mentoring struggling mathematics students.

Because she knows everything about our mathematics department and instruction, Megan keeps me updated about what goes well and what needs some improvement. She can almost always answer any question that I have about the department. It is important to note that Megan does not supervise or evaluate teachers and, most importantly, she stays out of any type of teacher evaluative situation. Above all else, our teachers need to feel comfortable around Megan, and she would lose their trust if they viewed her as someone who could negatively affect their evaluations. Megan works with all teachers no matter their level of experience or reputation in the classroom.

For example this school year, we changed the leadership of our mathematics department and most mathematics CLTs. At the beginning of the year, my biggest concern surrounded how our mathematics department would operate under a new department chair and CLT facilitators. Megan and I constantly talked about our new mathematics leaders, and how best to support them in their transition to Teacher Leaders. Megan serves as a great mentor and supports them in their new roles while also helping them meet their CLT responsibilities. We talk about the new dynamics of each CLT, and discuss where we need to push or give a little bit of reassurance to our new CLT facilitators. Without our weekly meetings, I would not be as in touch with how our new mathematics CLT facilitators feel about their roles within the school.
A COLLABORATIVE APPROACH: TWO PERSPECTIVES

In the last school year, 2012-2013, we had six new mathematics teachers out of fourteen in the department. We have four CLTs that meet weekly, of which three had new facilitators. In the 2013-14 school year, we currently have six new mathematics teachers out of thirteen in the department. Out of the four CLTs that meet weekly, three have new facilitators. Part of my job entails building leadership capacity within the school, so I mentor the CLT facilitators and guide them in creating weekly agendas, facilitating monthly data dialogues on common assessments, and running productive planning meetings.

To ensure that we make decisions based on data, Megan and I share information about assessment data during our meetings. Several months after I became principal, I shared with Megan the data results from a countywide common assessment involving our Math 7 scores. Megan and I discussed the findings, and we came to some conclusions in order to put a plan of action into place. First, we decided to visit a school with similar demographics that did well and find out what they did differently so that we could learn from them. Megan had discussions with their mathematics Teacher Leaders and their teachers so that we had this information for the following year. Second, we decided to visit all of our feeder elementary schools, seven in total, to talk about vertical articulation and mathematics class placement recommendations. Surprisingly, we discovered that many of the grade 6 mathematics teachers did not know what specific skills were required for some of the middle school classes, which made making recommendations difficult without this knowledge. Our feeder elementary schools appreciated our visits and now we make sure we visit them every year to preserve the collaboration.

Through weekly CLT meetings, classroom observations, individual teacher planning, and ongoing discussions, I have a good idea about what goes on in mathematics classrooms, as well as the stress level of our mathematics teachers. One major concern with teachers involved the proper placement of students in grade 7 mathematics courses. After a discussion with Baek and our director of student services (DSS), we decided that we needed to meet with all of our feeder elementary schools. With the help of my DSS, I contacted the counselors at each elementary school to set up a time to meet with grade 6 teachers, counselors, and administrators. This opened up the lines of communication and began our first steps toward more collaborative vertical articulation efforts.
More than a Mathematics Instructional Coach

Megan’s title does not do her justice; she does much more than the job description of a “mathematics coach.” Previously, Megan taught at Mark Twain Middle School, and had success with struggling students, so she now serves as a mentor in the building to several students through two of our mentoring programs. Megan also provides small group intervention to several students to assist them with their mathematics coursework. I believe this helps her stay grounded, and also allows her to test out new strategies before asking the teachers to try them. Although I think of myself as approachable, I know that many teachers do not tell their administration the whole story, and I do not want to make the mistake of giving too much credence to those who shout the loudest. As a result of Megan’s strong relationships with staff throughout the building, she has a great understanding of the “pulse” of the building. During our meetings, I ask Megan how the teachers feel about our new programs and if they feel overwhelmed. Finally, I seek Megan’s assistance for any mathematics teacher hiring. For the 2013-14 school year, we hired four new mathematics teachers and two new special education mathematics teachers and Megan participated in all the interviews. She asked and answered questions that I could not because of her expertise with mathematics instruction.

I became a mathematics teacher because I wanted to make an impact in mathematics education. I am fortunate because I had the opportunity to teach in the same school in which I now coach. A few of the mathematics teachers in our school saw me transition from teacher to coach and, luckily, I had their support and encouragement. Teachers know that I can build positive student relationships with struggling and reluctant learners, so teachers feel comfortable reaching out to me for help with difficult students or class periods. Although my job primarily focuses on working with teachers, I still seek opportunities to work with students as long as it does not inhibit my ability to support teachers. My work with students lets teachers know that I am “in this with them,” and although I do not have my own students, I still work with some of our most reluctant learners.

Conclusion

As you can see, I value the collaboration that Megan and I have developed. Our weekly meetings have become extremely important in making our collaboration work, and it helps me to focus on mathematics instruction. The true value of our collaboration, however, is not what I gain from our collaboration, but what the teachers and students feel that they acquire from Megan’s work. Our staff consistently tells me how Megan is invaluable to their development as mathematics instructors. Also, Megan has been instrumental in embedding critical and creative
thinking into our instruction by supporting our teachers through professional development and coaching. Finally, Megan and I look forward to seeing the results of the end-of-year state mathematics scores to see if our collaboration has resulted in improved test scores; however, just based on feedback from staff, I believe Megan’s role as the mathematics coach has contributed greatly to student learning at our school.
Abstract

My educational career path began as an elementary school teacher, then as an assistant principal, and now as a principal. With the educational experiences that I had at each level of my career, I was certain I would be able to handle an increase in the mathematical rigor presented to our students through the new Mathematics Standards of Learning for Virginia Public Schools (SOL) [1]. I found that, yes, I was able to understand the rigor. However, I found the challenge was providing the needed assistance to bring about results that would ultimately help our teachers and students be successful. I knew that something was needed, but what that something was I was not sure. Fortunately, Richneck Elementary was provided a wonderful opportunity of being assigned a mathematics coach for three years by way of a grant that the Newport News Public School division was awarded to support military-connected students. In addition, the grant supported teachers to work toward their Mathematics Specialist degree. As a result, Karen Joos, Mathematics Coach, received her master’s in education with an endorsement as a Mathematics Specialist. David Hundley, Mathematics Coach Facilitator, provided support for coaches under this grant. This article will provide a road map for the journey: working with the mathematics coaches and understanding their processes, promoting my leadership philosophy in relation to the new rigor of the state standards, improving communication through lessons learned, and identifying the collaboration process to achieve the best results for the school and community.

Richneck Elementary School: Collaborating to Improve Mathematics Learning

My life’s work has been in the Newport News Public Schools (NNPS) system. My educational path began as a student in NNPS, and I now serve as the principal of one of its elementary schools, Richneck Elementary School. After fifteen years teaching elementary school, I accepted my first administrator’s position as assistant principal at a Title I elementary school under an influential principal, Mary Ann Hutchinson. After three years and many wonderful learning experiences with Mary Ann’s strong mentorship, I was ready to become principal at Yates Elementary School. I held the students’ educational progress in my hands, but from a different viewpoint. I knew as a leader that I would need the support of the entire staff to ensure the success of each student. Through everyone’s collaborative efforts, Yates reached full accreditation and met adequate yearly progress on the SOL assessments [1]. Six years later, I was
asked to take leadership of Richneck Elementary. At the same time, the SOL assessments would change, and the rigor would increase—hence, my challenge!

Partnering to Support Improving Mathematics Learning

Fortunately at Richneck Elementary, we were afforded the opportunity to be part of a three-year Department of Defense Education Activity (DoDEA) 2011 grant. Little did I know but this grant was going to be just the support our school needed to guide our students toward proficiency in mathematics. The NNPS grant was entitled, “Boosting Students’ Mathematics Achievement and Promoting Positive Social Outcomes for Military-Connected Families at Targeted NNPS Schools.” Seven schools, five elementary and two middle schools, benefited from the acquisition of the DoDEA 2011 grant. There were two components of the grant: a military-connected student support system component, and a mathematics component of the plan. Both components were equally important and supported one another, but the mathematics component will be addressed here. The grant clearly and succinctly indicated the purpose and goal of the mathematics component:

- Purpose of Mathematics Component — The creation of a sustainable program to increase student achievement in mathematics at the upper elementary and middle school levels, such that the transition from elementary to middle school does not result in precipitous drops in mathematics achievement.

- Goal of Mathematics Component — Improve grades 3-8 mathematics achievement for all student subgroups by 5% (each year of the grant) on benchmark assessments and state standardized assessments.

There were several layers to the mathematics component. Beverly McDonald, the NNPS Grant Project Coordinator, was hired to oversee the grant, its operations, and results. The grant permitted mathematics coaches to be hired and, during the grant’s three-year span, these mathematics coaches supported the development of mathematical understanding with classroom-embedded professional development with the teachers. The grant speaks directly to our goal at Richneck to increase all students’ mathematical proficiency: “Mathematics Specialists, focused on building mathematical understanding and capacity within a school, will improve mathematics instruction that manifests as improved student mathematics engagement and achievement.” The grant also provided financial support for the coaches to work toward earning their Mathematics Specialist degree. They could earn their Virginia licensure endorsement as Mathematics
Specialists through Old Dominion University. Upon completion of the program, two coaches who already held a master’s degree earned their Mathematics Specialist endorsement. Two other coaches earned their master’s degree and the Mathematics Specialist endorsement simultaneously.

Each year of the grant, the teachers grew in their mathematical understanding as a result of the classroom-embedded professional development provided by our mathematics coaches. I have to say, so did I. We all grew in our mathematical understanding, and we began to teach mathematics differently. During Year 1 of the grant, our mathematics coach was David Hundley. While David did not pursue the Mathematics Specialist endorsement from the grant, his educational path certainly provided many opportunities for him to impact mathematics instruction. David had been in education for thirty-four years. His years of experience included teaching for seven years in Isle of Wight County and twenty-seven years in Newport News. While in Newport News, he taught for ten years at Richneck Elementary, eight years of which he served as mathematics Lead Teacher. David’s last seven years with Newport News was as instructional coach with a concentration in mathematics. He retired in 2011; however, he was soon hired part-time as the Year 1 mathematics coach under the grant. We were grateful he was assigned to Richneck Elementary.

When David began his role as mathematics coach at Richneck, no specific coaching model had been identified. The grant was just beginning to be implemented, so there were no specific teacher assignments or time requirements. As a result, he acted more as a resource for the teachers supporting their mathematical instruction. He would spend time in all of the mathematics classes. Observations were focused on seeing the instruction through the eyes of the student. He would also review student work with the teachers. During their conversations, the focus was more about the student’s mathematical understanding and how the teacher’s instructional strategies supported that understanding. At times, he also would support teachers by working with students who were struggling in their classes. David attended grade-level meetings where he engaged in discussions about teaching strategies and their impact on student learning. Professional development was embedded within these grade-level meetings. He modeled the use of the sequential method of instruction known as “Concrete-Representational-Abstract” (CRA) with the varying mathematical concepts identified by the Mathematics Standards of Learning and Curriculum Framework [2]. Initially, David felt as though he had more influence with the teachers in the group settings than he did on an individual basis. This helped to build mutual trust
and increased mathematical knowledge specific to the grade level. As a result, David experienced greater success in working with teachers individually.

David provided the beginning phase toward defining a Mathematics Specialist role at Richneck. He helped to bring some issues to light that needed to be addressed. The journey toward improving mathematics learning began when I understood and then accepted that I did not know everything about teaching and learning mathematics. As the administrator and instructional leader of the school, I had to place myself in a vulnerable and humbling position. I had to open up to learn and grow along with my staff of teachers and paraprofessionals. During the first year with David, I was able to listen to his knowledgeable explanations about how students learn mathematics and his views on where Richneck needed to begin to move toward a more rigorous program for all. We worked together in setting up a direction for the school’s mathematics program. First, the mathematical focus was on engaging the teachers in using the curriculum framework from the VDOE to direct their instruction. He designed a format based on a similar format being used in northern Virginia in which the teachers would “unpack” the standards. This allowed for mathematical discussion as they looked in depth at the mathematical understanding that the students were required to attain. Then, there was a focus on the sequential CRA method of instruction. The teachers were building their lessons on the premise that learning begins at the concrete level using concrete materials. Once there was an understanding at this level, the teachers would help the students make the connection between the concrete to the representational and, eventually, to the abstract. David worked with the teachers in grade-level meetings to model and explain the use of various concrete materials. He walked away from these meetings with the feeling that, at the very least, the seed was planted. David had helped the teachers see the importance of building student understanding of mathematics by using multiple strategies to make connections between concrete, representational, and abstract levels of thinking. He recognized that not all teachers were quick to adopt this instructional approach, but he believed that, with time and practice, it would become an additional tool in their toolbox of instructional delivery. At the end of the first year, both David and I walked away with positive feedback, and evidence that there were pockets of mathematical change occurring within the building.

As we continued into the second year of the grant, David was hired as Instructional Mathematics Coach Facilitator (mentor) for all of the instructional mathematics coaches hired for the second and third years of the grant. Since David accepted this new position, Richneck anticipated that a new mathematics coach would be assigned through the grant. Karen Joos
accepted the position as Richneck’s new Mathematics Coach. While Karen did not teach at Richneck, she had taught for twenty-six years at the elementary and middle school level in Newport News. Her positions ranged from middle school special education resource teacher, special education self-contained teacher, and K-5 and general education teacher in a collaborative setting. She had also served as a grade-level lead and social studies lead teacher, and served as a member of school improvement teams. During her last years of teaching, Karen taught fourth grade mathematics, science, and Virginia studies. She took advantage of the opportunity to earn her endorsement through the grant. Karen began and completed the work on her Mathematics Specialist endorsement degree while serving as our mathematics coach for the remaining two years of the grant. Karen revealed a passion for mathematics and shared it with the staff.

Our adventure was unique in that we were able to take advantage of the knowledge of a Mathematics Specialist, although under the grant, the position was still classified as a mathematics coach. However, in contrast to the first year of the grant, Year 2 and Year 3 of the grant-supported position included a specific coaching model design developed at Ohio State University. The design of our instructional coaching model has molded some aspects of the coach/principal relationship. Under this instructional coaching model, Karen was scheduled to work at two different schools. She coached at an elementary school and a middle school. Under the new model, both the coach and the teacher worked together for a predetermined time period that will be referred to as a “cycle.” While Karen was working at one school for a cycle, she would still visit the other school once a week to touch base with the teachers. At each school site, the teachers volunteered to work with Karen. She worked with three to four teachers specifically in a coaching cycle. All teachers were afforded the opportunity to be coached. Many teachers who did not volunteer to be coached on an individual basis did request, at times, other kinds of support concerning mathematical instruction.

New teachers as well as veteran teachers were seen as having the ability to learn and grow in their mathematical understanding with the support of the mathematics coach. In Year 2 of the grant, the cycles of coach and teacher working together lasted five weeks. In Year 3, the cycles were eight to nine weeks which permitted more time for coaching. Karen’s work was embedded in the classroom setting for three to four days a week for the entire mathematics block. Additionally, she provided assistance to the grade-level teams in their planning sessions and in professional development as needed, based on our discussions. The driving purpose of coaching was to improve both the teacher and student mathematical understanding, and to shift instruction to a design that would reduce time spent on direct instruction and increase time spent on student
exploration and dialogue. The teachers chose their own goals to improve their mathematical instruction and their students’ mathematical understandings and applications. Those goals were most often geared toward instructional delivery, but could address any aspect of teaching mathematics to include planning and assessments.

In order to coordinate Karen's work between the two schools, Lisa Gatz, the middle school principal, and I met to develop the coaching cycle schedule based upon the criteria from the grant and the school calendar. Before Karen began as the mathematics coach, Beverly, David, Karen, and I met to discuss the coaching cycles for her first year. Then, Karen was introduced to the staff and her role as mathematics coach was explained. At this time, teachers were given the opportunity to think about volunteering to be coached. Karen worked at the middle school level for four days each week during the first cycle of coaching, and worked at Richneck one day each week to establish a connection with the staff. This coaching model permitted collaboration between the schools. Toward the end of the first cycle, Karen led a professional development with Richneck and grade 6 mathematics teachers from the middle school. The collaboration was to review unpacking the standards and to delve into the vertical articulation of a standard. This provided an opportunity for the grade 6 teachers to share their problem-solving technique which Richneck adapted to the elementary level.

Since Karen was new to Richneck, one of her first tasks was to develop a rapport with the staff by assisting with classroom preparations, initiating mathematical discussions, and having conversations to get to know the teachers on a personal level. Building rapport and learning the new position of being a mathematics coach proved to be a challenging endeavor. Although Karen put forth great effort to build trust and confidence, developing a trusting relationship requires time. Ideally, a coach should have a time frame to build this rapport before beginning to coach a teacher. Using this time to support daily teaching activities allows personal relationships to grow. In our situation, Karen attempted to build rapport and transition into a new coaching role, simultaneously. To assist in that transition, David, in his new position as mentor, was very helpful. His guidance in supporting Karen with daily interactions with teachers and administrators proved to be indispensable.

The first year had permitted David to be a first-year coach at one school which allowed him to be readily accessible to teachers at any time. As Karen assumed the role of first-year coach in two different schools during Year 2 of the grant, the professional development embedded within the classroom was a strong aspect of the transition from the Year 1 coaches’
way of supporting teachers, to the Year 2 more defined coaching cycle model. The first vital step in the coaching cycle was individual teacher planning with the coach. Karen adjusted her planning time with a teacher depending on their needs. During the planning phase, they had discussions about the mathematical concepts to be taught and the varying strategies that supported them. The underlying emphasis was always on leading the teachers to deliver instruction that was based on providing a conceptual understanding of the mathematics. After planning with a teacher, Karen then observed the teacher and the students. This was followed by a discussion of the lesson with the teacher. Karen was able to provide feedback and research-based articles on problem solving, mathematical discourse, and developing a conceptual understanding of the mathematics concept. Leading teachers to a conceptual understanding of mathematics allowed them to help students replace their instrumental understanding. Getting the teachers to start teaching conceptually helped them to replace the “tricks” and develop their understanding of why the “tricks” worked mathematically. The end result was that the students could articulate their own mathematical thinking. At first, the focus was on various strategies which then led to the discussions of why these strategies were important to the students’ learning. Discussion of these strategies would often refer back to the curriculum framework and the CRA method that was introduced and expounded upon in the previous year.

**Reflection on the Impact of Richneck's Three-Year Journey**

As indicated previously, changing mindsets takes time, with each step of the journey building on previous steps. With the increase in rigor in the 2009 Virginia mathematics SOL, one of our first steps was to delve into the Virginia Department of Education’s *Mathematics Standards of Learning and Curriculum Framework* to determine what the students would need to know in order to apply their mathematical conceptual understanding to the SOL assessments [2]. The question we asked was, “What are the students expected to do based upon the Virginia Department of Education *Curriculum Framework* and not just our division’s curriculum?” Once this was understood, the instructional practices needed to be examined and changed. The curriculum framework was the first step. Other questions followed:

- Where do I begin?
- What are the expectations?
- What vocabulary needs to be introduced to the students?
- What essential prerequisite skills should the students be able to do to meet a particular standard?
What instructional strategies and experiences should the students have so they may gain an understanding and apply what is taught?

All of these questions were addressed as we began a process we call “Unpacking the Standards.” That first year, David provided professional development in “Unpacking the Standards” and how to use the information gained. He showed the teachers how to take a current standard and “unpack” it to gain a true understanding of what the students had to do. David created an “Unpacking” form for the teachers to use to record their findings. This became an effective way for teachers to begin planning, and really streamlined our planning and instructional delivery. Any time a teacher asked about mathematics instruction, the response would be “What does the Curriculum Framework say?” or, “Have you checked the Curriculum Framework?” We respected David’s expertise and learned a great deal. Once we determined what the students had to learn, we knew that we needed to adjust our instructional delivery to meet the standards. The question was where to begin? In the second and third years, Karen provided additional professional development built on the foundation of looking at the Curriculum Framework to now address the mathematical understanding that was necessary for the teachers. The teachers’ personal understanding of mathematics grew deeper, and the conceptual level of instruction in the classrooms showed evidence of increased rigor.

I am responsible for making instructional decisions that affect student achievement. In addition, I am also charged with developing my staff professionally by providing learning experiences that can stretch the staff and make them better educators. After professional learning on unpacking the Standards, we then worked toward implementing effective instructional strategies and connecting the concrete, representational, and abstract levels of mathematical reasoning. What does this mean? Aren’t we doing this already? This is where having a Mathematics Specialist/coach was vital. The Mathematics Specialist/coach taught us what research-based, student-centered instruction meant, and framed it by letting us understand what it is and what it is not. We also learned from the Mathematics Specialist/coach that we needed to stay at the concrete and representational stages as long as necessary for the students to gain mathematical conceptual understanding. Listening to the Mathematics Specialist/coach improved staff learning in this area. I was an active participant at every staff development session because I wanted my staff to know that I was learning right along with them to effect this change positively. My participation also allowed me to grasp the concepts and be able to articulate what I should be observing and why. It gave me a new way of looking at how we develop our students and staff. I had grown as a principal and thus changed how I viewed a mathematics lesson. My observations
of mathematics in the classroom were not just about the teacher’s delivery, but also about student engagement and the students' ability to articulate what they were learning. My participation and learning permitted consistency and continuity in communication with the teachers about what the Specialist/coach and I were both trying to convey. As a principal, I’m ultimately responsible for the entire school. The Mathematics Specialist/coach is focused strictly on mathematics. This is why collaboration and communication are so important, and why I collaborated with the Mathematics Specialist/coach to prepare an agenda and to schedule the staff learning.

Lessons Learned During the Journey

Continuous communication between the principal and the coach is vital to collaborating effectively with each other. In addition, there must be follow-through on the collaborations so that the program remains consistent and that the results garnered are on target. During Karen’s first year, we met after each cycle to review our progress. We discussed what was accomplished, growth areas, and next steps. In looking back, I realize that having more meetings with Karen and the teachers being coached would have assisted in more effective coaching cycles. Meetings were scheduled, but I did not always follow through with them. We had several impromptu conversations, but we did not really sit down regularly to discuss our progress. The life of an administrator can be busy; however, it is critical to maintain the pre-arranged meetings to ensure that both the principal and the coach are on the same page. This will also allow the school to see the principal and Mathematics Specialist/coach as united and focused on mathematics. This was certainly a lesson learned. At the beginning of Karen’s second year, I asked her to provide a staff development to six new teachers and, with my new insight, we met to plan the professional development. Karen submitted PowerPoint slides to be used during the presentation, and together we went over it. We met again to finalize the details. Ultimately, the presentation was well received. Our collaborative efforts helped the teachers to begin their year at Richneck with the mathematical learning that the current Richneck staff had already received. Supporting the Mathematics Specialist/coach in this way continued to help support our relationship.

A principal has to be willing to learn and grow. As a result of our work over the last three years, I am now in a position to work with other mathematics coaches more effectively. I have brought forward the lessons I have learned from this experience. I offer these lessons to all principals embarking on this journey of collaboration with a Mathematics Specialist/coach:

- Examine your data together and look for trends in your data;
- Make observations together and compare viewpoints about what you are seeing;
• Be direct in communicating expectations with the Mathematics Specialist/coach and staff;

• Provide checkpoints along the way to ensure that everyone is on the same page and that you are seeing the results you wish to see;

• Hold regular meetings to maintain the progress that is expected; and,

• Make communication a priority as it is of the utmost importance.

Our story has a happy ending—Richneck Elementary School has continually progressed in the area of mathematics based upon the results of the Virginia SOL. We were at 90% of our third, fourth, and fifth grade students passing the mathematics SOL test in 2010-2011. Then in assessment year 2011-2012, our SOL percentages decreased to 59% due to the increased rigor of the new Standards of Learning and new assessments. With the support of our Mathematics Specialist/coach, we achieved an increase in the percentage of students passing the mathematics SOL assessment in 2012-2013 to 71%. Our school has increased the overall percentage of students passing the mathematics SOL by 12 percentage points! Each grade level increased their percentage of students passing in the following manner: third grade up 12%; fourth grade up 11%; and, fifth grade up 16%! Our hope is that we, as educators, will continue to grow in our mathematical knowledge and provide instruction to our students that will allow them to be proficient in articulating their mathematical thinking.

Conclusion

My personal perspective of this collaborative effort as a principal is one of introspection, success on many levels, and lessons learned. My self-examination has led me to be a better principal and a better collaborative partner. David, Karen, and I grew to respect and trust each other professionally. This collaborative effort began by building that trusting relationship. We were all excited about effecting change in the area of mathematics and realized that change does not happen overnight. It also does not happen by chance. Trying to change mindsets on mathematics instruction has taken time and courage to implement. It required a new way of thinking and a new way of delivering instruction. I, too, had to depart from the way that I had learned mathematics as a student and later how I taught mathematics as a teacher. Leaving the mindset of “tricks” and mnemonics in mathematics instruction was difficult. The staff and I came to realize that tricks only allowed students to develop short-term strategies and pass the computational level of mathematics assessments. We had found success in what we were doing
on the previous state *Standards of Learning* assessments, but that was not enough with the new rigor of mathematics measured on the current assessments. We were doing our students a disservice by not assisting them in building a mathematical understanding that would be their foundation for other mathematics concepts. The students had to be able to apply their mathematical conceptual understanding to the new and rigorous tasks presented to them. The new rigorous tests also did not support the old adage that there is one answer to each problem on the test—A, B, C, or D. These new assessments made the students grapple with tasks that required them to create graphs, use an on-line ruler, solve multi-step (really triple-step) problems, represent fractions, and a host of other higher-level thinking items. Some of these questions were presented to our third, fourth, and fifth grade students with more than one answer. The students had to show their proficiency performing these mathematical tasks. Our school was in need of an instructional shift, and that shift needed the support of a Mathematics Specialist. During the three years of having mathematics coaches, we have seen great growth in our teachers and in the students’ understanding of mathematics. There is still much to learn, but we are well on our way!

**Acknowledgments**

The author would like to acknowledge Ms. Karen Joos, Mathematics Coach, and Mr. David Hundley, Mathematics Coach Facilitator, for their contributions toward this article. Their efforts toward improving our mathematics knowledge and instruction will resonate beyond their years at Richneck Elementary School.

**References**


Abstract

The role of a Mathematics Specialist can vary from pre-K through grade 8 schools. One of the most distinguishing factors involves the relationship between the Mathematics Specialists, administrators, and teachers. In this article, we share our experiences in a school culture that supports common language, collective commitments, trust, and transparency. Using this model, we have experienced high levels of teacher professionalism and student success. As lifelong learners, we continually reflect upon our practices and look for ways to meet the needs of our students. This occurs by implementing purposeful meeting structures that allow us to facilitate discussions around mathematics content, lesson planning, assessment results, and student progress. Administrators Brian Butler and Diane Kerr, along with Mathematics Specialists Tracey Hulen and Jennifer Deinhart, have formed a powerful relationship at Mason Crest Elementary School. This is a Title I school with 560 students, pre-K through grade 5, which promotes reflective practices and allows for flexibility and creativity as we continue to strengthen and improve our practices. Together, we share a story of our collaborative journey with teachers and students to create an effective mathematics program that embraces a conceptual learning philosophy.

“Ultimately there are two kinds of schools: learning-enriched schools and learning impoverished schools. I have yet to see a school where the learning curves...of the adults were steeped upward and those of the students were not. Teachers and students go hand in hand as learners...or they don’t go at all.” [1]

Roland Barth, “Hand in Hand, We All Learn”

The Collaborative Culture

Our journey as a school began by collectively creating a vision and mission to ensure high levels of learning for all students and adults. As a school, we embrace the “Professional Learning Community at Work” model as defined in the book Learning by Doing [2]. The authors describe a Professional Learning Community (PLC) in the following manner:
...an ongoing process in which educators work collaboratively in recurring cycles of collective inquiry and action research to achieve better results for the students they serve. Professional learning communities operate under the assumption that the key to improved learning for students is continuous job-embedded learning for educators [2].

It is a never-ending learning journey for all and it begins by building common knowledge, common language, and common expectations in order to move forward as one school made up of collaborative teams. A school that functions as a high performing Professional Learning Community focuses on the Three Big Ideas: A Focus on Learning, A Culture of Collaboration, and A Focus on Results. The Three Big Ideas drive the work that we do each and every day. Within our collaborative culture, as Mathematics Specialists and administrators, we have developed strong relationships with each other and all of the teachers at Mason Crest. These relationships are the cornerstone of our work. They are based on mutual trust and respect. It is because of these relationships that we are able to consistently communicate our vision and meet our goals. In the Mathematics Specialist role, we act as coaches, facilitators, and teacher models to develop pedagogical content knowledge and overall best practices for teaching mathematics. In the administrator role, we encourage and expect the Mathematics Specialists to bring ideas to the table; they are, after all, the Mathematics Specialists and experts in their content area, and we allow them to use research-based programs and resources that enhance the mathematics program at our school.

The Relationship between Mathematics Specialists and Principals

At the beginning of our relationship, we met on a bi-weekly basis to discuss plans for meeting with teams, whole staff professional development, and how our goals would meet the needs of our students throughout the school. Over time, a trusting relationship developed. Now, when either party feels the need to discuss any element of our mathematics program, meetings are scheduled on an as-needed basis. Problem solving around student progress is done in a mutually respectful environment so that we can effectively support all staff members in the work of teaching mathematics. In these discussions, together we make key decisions, such as extending the mathematics instructional block from sixty minutes to ninety minutes, implementing the use of the *Investigations* text series schoolwide, and developing a five-week course for the entire staff that highlighted components of effective mathematics instruction [3].
**Common Language and Learning**

In order to realize our mission of high levels of learning for all, while developing and implementing highly effective mathematics practices, we felt that it was important to build a foundation of common knowledge. This would set the stage for our continued learning together with our entire staff.

Through our own professional learning (respective Mathematics Specialists master's programs, national conferences, and countywide in-services), we were able to use ideas learned to develop a mathematics course that focused on four elements of instruction:

1) Creating the physical and cultural classroom environment;
2) Identifying effective facilitation techniques;
3) Defining formative and summative assessment; and,
4) Writing and evaluating effective tasks.

All instructional staff, including administrators, participated in all fifteen hours of the course. While this course was an effective start, we needed to develop a structure of meetings that would support further collaborative work, and build on and strengthen the learning from the course. Ultimately, this course would deepen the learning for individuals, teams, and students.

Learning is an ongoing process, and as teachers, our best learning is through the day-to-day work of instructing our students and actively addressing the Professional Learning Community’s critical questions of learning. The following four critical questions should be addressed:

1) What is it we want our students to know?
2) How will we know if our students are learning?
3) How will we respond when some students do not learn?
4) How will we extend the learning for students who are proficient?

These questions keep us focused on the right work in our collaborative time together and prevent us from getting lost in trivial, meaningless housekeeping that can be done through other means.
Planning Meetings

The following are the purposeful meeting structures that allow us to answer the four critical questions as we facilitate discussions around mathematics content, lesson planning, and discussing assessment results and student progress. This is the work; this is the process that leads to higher adult learning. At Mason Crest, we meet formally in the following ways:

- Weekly planning meetings to create our instructional plan;
- Monthly data discussions to analyze the results of our common assessments;
- One-on-one coaching for all first-year teachers or those new to a grade level; and,
- Vertical team observations and reflection based on team needs.

In addition, we monitor all students during quarterly progress meetings in which we take the following actions:

- Analyze assessment results from our district tests;
- Create homogeneous and heterogeneous student groupings to use in guided mathematics instruction;
- Develop an instructional plan that will allow additional time and support for some students who are not yet showing mastery and extend the learning of those who did show mastery of the objectives assessed; and,
- Note the frequency, duration, and ratio of any guided instruction.

While the Mathematics Specialists facilitate these meetings, administrators support the process not only by being a part of the meetings themselves, but by having the expectation that all teachers involved in the learning of students at a particular grade level are present. These include teachers, such as classroom, special education, and English as a Second Language, as well as instructional assistants. We share a collective responsibility for the learning goals of all students in our school, so all team members are seen as equal contributors. We do not see students as “my students” or “your students,” but “our students.” This collective commitment to each other allows us to share ideas, learn from each other’s strengths, and share the workload as we develop lessons and assessments.

During weekly planning, we explore content, create scaffolds such as sentence frames and visual vocabulary, and from our collective resources, develop focus lessons and active
learning tasks for each day of the week. We differentiate our instruction for the varied needs of our students by using tiered tasks, mathematics menus, and guided instruction. We decide as a team how to set up our mathematics workshop each week so that teachers can support students in small groups based on their needs.

Since we share the responsibility of planning instruction together, we share the responsibility of teaching together in an inclusive environment. Classroom teachers and resource teachers use a variety of co-teaching models, such as the following examples:

- Team teaching—where teachers jointly deliver instruction.
- Parallel teaching—where one teacher leads the larger group during the focus lesson and the other provides specific scaffolding for a small group of learners.
- Guided instruction—where after the focus lesson, teachers support students as they solve problems and complete tasks.

Data Discussions

At Mason Crest, after every unit assessment, grade-level teams engage in data discussions. The data comes from common assessments which our team created to match the rigor of the state assessments. This process relies heavily on our ability to trust our teammates, be honest and transparent about our strengths and weaknesses, and recognize that we are collectively responsible for the success of every student. While the Mathematics Specialist is the facilitator of our data discussions, all team members are seen as equal contributors. Administrators are often present and participate in the discussions, further encouraging the culture of trust and transparency. Their presence is not seen as top down but as members of the team who want to learn together to ensure that we are honoring our mission. The one thing that administration tries to model is transparency, and that making mistakes and admitting our own individual challenges is part of the process. Having the courage to share mistakes openly with teammates helps the entire team learn and grow. A motto that we have is “Get Comfortable Being Uncomfortable,” and it means that we don’t expect perfection—just that progress and mistakes are welcomed as opportunities to learn and grow! The administration is quick to admit that they make more mistakes than anyone and are fine with this because they get better each time they learn from a mistake or challenging situation.

Teams use a protocol for the discussion that focuses on these key ideas:

- Identifying students who need extra time and support, and those who may need to be extended in their learning;
• Identifying student needs (objectives where students were successful and areas where they will need more support) that have been identified by the individual teacher;
• Identifying team trends that highlight a need for re-teaching across the grade level;
• Sharing strategies from teachers who were successful in particular areas that may benefit the whole team;
• Reflecting on the reasons for our successes or shortcomings; and,
• Making general next steps for addressing student needs.

Progress Monitoring

A data discussion is most meaningful when there is follow-through at our next weekly planning meeting. As a response to trends in the data, we plan for instructional changes based on student needs. Examples include creating small-group focus lessons for particular students, incorporating another teacher’s strategy that was deemed successful, providing an opportunity for whole-group re-teaching with a different approach than the initial instruction, or planning for additional practice opportunities for students during the mathematics workshop in the form of games and independent tasks. These conversations about student learning become deeper at progress monitoring meetings. These meetings are held quarterly to discuss individual student progress in the area of mathematics. Students requiring specific interventions or extensions are identified, and specific goals and plans are created.

Learning through Observation

We at Mason Crest value the job-embedded professional development described above, but also included in this work is observing each other teach. Teachers have the opportunity to visit other classrooms or watch videos of others at their grade level or vertical teams. For example, if one team is looking to implement a new workshop model or instructional strategy, the Mathematics Specialist has the vertical lens of the school and can help direct teams in choosing a specific teacher or team to observe. Teachers take observational notes on the practices seen and generate questions. After the observation, the team debriefs with the Mathematics Specialist to reflect on which parts of this new learning can be applied in the classroom setting.

The role of a Mathematics Specialist can look very different depending on the school culture and the involvement of administration. We have found this model to be effective based on the progress of our teachers and, most importantly, our students. We continue to reflect on our
roles, both as Mathematics Specialists and administrators, recognizing that this partnership is crucial in our work to build capacity in mathematics among teachers.

References


**A TALE OF TWO FIRST-YEAR MATHEMATICS SPECIALISTS**

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**Introduction**

The two Mathematics Specialists have been teaching together for over twelve years, and in fact are considered a “package deal,”—a “buy one, get one,” if you will. We were both accepted into the Mathematics Specialist training program funded by a National Science Foundation (NSF) grant, and began our training in 2003, obtaining the Mathematics Specialist endorsement in 2007. Since then, we have been asked to act as master teachers for various NSF-MSP grant-supported institutes offered by Virginia Commonwealth University (VCU), University of Virginia (UVA), and Norfolk State University (NSU). We were asked to join the first Middle School Mathematics Specialist cohort.

Our school district provided the NSF grant committee with information from which two control schools and two treatment schools emerged with comparable demographics. Treatment schools would receive a Mathematics Specialist and the control schools would not. Doug Floyd was placed at Hugo Owens Middle School (HOMS) and Jamey Lovin at Great Bridge Middle School (GBMS).

**Doug Floyd and Mike Perez at Hugo Owens Middle School**

My journey began on an early August morning when I met with my new principal, Mike Perez. The start of the school year was still a few weeks away, but I wanted to establish a rapport with him before everyone returned. I did not know anyone at Hugo Owens Middle School, and was a bit apprehensive about venturing into uncharted waters. I was soon put completely at ease when I met Mr. Perez. He greeted me with an enthusiastic handshake, and was very excited...
about being selected to receive a Mathematics Specialist. It was fortunate that he had been going over the results of the previous year’s SOL assessment results. We talked about my role as a Mathematics Specialist and went over some expectations for the upcoming year. Having gone through some of the summer sessions for principals, Mr. Perez and I found ourselves on the same page. He understood that my role was not evaluative in nature, but rather that of a mentor. He was eager to see a cultural change in the school where classrooms shifted from the traditional teacher-centered to a more student-centered approach. One particular concern was the sixth grade performance on the state assessment. Historically, the school had performed well in the past, achieving scores in the high middle range for the district’s ten middle schools. The current scores were in the lower third of the middle school scores.

**Principal's First Meeting with the New Mathematics Specialist**

I was excited to meet with my new Mathematics Specialist, after having gone through the NSF Principals’ Institute offered through the Middle School Mathematics Specialist grant, and because Doug Floyd’s former principal told me how good he was at teaching math. I knew the SOL math data was not good in specific areas, but I also knew that I had a staff of very good teachers. That is the conundrum that I shared with Doug because I did not understand how such good teachers were getting such poor results in certain areas. I needed his help in finding out why. He shared his insights on what he thought might be some of the reasons, and we agreed that he would begin with my introduction and then spend time observing teachers teaching, planning, and assessing students.

*Mike Perez Reflection*

The reference to assessing in Mr. Perez’ reflections frightens me a little since it is not clear what it refers to—assessing the teachers, assessing the students? The scores were partially a result of a change in the assessment itself. The Commonwealth had increased the rigor of the questions, as well as added technology-enhanced items. These items consisted of questions without a multiple-choice answer. Instead, students had to drag and drop their responses in appropriate categories, answer free-response questions, select multiple correct answers, and manipulate graphs and charts. The principal felt that we needed to focus our attention on the sixth grade to ensure that the students received a strong foundation in both the mathematics and the testing strategies. He provided me with a stack of disaggregated data from the assessment,
showed me my new office, and welcomed me to the staff. I left the school feeling a bit overwhelmed but excited about my new responsibilities.

The first day of teacher pre-service week began as most do. Excited teachers renewed friendships and shared tales of their summer vacations. The staff had a breakfast provided by the PTSA, and then it was time for the administration to start the meeting. Mr. Perez welcomed everyone back and introduced the new staff members to the group. I could see some questioning looks from a few of the staff, and I recalled how I always felt when a stranger arrived with the task to “help improve instruction.” I was the unknown quantity, and I’m sure many of them were wondering what made me the “expert.”

Later in the day, Mr. Perez had scheduled a meeting of all mathematics teachers and special educators to formally introduce me to that staff. He did a great job of explaining the role of a coach and what I could do for mathematics instruction in the building. People were friendly, but I could sense skepticism on the part of many.

Introducing the Mathematics Specialist to the Mathematics Department

My main objective in the first meeting with Doug and the mathematics department was to make sure they all knew that he was there to help the teachers through staff development and collaboration which, in turn, would improve student achievement. I emphasized that I knew they were good teachers and that Doug was not there to evaluate them, but to help show them new ways to teach certain skills, including technology enhanced items (TEIs). I showed them some video highlights of the 1992 US Olympic Men’s Basketball “Dream Team.” The team included some of the best basketball players in the world on one US team, including Michael Jordan and Magic Johnson. I then showed them some video of their coach. The point was that the best players in the world benefit from having a coach and the Mathematics Specialist was designed to be their coach. This showed them that it was not punitive, and that they should embrace the opportunity to have the assistance of a Mathematics Specialist.

Mike Perez Reflection
As the year began, I decided that the best way to reach the teachers was to build relationships. I attended all planning meetings, offered ideas when appropriate, and took on administrative tasks to lighten their load. I also started dropping by classes to observe the learning taking place. As my familiarity with the staff increased, I started to be more assertive when presenting instructional ideas and best practices. Grade-level content planning meetings were held twice a week. After a few weeks of the school year, I took on a more assertive role in the meetings and shared my ideas on some best practices to use when presenting new material to the students. I developed lesson plans and activities they could use in their classrooms. My suggestions were well received, but not always implemented.

Just such an example occurred in late October when the pre-algebra teachers started a unit on proportions. I asked them how they taught the concept and their response was surprising. They explained that they teach the students an algorithm using the calculator. I explained that, while it may be expedient to teach it that way, the students are not gaining any understanding of what a proportion is and its importance in mathematics or in real life. I demonstrated a method of teaching proportions that develops understanding, as well as providing the students with easy access to the solutions. One of the teachers was adamant that her students would never take the time to set up the problems my way. I modeled the process several times, explaining how each step would enable the students to develop their understanding of proportionality and help them reach a solution more easily. Proportionality is such an important concept in the middle school curriculum, I just could not let the teachers' reluctance to try a new process inhibit the proportional understanding of their students.

I left the meeting a bit dismayed, and decided that I needed to take action. I wrote a lesson plan and forwarded it to each of the teachers with a schedule of when I would be coming to their classroom to present it with them. I was taking a big risk and hoped that it would not backfire. I worried that the progress I had made in developing relationships could be ruined, but I hoped that they could see my passion and would allow me to proceed. When I sensed that a couple of the teachers appeared to be a bit disconcerted by my approach, I felt that I should inform Mr. Perez of my actions. I did not want him to be caught unaware if questions came his way. I told him why I had taken the radical approach, and asked him if he thought I was pushing too hard. His response made me smile. To paraphrase, he said, "If you want to make a cake, you have to crack a few eggs!" I left his office very appreciative of his support. Armed with the support of the administration and a confidence that I had done the right thing, I proceeded with my plan. The lessons went well and the students had great success solving proportional
relationship problems. After seeing the lesson, the teachers agreed that it had worked well and incorporated it with their calculator strategy. A week later, the students were being tested on the unit. In the afternoon, the teacher that was most adamant that her students would not take the time to employ my strategy stopped me in the hall. She explained that her students were asking her if they could have extra scrap paper so they could solve the problems using “Mr. Floyd’s way.” She then told me that the scores were the best she had seen in years—I had won an ally!

The news of her success spread quickly through the mathematics department. Soon, I was getting requests from teachers at all grade levels to help them develop activities for their classrooms.

Mathematics Specialist Makes a Difference

The positive change was evident early on in the first few weeks of school. I received positive feedback from the mathematics department chair and from some of the more vocal teachers. Then, I would see the students recognizing Mr. Floyd from his being in their classrooms observing, co-teaching, and teaching as he modeled lessons for the teachers. Students would also shout as they saw him, including one day by the cafeteria when an entire class shouted at Doug, “Hey, Mr. Histogram Man.” The icing on the cake came when one of the most skeptical teachers who initially said, “My [students] won’t be able to do that,” then later exclaimed, “Oh my goodness, not only did they do that, but they scored the best on this unit test than any class I have ever had.”

Mike Perez Reflection

Grade 6 teachers were the most enthusiastic group. They knew that their previous state assessments were a concern and were eager to find ways to reach their students. The problems on which their students had done poorly involved the concept of finding mean as a balance point. The teacher had read the standard, but still did not understand what it meant. They asked for my help, and I developed an interactive whiteboard lesson for the teachers to try. I used the coaching model in each of their classrooms where I taught the lesson to the first bell; students, followed by the teachers, then took a larger role in successive bells [1]. Eventually, I was just an observer. The lesson was a huge success! Not only did the students grasp the concept, but the teachers understood the standard for the first time.
Mathematics Specialist’s Work with Teachers Impacts Students’ Test Scores

I knew from NSF Principals’ Institute presentations that the expected increases in student achievement were expected to come after three years; but, I also knew that Doug was having a huge impact and predicted immediate and significant improvements in standardized mathematics test scores. The test results showed that was indeed the case. The Mathematics Specialist built relationships with staff and students so they knew he was there to help. He helped in planning, lesson and activity development, devising common assessments, co-teaching, and modeling new ways to teach skills. I am a big believer in the Mathematics Specialist program, and I am willing to pilot the program at the high school level.

Mike Perez Reflection

After many such successes, I found that there were not enough hours in a day to keep up with all the requests from the staff. As the year came to a close, I could feel a shift in the mathematics teaching culture of the school. Classrooms were becoming a bit more student-centered, teachers were regaining lost excitement for the subject, and our scores on the state assessment saw a marked increase. In fact, the sixth grade scores increased by over 20%. It truly was the “spring of hope!”

Jamey Lovin and John Cavanaugh at Great Bridge Middle School

I arrived for my initial interview with Craig Mills, Principal of Great Bridge Middle School (GBMS), confidently armed with awesome questions straight from my Lucy West textbook, a steno pad, a freshly sharpened pencil, and a second for backup [1]. I did not get a chance to ask many questions as Mr. Mills had prepared information and questions for me. He began by sharing his vision of mathematics for the school. He recognized our SOL scores were great; the best in the city, as a matter of fact. He called my attention to the disparity in performance among certain gap groups, and encouraged me to start there. Additionally, he invited me to work on changing the perception of mathematics in the school. He knew students did well in mathematics at GBMS, but he had never heard anyone say they liked it. Also attending the meeting was Mr. John Cavanaugh, assistant principal and building administrator in charge of mathematics instruction. He would help formulate the details of the vision and be the
person with whom I had daily contact. Mr. Cavanaugh had the reputation of having been an extraordinary mathematics teacher in our district and one the students loved. No pressure!

Mathematics Specialist’s Challenge to Be Accepted

Before even meeting Jamey, I had already assumed that our new Mathematics Specialist would meet initial resistance from our staff. This is by no means an indictment of our mathematics teachers. We have an excellent staff with a wide range of teaching experience. Rather, it would have been unrealistic to expect our staff (or any staff) to begin taking direction/suggestions from someone that they did not know. Our new Mathematics Specialist was going to have to “establish her credentials,” and I expected it to be a slow process.....kind of a grass-roots movement. I presented this theory to Jamey when we met initially to discuss her role.

John Cavanaugh Reflection

Mr. Cavanaugh’s marching orders were to work with the grade 8 teachers. He encouraged me to start with two he had chosen. One was the teacher of a group of at-risk students in a mathematics prep class, the makeup of which reflected the gap groups Mr. Mills had referenced. The second was a teacher new to the profession and new to the school. The conversation continued with him discussing what he thought I would be able to accomplish. I left with a full steno pad and two dull pencils.

Mathematics Specialist Supporting Teachers

As Jamey mentioned, I did discuss two teachers in grade 8 that I wanted her specifically to work with at the start of the school year. One of the teachers was brand new to teaching. Common sense dictated that if we have a Mathematics Specialist in the building, that person should be providing support to a new teacher. The second teacher was a veteran teacher that was teaching our Mathematics Prep class. Each student in this class had not passed their Mathematics 7 SOL Test the previous year. They were enrolled in this class so that they could receive additional support beyond the Mathematics 8 instruction. I felt that these students needed to have mathematical concepts presented to them in a different way, and that Jamey would be able to provide support in this area. While the teacher of this class was an excellent teacher, I believed that Jamey and this teacher would work well together, which would ultimately benefit the students.

John Cavanaugh Reflection
As I left the meeting, I was reminded of a leadership class activity, during which we were asked to complete the simile: “Being a Mathematics Specialist is like [fill in the blank].” Although I had been unsure how to finish that sentence just two months before, I realized in that moment that I would say, “Being a Mathematics Specialist is like being a master juggler.” Where was I going to start? I knew that I needed to plan a space in my schedule to grow Professional Learning Communities (PLCs), help teachers develop more student-centered lessons, and facilitate collaboration and cooperation among the teachers.

My first step was easy. Mr. Cavanaugh saw that I had a well-appointed room where I set up a welcoming environment with coffee, water, and snacks. We would be able to meet there to plan lessons, model new ideas, arrange coaching sessions, share activities, design common assessments, and compare data. I felt like I had created an environment where PLCs could flourish.

My second step started off slowly. I had thought the best way to engage students and excite them about mathematics was to implement more student-centered lessons in the classrooms, and I sought to incorporate at least one into every unit. To aid in this, I set up learning centers in my room for the teachers. Each center was replete with best lessons from a variety of sources, including those from the Virginia Department of Education (VDOE) “Enhanced Scope and Sequence Sample Lesson Plans” [2]. Each lesson was directly aligned to the grade-level pacing guide (Math 6, 7, 8, Algebra and Geometry). The lessons were ready-to-go, cut out, laminated, and included a copy of all reproducible manipulatives and teaching notes. Teachers could check them out to use in their classrooms and if assistance was needed, sign up for me to join them for a day. These days were the highlight of my position. After a planning session, I would spend the entire day with the teacher, modeling the lesson during our first session with the students. The teachers would follow along with provided teaching notes or notes we had made in our pre-conference, then modifying them as they observed the students, jotting down questions I used to illicit certain student responses, and documenting moves I made to push on student understanding. Most importantly, they would highlight areas they thought they could teach on their own during our second session with students following a co-teaching model. During this session, the teacher would teach the portions of the lesson they felt most comfortable with and I would teach the others. Additionally, we worked out signals for me to support them should they need assistance during a portion they had previously selected to teach alone. Most of the time, we would meet for a few minutes before the final session in which the teacher would teach the lesson alone and I would act as an observer.
At first, my schedule was free and full of opportunities to work with the at-risk students. We joined in the stock market game and consistently placed in the Top Three of our division. As word spread and student interest increased, other teachers became interested in participating in the coaching sessions.

By January, I felt a buy-in on the part of most of the teachers on the grade level. By February, other teachers from other grade levels began to invite me into their classrooms. One teacher attended a stock market game meeting with me and then enrolled her class. In the end, my schedule was so full I had to leave one class a few minutes early to arrive in the next a few minutes late. I travelled the halls carrying my appointment book so people could book me on the run. I was happily overbooked!

Mathematics Specialist Supports Professional Learning Communities

Jamey’s first year with us coincided with our implementation of Professional Learning Communities (PLCs). We had recently shifted from having one subject area meeting per week to two per week. Now, our focus was to change the nature of these meetings. Jamey played a tremendous role in this transition. The PLCs were held in Jamey’s room twice a week. I would on occasion visit the meetings, and I was able to see how these meetings evolved as the year went on. I was particularly impressed with the evolution of the grade 8 PLCs. What had started out as discussions of “Where is everybody in the pacing guide?” morphed into discussions about effective strategies, knowledge sharing, and data analysis. Whether they realized it or not, the grade 8 mathematics teachers had become the model for what a PLC should look like. Jamey’s role in this evolution cannot be overstated. Jamey discussed effective instructional strategies in the PLC, and modeled/co-taught lessons in their classrooms. The frequency of her classroom participation was minimal initially. However, once the teachers began to hear how effective Jamey was in the classroom, her invitations to model/co-teach became more frequent.

John Cavanaugh Reflection
The final step proved to be the most difficult as the majority of the staff were veteran teachers with great success rates. It was hard to ask them to change something that had appeared to work for a number of years. There was no problem adding a student-centered activity or two, or developing a common assessment per quarter, but all of this sharing and togetherness required collaboration and compromise. One teacher worked on warm-ups, one teacher searched for activities, one teacher brought together a collection of paper-and-pencil practice to support learning, while one searched for technology to reinforce classroom lessons. The revealing moment came during a grade-level meeting when one teacher said, “How can this collection of everyone’s ‘stuff’ be better than mine?” She stopped—then finished, “Oh, did I just say that?” We all laughed in acknowledgement of the concessions we had made for the purpose of community and increased student learning.

Success with the Hard-to-Reach

Revisiting my decision to pair Jamey and my Math Prep teacher: of the twenty students in the Math Prep class, ten of them ended up passing their Math 8 SOL. While a 50% pass rate for a class might not sound impressive, it must be remembered that the entire class roster consisted of students that had failed the previous year’s SOL test—in fact, a significant number of the students had never passed a Math SOL. I viewed this as a success story, and the collaborative efforts of Jamey and the Math Prep teacher had a significant impact.

John Cavanaugh Reflection

All in all, it was a great year. Several teachers scheduled meetings with me for the summer so we could get a head start on the new school year! We exchanged phone numbers, addresses, and summer e-mails. It really was “the best of times.”
A TALE OF TWO FIRST-YEAR MATHEMATICS SPECIALISTS

References


THE COLLABORATION OF A PRINCIPAL AND A MATHEMATICS SPECIALIST

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Abstract

This article describes the importance of the collaboration between the principal, Patty Granada, and the Mathematics Specialist, Susan Garthwaite, in fostering a highly functioning mathematics program. While many aspects of the collaboration as facilitators for a mathematics program are logical, the “messy” aspects provide greater challenges. Through continued collaboration, they have come to embrace the “messiness” which has contributed to an awareness of similar belief systems in their roles. These beliefs include openness to learning and a sincere commitment to bringing out the best in students and teachers. The principal and the Mathematics Specialist share their continued journey in this collaborative relationship that is essential to the success of the mathematics program.

The Logical Start

Developing a strong mathematics program is both logical and messy. The logical part started before the beginning of the school year when Patty Granada (the principal) and Susan Garthwaite (the Mathematics Specialist) met to establish roles and clarify the vision for the mathematics program. Scheduling a regular weekly meeting to check in about the mathematics program was logical. Deciding what Susan does and what Patty does was logical [1]. Logical, simple, almost easy.

The vision for the mathematics collaboration was clear. They trusted the professional literature about the role of the Mathematics Specialist to support teachers in their continued learning, and the necessary support of the administrator in the success of the mathematics program. Susan’s responsibilities were to facilitate and attend meetings, plan and co-teach lessons, and manage the details of coordinating a mathematics program. Patty’s responsibilities were to oversee the bigger picture of how the mathematics program fit into the school, communicate a vision and expectations regarding the mathematics program, and coach Susan [2, 3].

Yes, this seemed so logical. The meetings that Susan would facilitate and the classrooms where she would provide the most support were prioritized. The School Improvement Plan was
reviewed and a common understanding about the school’s student achievement goals was reached. A weekly meeting time for the two to meet was set. In these meetings, Susan would come prepared with a list of items and questions. These generally fell into three categories: 1) conducting administrative tasks, such as ordering materials; 2) coordinating the mathematics program, such as facilitating meetings and teacher visits; and, 3) sharing perspectives related to best practices in mathematics instruction.

Instructionally, the schoolwide focus was to strengthen the mathematics program by continuing to take the following actions: engage students in meaningful, challenging experiences that developed their critical thinking skills; develop students’ capacity to solve problems in real-world contexts; and, support the role of the teacher as facilitator of student learning.

Yes, it was all so clear and logical. It was going to be an easy year.

The Messiness Begins

The school year began. The students arrived, and mathematics instruction was underway. As time progressed, Susan was increasingly noticing the challenges students were having with solving mathematics word problems. This seemed to be a common concern in dialogue with teachers, too. At the same time, in every classroom, Susan noticed anchor charts and posters related to reading strategies. She initiated informal dialogue with the reading specialists, teachers, and teams about these strategies in the reading program. What were these strategies? How were they used to support student thinking? If they could help student thinking in reading, what might be their application to mathematics?

Susan gradually came to understand that these reading strategies had the potential to be helpful if applied to mathematics problems. This was a sentiment shared by several teachers. Together, Susan, a reading specialist, and classroom teachers from different grade levels created and co-taught lessons to help students make those same connections. They reflected on their work with students around this topic, and how to continue to help students gain a heightened understanding of how reading connected to mathematics and how thinking strategies could be applied in mathematics. At the next school leadership team meeting with representatives from every grade level, the teachers involved shared their continued learning about the powerful connections between reading and mathematics, and how student learning was being impacted.
As the months went by, teachers and teams gained an increased awareness of thinking strategies that apply to both reading and mathematics. The teachers and teams continue to embed thinking strategies to support students in becoming more proficient problem solvers.

During this process of reflection and learning about how to apply thinking strategies to both reading and mathematics, Patty had a supportive leadership role. She coached Susan and the reading specialist throughout the process. She asked questions and helped them clarify their thinking, plans, and goals. She directly and indirectly communicated her support for this learning, acknowledging that this learning process takes time.

This collaboration around these mathematics-reading thinking learning strategies is reflective of a key principle outlined in All Systems Go: “The solution is not a program; it is a small set of common principles and practices relentlessly pursued. Focused practitioners, not programs, drive success” [4]. Their collaboration also aligned with Cwikla’s descriptions of teaching professionals actions when facilitating change [5]. Cwikla used the following criteria:

- Focus on students’ thinking and learning.
- Participate in productive collaboration.
- Engage in gradual but steady improvements.
- Conduct classroom experiments.

Reflection on the learning and practices related to mathematics reading thinking strategies led to the realization of the lack of a plan or following logical steps. This process of supporting students’ critical thinking in mathematics has been, and will continue to be, quite messy. Furthermore, it demonstrated, as working in complex systems often does, that just one question—“How can we apply ‘thinking’ strategies to mathematics?”—can lead to deeper, more profound questions:

- How do students think in mathematics?
- What do they do that demonstrates their thinking?
- Are their misconceptions related to mathematics concerns or reading concerns, and how can we make that distinction?
Are We the Problem Solvers?

In conducting continuous dialogue about the mathematics program at the weekly meetings, the driving question is always this: how best to support the mathematics program that engages students in challenging, real-world problems to solve? Sometimes the focused dialogue allows insights that would not have occurred otherwise. This, too, lends messiness to the collaboration.

For example, a few months ago, Susan shared her perception of a pattern beginning to emerge with several grade levels. When students were asked to solve problems, part of their challenge appeared to be in reading and following directions on the paper. Students seemed too dependent upon teachers for clarification in order to begin independent work. Patty and Susan identified the problem: Students could not understand directions. Check.

The next logical step was to begin to generate a solution to this problem. Susan would meet with teachers, introduce direction reading as a genre, and collaborate with the reading specialist to provide modeling and instruction to teachers on how students could become independent readers of directions. Patty and Susan solved the problem: Teachers were going to get trained. Check.

Fortunately for Patty and Susan (as well as the rest of the staff and 700+ students), as they were solving the problem, they stepped outside of their dialogue. Patty and Susan realized that this problem solving they had gotten caught up in was not going to work. It seemed like they were riding on some train, and they began to question where it was heading, who was driving it, and if it was really the right train in the first place. While reflecting on the problem solving, they realized that they had been making assumptions about whether there was a large-scale problem with reading directions in the first place. They were jumping to solve a problem of their own making, and weren’t including the teachers in the process.

By the end of their meeting, they were both completely clear that, while reading directions might be a topic of future exploration, it was certainly not one that was an immediate priority. Teachers were still growing in their learning about the connections between reading and mathematics, and believed in the benefit of those connections. Teachers did not believe direction following to be a key issue in mathematics, and therefore, adding that on as another instructional change would detract from the bigger focus of thinking skills.
A conversation that had started with the question, “How are we going to support student understanding in mathematics?” had ended with the more significant question, “If we are not problem solvers, what is our role as we support this mathematics program?” This was definitely a messy question to answer.

**We Are the Facilitators of Learning**

This led to a significant insight about decision making in their school. When Susan meets with anybody—Patty or teachers—Susan is the content expert. If asked questions about mathematics, she could have a lot of answers. Therefore, if her role were logical, perhaps she would simply answer questions and solve problems. Yet she has come to understand that she is more a facilitator of teachers’ learning; as such, she supports teachers in constructing their own learning and is a guide along the way. Similarly, when Patty meets with Susan, Patty’s role is to facilitate Susan’s thinking, not to give Susan steps to follow. Steps to follow might seem logical, but if Patty determined these for Susan, it certainly would not honor her as a learning professional.

Through collaboration, Patty has come to a greater understanding of her role in supporting the mathematics program. As a principal, Patty makes decisions about the mathematics program, and one key decision she has made is this: The teachers make their decisions about their teaching and learning focus. The teachers are the deciders and the implementers. Therefore, when Susan and Patty collaborate, it is with the understanding that both are facilitating a process of learning that empowers the teachers. In their collaborations and throughout the building, Patty and Susan are facilitators, liaisons, coaches, and resource-developers. They have become clear that all the aspects of their roles, both the logical and messy, are in developing the resourcefulness of the teachers because it is the teachers who are developing the most important resource—the students [6, 7].

**Common Beliefs Are Essential to Collaboration**

The progress in their collaboration is attributed to commonly held beliefs. They have come to understand that these beliefs are the essential element of the mathematics program’s success.

**Students Are the Primary Focus** — Their work is guided primarily by the students. The students are the reason for collaborating, their learning is the goal, and they are the first consideration and
the bottom line. Patty and Susan believe that the students’ learning in mathematics will provide them the skills and capabilities that are preparing them for a future of limitless possibilities.

**We Are Learners** — Every meeting is an opportunity for Patty and Susan to grapple with questions about how to support teachers and students, and are open to new ideas. This “disequilibrium” is an essential part of the relationship and growth. For example, when Patty noticed that teachers were frustrated with students struggling with multiplication facts, she asked Susan for help in understanding the underlying issue and options to address it. In the ensuing dialogue, Susan opened Patty’s eyes to a new way of thinking about multiplication facts.

Susan, who stays current with research and literature about best practices in mathematics instruction, enjoys her learning with teachers. She enjoys grappling with how to make research-based practices relevant in a class full of twenty-nine students. She enjoys the collaborative team meetings, where surprising ideas can unfold, whether it is insights related to student assessment data or ideas about using hand signals in mathematics class.

When meeting, their identity as learners takes precedence, and more down-to-earth notions about their work together where learning is the core is adopted. This can potentially be a challenge for a principal and Specialist to navigate. According to Tschannen-Moran, “Because of the hierarchical nature of the relationships within schools, it is the responsibility of the person with greater power to take the initiative to build and sustain trusting relationships” [8]. Patty accepts responsibility for her important part in developing and fostering that trust.

While Susan and Patty may have clearly established roles when they first began working together, they did not begin immediately with a high level of trust. Yet trust began to build through every interaction and meeting. Their dialogues about learning in the mathematics program have helped them continue to develop trust. Susan knows that when they meet, Patty wears a coach hat. Susan’s trust in Patty as a coach allows her to share her thoughts freely and openly. Patty knows that when she is sharing a thought with Susan, it won’t be interpreted as a decree for which action is expected afterward. Patty, who will offer a variety of thoughts and suggestions, trusts in Susan’s critical thinking skills to crystallize their thinking and elevate the dialogue. Patty and Susan would both agree that when they meet, the center of the meeting is learning. Their learning invigorates them.
A Belief in Everyone’s Potential — Patty and Susan firmly believe that all students can reach far and high, and that all teachers and teams have infinite possibilities within them. Everywhere they look, they see committed, dedicated students and staff members working together for student success. They believe that when everybody walks in the door, they are walking in with a mindset of possibilities. They believe that everybody wants to be their best and is trying to be their best. Patty and Susan are inspired by the learning community of which they are fortunate to be a part, and that makes them want to continue being their best.

Logical and Messy: Final Thoughts on Their Collaboration

When Susan and Patty began working together, the collaboration initially seemed logical. In truth, many aspects are, indeed, quite logical. The mathematics program has clear instructional goals. Patty and Susan have clear roles to support these goals. There is a logical structure to their meetings, and they have a logical algorithm to the work. Patty develops Susan, Susan develops teachers, and teachers develop students. They have three simple, deeply held beliefs that are mirrored in their relationships with each other and with staff members. The logic and structure of their communications are definite assets. It’s how they navigate them together that can be messy. This messiness reflects the nature of working in a highly interdependent system. The messiness lies in the surprises that come when they really pay attention to what students and teachers are learning, and how they are learning. The messiness is evident when one simple question leads to several more questions, and they do not have simple answers. When we embrace our collaboration as learners, we accept that our learning will always transcend logical structures and processes. While messiness is a challenge, it is a joy worth the journey together.
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DEVELOPING A NEW PARTNERSHIP

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Abstract

Many factors contribute to the success and impact of a Mathematics Resource Teacher on K-5 mathematics instruction. Developing a strong partnership with stakeholders and sharing a common vision for quality mathematics instruction are key factors in the successful implementation of the Mathematics Resource Teacher program. In this article, we share the experience of elementary school principal, Timothy Martino, as he prepared to open a new elementary school in August 2012. Frederick Douglass Elementary opened with a full-time, school-embedded Mathematics Resource Teacher, Mrs. Cindy Brady. Timothy Martino and Mrs. Brady developed a partnership with division-level central office staff and with the teachers of Frederick Douglass Elementary. Thus, they began the journey toward improving mathematics instruction for students through a team approach.

The Mathematics Resource Teacher (MRT) program has been evolving in Loudoun County Public Schools since it began in 2004. With the inception of the MRT position, a program and job description needed to be clearly defined and implemented with classroom teachers. The following questions needed to be answered:

- What is the purpose of the program?
- Is the MRT a support system for teachers?
- Do they deliver lessons?
- Is the role of the MRT to model teaching and learning practices?
- Is s/he a remediation specialist?
- What is the role of the building principal in the MRT program?
- What is the role of central office staff in the MRT program?
Since the MRT program began, the program has gone through several different implementation models. One of these implementation models was school based, where the MRT supported a single school, two schools or up to six schools, and provided support to K-5 grade teachers in a single school setting, or supported select grade levels/teachers when shared among several schools. Another implementation model was a divisionwide professional development program. In this model, the MRTs provided professional development in content and pedagogy to cohorts of teachers, and sustained the professional development by supporting teachers at the school level. In each iteration of the MRT program, two key principles that defined the role of the MRT and the purpose of the program remained intact: 1) the MRT serves as a professional development support to teachers for continuous improvement of mathematics teaching and learning; and, 2) defining a program model to include a certain level of flexibility in order to meet the diverse needs of the schools. The implementation model was not the only component to have gone through changes. The roles of the stakeholders (principals, central office staff, teachers, MRT) also evolved. Through each change, it became evident that the most effective implementation model came from the successful partnership between the principal, central office staff, MRT, and teachers.

The Principal and Central Office Partnership—Setting Expectations

In Spring 2012, the Loudoun County Mathematics Resource Teacher (MRT) program was going through change in its implementation model. The MRT program moved from a divisionwide professional development model to a single school-based role. Having only eight MRT positions in the entire county, one position was offered to Frederick Douglass Elementary. Central office staff partnered with the principals in implementing the MRT program in order to establish a common expectation for the MRT program and the MRT role. Revisiting two key principles of the MRT program, the MRT would serve as a professional development support to teachers, and the MRT would have certain levels of flexibility to support the diverse needs of the schools.

During that same time, as a principal I was preparing to open a new school, Frederick Douglass Elementary School, with a new staff and a vacant Mathematics Resource Teacher position. Finding the right person for this position would be crucial for the MRT program to succeed and positively impact the students of Frederick Douglass Elementary School. Having been provided a program description and job qualifications from the central office, it was now my responsibility to select the best candidate to fill this position. I needed to identify the candidate who possessed the right balance of technical skills and qualifications, with the coaching skills and
the right personality to match the desired school climate. As the school principal, the first step to developing the successful partnerships is in the collaboration, communication, and trust.

The Principal and MRT Partnership: Building a Common Vision

The journey of the MRT position at Frederick Douglass Elementary School began during the 2012-2013 school year. Having experience teaching secondary mathematics and having earned her K-8 Mathematics Specialist endorsement, Mrs. Cindy Brady was selected to serve as the Mathematics Resource Teacher for Frederick Douglass Elementary. With a newly assembled staff and a new school, Mrs. Brady and I had a chance to make critical decisions as to how our partnership would support teachers, but most importantly raise student achievement. Our partnership began during the summer before opening the new school and welcoming the staff to the full implementation of a school-based MRT.

Understanding that the implementation of the MRT program at a school needed to be carefully orchestrated, we believed it was important to better understand our areas of strength and our areas for improvement as a new school staff. To gain this understanding, we decided that Mrs. Brady’s role would be to provide model lessons in mathematics classrooms until I could gain a better understanding of the teachers’ instructional mathematics skills. Knowing that it was important to start off on the right foot and have Mrs. Brady develop and build trusting relationships with the new staff, Mrs. Brady and I made it a priority to ensure consistent communication between the two of us—building a trusting relationship between the principal and MRT. We held regularly scheduled meetings every two weeks, and more frequently as needed, to discuss the status of our mathematics program, as well as discuss strategies to enhance our program. Through this consistent communication and partnership, we have a shared vision for our mathematics program and are working together to meet our school goals.

The MRT and Teacher Partnership: Building a Team

Mrs. Brady jumped into her role modeling mathematics lessons for classroom teachers, and worked hard to build quality relationships to ensure her time in the classroom was not invasive. During this initial time, Mrs. Brady also organized and created a “mathematics closet” to support instruction, and she provided information and professional development on the tools and manipulatives available to support students in learning mathematics. As Mrs. Brady and I continued our regular meetings, we believed that modeling mathematics lessons was a value-added practice to improve the staff’s mathematics teaching practices. As a team, Mrs. Brady and I made the decision to continue our focus on providing model lessons, but also to increase her
role as a team-teacher with the classroom teacher. Mrs. Brady’s gentle approach of introducing strategies, modeling strategies for teachers, and partnering with teachers in co-planning and co-teaching, led to more and more teachers seeking to team-teach with Mrs. Brady. With principal support, gentle suggestions with appropriate supports in place, and a shared vision for the school’s mathematics program, a trusting relationship was being built. Teachers more frequently implemented strategies that were once modeled by the MRT, and classroom walkthrough observations revealed more differentiated small groups for both remediation and enrichment. Students were benefiting from the collaborative partnership between the MRT and the teachers.

Maintaining the Partnerships: Continual Growth and Improvement

During the summer prior to the 2013-14 school year, Mrs. Brady and I reflected on the previous year: identified accomplishments, identified areas in which we could continue to grow, and planned our next steps. We still believed there was more our entire school team could offer the students at Frederick Douglass Elementary. Now that the partnership between Mrs. Brady and the teachers had been established, we adjusted our focus to be on continual professional development and leadership development among the school staff.

Throughout the summer months, Mrs. Brady and I assembled a professional development team that focused on changing the landscape of mathematics teaching and learning by implementing activities like “Problem of the Day” and “Number Talks.” Mrs. Brady and our professional development team delivered several mathematics professional development sessions prior to beginning the school year under the direction of our central office staff. These sessions were very successful, focusing on higher-level thinking skills and getting away from “regurgitation and repetition.” We all shared the same vision for our students to be critical thinkers who could apply and justify their mathematics skills.

As it became evident that Mrs. Brady needed to spend more time in classrooms, we created the “MRT Weeks” schedule to provide the needed supports in a consistent manner. The MRT Weeks was a specific schedule where the MRT supported a specific grade level and team-taught with that grade level on a regular basis. The MRT Weeks schedule allowed for our standardized testing grades (grades 3-5) to have access to Mrs. Brady on a weekly basis while primary grades (non-standardized tested grades) had access to Mrs. Brady on a biweekly basis. With this new schedule, Mrs. Brady was in classrooms nearly the entire day, assisting with the delivery of instruction, providing non-evaluative constructive feedback to teachers, and assisting with every aspect of instruction and assessment. This change is an example of the flexibility in
the MRT program model that was necessary in order to meet the needs of our school and have a greater impact on student achievement.

Our practices in mathematics teaching and learning have improved significantly in a short time, and it is the strong partnership between the Mathematics Resource Teacher, the principal, the teachers at Frederick Douglass Elementary, and central office that is helping the MRT program succeed. Mrs. Brady and I talk regularly, evaluating our progress and making decisions to enhance our school’s mathematics program. We now meet quarterly in a formal setting to work out any issues or challenges we are facing with our mathematics program. One of the most important aspects of improving our mathematics instruction is the relationship that Mrs. Brady and I have built. It is focused on trust, listening, and hearing one another’s thoughts on how to better serve our students. We rely on each other’s expertise and have a true dialogue centered around quality mathematics teaching and learning. We provide input constantly about improving achievement. We look at data together, discuss instructional practice, and continually focus on her evolving role. Another important reason we are successful is the dedication and commitment of our classroom teachers to improve their practice. They have a “students first” attitude, and are willing to grow to better serve our students. When you enter a classroom and see a mathematics lesson, you now see highly differentiated instruction, modeling, getting students to “think outside the box,” and moving from simple paper-and-pencil tasks to students justifying, clarifying, and supporting their answers. Students and teacher alike not only believe, but also support that there are multiple avenues to solving a mathematics problem.

Beyond the walls of our school building, the central office must serve as a partner on this team, maintaining an open communication and providing the necessary resources to support this program. The open communications between the Frederick Douglass team and central office provide us with professional development opportunities and resources for continued growth for each of the stakeholders. This partnership also provides central office staff with feedback as they look to continually improve division-level programs and support to schools. As we continue to move forward, each member of this partnership clearly understands that there is room to grow. We will continue to keep the lines of communication open as we focus on student achievement that will ultimately turn our students into critical thinking mathematicians!
Introduction

Since 2009, there has been increased rigor in the Mathematics Standards of Learning for Virginia Public Schools (SOL) [1]. Emphasis on rote memorization has been decreased. Retention and application of content from previous years, as well as vertical alignment, are now essential to support mathematics instruction at the elementary school level.

With the increasing difficulty of the SOL assessments, the mathematics SOL scores of Jamestown Elementary School’s students began to decline, and a number of other disturbing trends became apparent. There was an overall decrease in assessment results, with more students failing, as well as a significant decrease in the number of students scoring in the “Pass/Advanced” range. When Jamestown’s Leadership Team analyzed mathematics data over time, students at Jamestown demonstrated higher proficiency in mathematics in their primary years than in their upper elementary years. Therefore, while we needed to continue to emphasize mathematics instruction in the primary grades, a plan of action for the 2013-2014 school year that focused on mathematics instruction in grades 3-5 was crucial.

Special education students, even if they did not have mathematics goals on their Individualized Education Programs (IEPs), were not passing their mathematics SOL assessments at the same rate as their peers. Another disturbing trend was the inequity in mathematics performance between girls and boys. The SOL mathematics data from 2013 showed that, in all grade levels, boys outperformed girls at a rate that increased with each grade level. In the third grade, there was a one percentage point difference; in the fourth grade, a seven percentage point difference; and in the fifth grade, an eight percentage point difference in pass rates.

Many of the students identified as gifted in mathematics did not perform at the advanced rate on the 2012 and 2013 mathematics SOL assessments. In 2012, 47% of the students identified as gifted in mathematics scored 525 or below on the mathematics SOL assessments. In 2013,
43% of students identified as gifted in mathematics scored 525 or below. Because Jamestown has had a high number of students scoring in the Pass/Advanced range on the mathematics SOL assessments in the past, these performance issues were disturbing. As a school community, we knew that significant changes had to be made in the upper elementary mathematics instruction.

After Jamestown’s principal attended the “Virginia Principals’ Institute: Partnering to Raise the Ceiling and the Floor in the New Era of Mathematical Standards” in July 2013, she knew that the school’s vision for mathematics instruction needed to change. She modified the Institute’s goals and was determined to do two things during the 2013-2014 school year:

1) Collaborate with Jamestown’s teachers to build a mathematics program that would utilize all available resources to increase understanding and proficiency for students at all mathematics levels; and,

2) Develop the capacity of Jamestown’s administrators and teachers to encourage rigorous mathematics instruction that would include integration of both Virginia SOL mathematics content standards and process goals.

In order to have thirteen highly effective mathematics classrooms in grades 3-5, basic procedures and practices needed to change. As Jamestown’s Leadership Team collaborated over the summer, it decided to implement three practices in grades 3-5 to improve instruction in mathematics:

1) Cluster-group students for mathematics instruction;
2) Implement co-teaching teams for mathematics instruction; and,
3) Focus the efforts of the Professional Learning Communities (PLCs) on improving mathematics instruction.

**Resources in Place**

There were a number of important components in place at the beginning of the 2013-2014 school year that could help with the transformation:

- Administrators and Teacher Leaders had participated in professional development related to PLCs, co-teaching, and higher order mathematics instruction.
- The math coach, experienced both as a classroom teacher and a Mathematics Specialist, was respected, skillful, and collaborative.
• The Resource Teacher for the Gifted (RTG) was collaborative, passionate about co-teaching, and skilled at differentiation.
• The mathematics Lead Teacher had excellent knowledge of elementary level mathematics instruction related to both content standards and process goals.
• The three special education resource teachers had significant experience co-teaching, differentiating instruction, utilizing technology, and collaborating.

There was a stable group of classroom teachers in grades 3-5. All of the teachers were experienced teachers who had collaborated successfully on the same grade-level teams. The Arlington Public Schools’ (APS) Supervisor for Mathematics Instruction and the Supervisor of Gifted Services supported the cluster-grouping and co-teaching models, providing insight as well as professional development for the math coach and the Resource Teacher for the Gifted (RTG). There were districtwide and schoolwide initiatives to implement PLCs during the 2013-2014 school year.

The *Math Expressions* grade-level series published by Houghton Mifflin Harcourt had been the primary textbook resource of APS for three years [2]. Teachers were familiar with the content, strengths, and challenges of this adopted textbook series:
• Grades 3-5 had a consistent 60-minute mathematics block daily.
• Grades 3-5 had a 90-minute block weekly for PLC meeting time.

**Explanation of Cluster-Grouping**

Cluster-grouping is a research-based, best practice in mathematics instruction, a model where students are clustered in a classroom within the ranges described below. In our cluster-grouping model, teachers differentiate and scaffold lessons, while incorporating both the content strands (number and number sense, computation and estimation, measurement, geometry, probability and statistics, patterns, functions, and algebra) and the process goals of problem solving (communication, representations, proof/reasoning, and connections). In cluster-grouped classes, students have the opportunity to learn from each other while being challenged with their intellectual peers.

During Summer 2013, Jamestown’s Leadership Team read and discussed *The Cluster-Grouping Handbook: How to Challenge Gifted Students and Improve Achievement for All* [3].
The team adapted the strategies and procedures presented in this book and created a process for dividing students in grades 3-5 into cluster groups for mathematics instruction. Because cluster-grouping was different than performance or aptitude grouping that had previously been implemented at Jamestown, the practice of cluster-grouping was discussed with parents and classroom teachers throughout the summer.

In the Jamestown interpretation of the cluster-grouping model, all students at each grade level received a grouping number:

# 1. — Students identified as gifted in mathematics
# 2. — Highly able mathematics students who were not identified as gifted
# 3. — Students performing on grade level in mathematics
# 4. — Students achieving below average in mathematics
# 5. — Special education students with mathematics goals on their IEPs

The Leadership Team analyzed the available mathematics data for each student, primarily the Spring 2013 SOL mathematics data, and the APS Fall 2013 beginning-of-the-year mathematics assessment results, to assign each student in grades 3-5 a grouping number. Based on these analyses, students were placed in heterogeneous classes with three clusters of learners in each group.

According to Winebrenner and Brulles, there are procedures that need to be followed when placing students in classes in order to narrow the overall range of learners while maintaining the heterogeneity of the classroom [3]. The overall goal is to create classrooms where all students can be both challenged and remediated as needed:

- The highly able students, who were not identified as gifted, needed to be separated from the students who were identified as gifted.
- The students who were identified as gifted in mathematics needed to be separated from the special education students who had mathematics goals on their IEPs.
- Students who were achieving below average in mathematics needed to be separated from students with mathematics goals on their IEPs.
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<thead>
<tr>
<th>Grade Level</th>
<th>Teacher</th>
<th>Cluster Numbers</th>
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<tbody>
<tr>
<td>3</td>
<td>Teacher 1</td>
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<tr>
<td></td>
<td>Co-teacher: RTG</td>
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<td>3</td>
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<td>1, 3, 4</td>
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<td>3</td>
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<td>3</td>
<td>Teacher 4</td>
<td>2, 3, 4</td>
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<td></td>
<td>Co-teacher: Math Coach</td>
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<td>Co-teacher: Math Coach</td>
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Advantages of Co-Teaching

This cluster-grouping model has allowed Jamestown to use their Mathematics Specialists, the math coach, RTG, and special education resource teachers strategically.

The math coach has been able to co-teach with four teachers in grades 3-5 on a regular basis instead of working with all thirteen classroom teachers separately. This model allows her to co-teach in three or four mathematics classes at each grade level on a weekly basis. Because she is able to co-teach regularly in classrooms, she can collaborate with classroom teachers to plan and to model differentiation for the range of learners in the mathematics classes. Working together, the math coach and the classroom teachers are able to provide differentiated activities for students who need extensions, as well as for students who need remediation by using rotations, tiered lessons, independent work, and learning contracts that compact the curriculum. This year, the math coach has also been more available to consult with the special education resource teachers during PLC meetings.

The RTG is making more of an impact on the instruction of the students identified as gifted in mathematics when this cluster-grouping model is used. Many of the gifted learners are abstract thinkers. The importance of cluster-grouping for those identified as gifted in mathematics is that teachers are differentiating and creating lessons that challenge students’ thinking about a concept through problem solving and higher-level questioning. On a daily basis, all students have the opportunity to solve challenging problems with their peers. The classroom teachers and the RTG plan together weekly and collaborate during PLC meetings. Co-teaching by the RTG has resulted in effective modeling of innovative ideas, shared responsibility for students’ outcomes, and the utilization of a wider repertoire of those resources previously used only in the gifted resource room. The differentiation is often invisible to the students.

In the co-teaching model, a special education resource teacher has co-taught five days a week with the classroom teacher whose cluster-grouping includes the Cluster 5 students, those with mathematics goals on their IEPs. For classes that include these students, we know it is critical that teachers are differentiating and giving students many different opportunities to learn a concept. Especially in classes with students in need of special education services in mathematics, conceptual and hands-on lessons have been emphasized.

This focus on mathematics which has emphasized co-teaching and planning, as well as participation in PLCs, has allowed special education resource teachers to apply their special areas
of expertise related to lesson planning and differentiation with the efforts of the entire team. Resources and strategies employed by the special education resource teachers have been shared with the grade-level team members during PLC meetings, and many have been adapted and implemented by all the teachers on the grade level. After establishing trust with the grade-level teams, there has been honest, courageous, and sometimes uncomfortable conversations among PLC team members about what needs to be done to meet the needs of all learners. The climate at Jamestown has started to change from the climate of “The student isn’t learning the way I am teaching” to “How can I change my teaching practices so the student can learn?”

The special education lead teacher has found that the biggest benefit has been the level of commitment from her co-teacher. In the past, she has observed that teachers with students who have IEPs have been curious and invested, but with co-teaching she has found that there is a true, shared interest. The students in the class feel it, too. They approach both teachers for assistance. They know they have two dedicated adults that they can equally trust for help. When one of the co-teaching teams, a fourth grade classroom teacher and a special education resource teacher reflected on their collaboration, they agreed.

A major benefit of co-teaching is the discourse that occurs between the two teachers during lesson planning and in the reflection that occurs after instruction. When you plan instruction together, you are forced to verbalize your go-to strategies and philosophies. Once these ideas are on the table, they are tweaked and improved upon on a daily basis. Both teachers are able to ask probing questions of one another; such as, what the core objective of the lesson is or how the lesson will engage and challenge the strongest students in the class while also ensuring that the struggling learners’ needs are met. After the lessons, both teachers are able to offer daily, observation-based, constructive criticism about delivery and content of instruction as well as behavior management. The end result of all of this is more individually tailored instruction for the students, which leads to improved learning outcomes.

This year, because of co-planning and co-teaching, the expert mathematics educators (who have had training and experience with the process goals) have been able to influence mathematics instruction for all students. On a daily basis, “math talk moves” have been implemented and there is more mathematics discourse. The regular use of the *Exemplars* mathematics tasks at grades 3-5 has emphasized problem solving, proof/reasoning, and communication [4].
There are many students struggling to communicate their mathematical thinking orally and in writing. Teachers continue to reflect on this issue and to implement strategies that help students practice using appropriate mathematical vocabulary. The co-teachers who teach multiple grade levels are able to give students and classroom teachers information about the “big picture” view of mathematics that helps them make connections across the grade levels. When co-teachers teach across three grade levels, they can see the connections in the curriculum and then help the students make those connections.

One of the characteristics of gifted learners is their ability to quickly make connections within content areas. If this is expected of gifted learners, then it should be modeled in the classroom. For example, learning how to break apart a harder multiplication fact into the easier facts (12 x 8 becomes 10 x 8 plus 2 x 8) in the third grade becomes an essential foundation for the fifth grade SOL objective involving the distributive property. Co-teachers who teach the curricular connections across the grade levels are able to make this “connection building” a daily component of their mathematics instruction in ways that classroom teachers, who are only familiar with the curriculum standards of one grade level, cannot.

Professional Learning Communities (PLCs) Focused on Mathematics Instruction

A major initiative of Arlington Public Schools has been the districtwide implementation of PLCs. Because of this initiative, Jamestown staff was able to form PLCs at each grade level for the 2013-2014 school year.

As teachers closed out of the 2012-2013 school year, they received a copy of Learning by Doing: A Handbook for Professional Learning Communities at Work [5]. They were asked to read the book over the summer with the expectation that their teams would start forming PLCs during the pre-service week in August 2013. According to the authors of this book:

A PLC is an ongoing process in which educators work collaboratively in recurring cycles of collective inquiry and action research to achieve better results for the students they serve. Professional learning communities operate under the assumption that the key to improved learning for students is continuous, job-embedded learning for educators [5].

Members of the Leadership Team decided to focus on three essential concepts of the PLC process during the 2013-2014 school year:
1) The purpose of our school is to ensure all students learn at high levels;
2) Helping all students learn requires a collaborative and collective effort; and,
3) Assessing our effectiveness in helping all students learn, we must focus on results evidence of student learning, and use results to inform and improve our professional practice and respond to students who need intervention or enrichment.

During Summer 2013, members of the Jamestown Leadership Team attended a week-long intensive training on PLCs. During the training, the Leadership Team decided that focusing our PLC initiative on mathematics instruction in grades 3-5 would enable teachers and administrators to collaborate on the improvement of mathematics instruction. This type of implementation would also narrow the focus of our PLC implementation enough to make it manageable for the grade-level teams as well as the Specialists working with these three grade levels.

During the development of the master schedule, weekly PLC meeting times were designated on the master schedule, along with sixty-minute blocks of time for mathematics instruction at all grade levels. The following non-negotiables were established for the implementation of the PLC process with a focus on mathematics instruction:

• All classroom teachers and Specialists who co-taught would attend the weekly PLC meetings;
• At least one administrator would attend all PLC meetings;
• Minutes would be written in Google Docs™ for all PLC meetings; and,
• All members would contribute to the Google Docs™ agendas for PLC meetings.

As the school year progressed, the following became the normalized practices of PLC meetings for grades 3-5:

• Discussions about Virginia SOL mathematics content strands and process goals that needed to be covered each quarter and how students would master them.
• Discussions of management, procedures, resources, and strategies necessary to differentiate instruction.
• Creation of common assessments with a focus on backward design, which has also encouraged conversations around what the students do and need to master by the end of each unit.
• Discussions about how students were/were not learning mathematical concepts.
• Common planning focused around the idea of problem solving, especially the use of mathematics tasks from the *Exemplars* website and other types of problem solving.
• Analysis of data from formative assessments and using that data to drive future instruction.
• Discussions about the shared responsibility for student achievement and the concept that all members of the grade-level PLC were responsible for the progress of all students at that grade level.
• Discussions of the students’ progress toward the mathematics goal shared by all the members of the grade-level PLC.

As a result of the PLC process, teachers have collaborated on analyzing data, planning lessons, developing differentiation strategies, and writing common assessments. Since this is the first year of implementation, teachers are working through the significant changes in their practice and the PLC teams are at different levels of proficiency.

**Shared Responsibility for Students’ Outcomes**

After analyzing student mathematics data, each grade-level PLC created a goal focused on the needs of all of the students on that grade level. Since teachers and co-teachers have been collaboratively analyzing grade-level mathematics data, creating common assessments, solving issues related to teaching and learning, and planning collaboratively, all of the teachers at each grade level agreed to share the responsibility for the achievement in mathematics of all of the students. Achievement of the PLC goal will be a very important component of the teachers’ annual evaluations, and students’ academic progress in mathematics—related to the grade level goal—will be used as an important piece of evidence on teachers’ annual evaluations at the end of the 2013-2014 school year.

**Challenges**

At Jamestown Elementary School, classroom teachers have traditionally taught their students all subjects. Our philosophy has been that elementary classroom teachers build strong and effective relationships with the students they teach and with their parents. Home-school communication is a strong bond between the classroom teacher and the parents. It includes weekly e-newsletters, frequent informal conversations, and formal parent-teacher conferences. With our new model of cluster-grouping, many students have a different teacher for mathematics than they have for their other subjects. Parents, who have been supportive of the cluster-grouping approach in mathematics, have been concerned that they do not have the same level of
communication with their children’s mathematics teachers as they do with the classroom teachers. Consequently, the PLC teams have been working on improving communication with parents regarding progress in mathematics.

More professional development is needed in all aspects of this transformation, and the professional development needs to be differentiated. In some cases, teachers need more basic education in mathematics content, as well as more training in the new research-based pedagogies. Teachers need more support in understanding and implementing a wide variety of differentiated learning strategies—including rotations, compacting, and technology integration—because differentiating mathematics instruction is imperative for cluster-grouping to be successful. Finally, teachers and administrators need more professional development in data analysis and assessment.

Building a collaborative culture, which is absolutely essential for both effective co-teaching and functioning PLCs, is difficult. It takes commitment, time, and effort as well as more sustained and systematic professional development. Planning time is a major consideration. When co-teaching is the expectation, common planning time is extremely important. There is scheduled time for weekly PLC meetings, but these meetings often do not include time for planning and preparation for the co-teaching teams. At this point, much of the co-planning occurs after school or on weekends.

There is also the more subtle challenge of changing the conventional thinking of how students are grouped. Many teachers, parents, and even the students themselves only think of grouping students by their “level” in mathematics. If we are successfully implementing best practices, all of our students will be able to be educated in a heterogeneous environment in elementary school.

**Next Steps**

Our goals for the future are many. Specifically, we would like to offer professional development based on the following topics:

- Professional Learning Communities;
- Higher-level mathematics content for teachers;
- Data analysis, understanding, and utilization to inform instruction;
- Collaboration and co-teaching; and,
- Training related to the pedagogy of specific strategies, especially differentiated instruction.

Our combined perspectives, resource knowledge, and collaboration have provided us with a unique foundation. This insight has led us to create our other goals:

- Keep co-teaching teams together for next year; it can take several years for co-teachers to function at full potential because it takes time to build relationships and trust.
- Create more common planning time for the co-teaching teams of Specialists and classroom teachers.
- Utilize technology to support higher-order thinking skills, problem solving, mathematical communication, and differentiated mathematics instruction.
- Educate parents regarding the process of cluster-grouping, the need to increase the rigor of mathematics instruction, and the importance of problem solving and the communication of mathematical thinking.
References


MATH SPEAK AND STUDENTS’ JUSTIFICATIONS PROMOTE DEEPER UNDERSTANDING OF MATHEMATICS CONCEPTS

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Winchester, VA 22601

Introduction

“Talking during math class? You mean you actually want us to talk during class? This must be a trick! Our teachers must be going crazy!” These are the thoughts going through our third graders’ heads here at John Kerr Elementary School in Winchester, Virginia. This year, math class has been different than in many previous years for both teachers and students. After attending professional development sessions and learning about the importance of “math talk,” we have revved up our conversations in math class. Students are now encouraged to share their thinking, and how and why they arrived at their final answer. We have witnessed first-hand the positive impact this has had on our students’ depth of knowledge and mathematical understanding. Our team collaboration, the restructuring of our students, and the components of our lessons have contributed to the increased level of success in our classrooms.

Team Collaboration

They say it takes a village to raise a child and here at John Kerr we are no different. We believe collaboration among our team members and other support staff within the school has directly impacted the success of our students. It truly is a team effort and our district motto “Learning For All, Whatever It Takes,” is evident in our classrooms.

We are a four-person team in which each teacher is responsible for planning lessons for a specific content area. From making Smart Board™ Notebooks, PowerPoint presentations, counting copies, or pulling manipulatives for each classroom, the Mathematics Specialist ensures we have all the materials to teach that day’s lesson. This format allows us the opportunity to have four “experts” on our team who dedicate all of his/her attention to producing effective, differentiated, and intriguing lesson plans. Joe Svoroda is our own math expert. The additional time this planning method allows has led to an increased focus in the inclusion of higher-level thinking problems, collaborative activities, and application problems within our plans.

In addition, we meet at least three times per week to discuss our plans and to reflect on lessons taught. We feel reflection is an essential part of our lessons to adjust our instruction and
make continuous changes to best suit each student’s needs. Our weekly Professional Learning Community meeting includes the following personnel: an administrator; other support staff, such as the English as a Second Language (ESOL) teacher or reading specialist; and, a rotating specials teacher (Art, Music, PE, Library). During these meetings, we discuss student strengths and weaknesses, as well as strategies to use for instruction. This process has increased our ability to provide individualized instruction and intervention for students.

John Kerr is an open school which presents certain benefits. Our pathways into each other’s rooms allow us the opportunities to team teach or peer poach (observe) with our closest neighbor. The collaboration extends beyond the grade 3 realm. Walk into any room at our school and you will see mathematics at work. In art, our students can be seen working on geometrical figures and angles; in music, patterns; in the library, ordering numbers; or, students may be seen skip counting in PE. At John Kerr Elementary, it really does take a village!

Restructuring Math Time

We have a ninety-minute block of time for mathematics instruction. Usually that includes forty-five to sixty minutes of whole group and forty-five minutes of math workshop (differentiated grouping). In order to meet the needs of our students, we have restructured our math groups. During our weekly Professional Learning Community meeting, we identify students that typically struggle in math, but who would be capable of mastering the content if they received continuous individualized instruction on their pace. These students are all moved to our “experts” class for the entire scheduled math block. Who better to teach them than the person responsible for planning our lessons! Joe’s homeroom is then divided among the rest of us. We feel this way of differentiating our mathematics instruction meets the needs of all of our students and provides an optimal learning environment.

The restructuring of our math time has allowed us to provide quality instruction at an appropriate pace for each of our students. Caryn Glassbrenner, Pat Hollins, and Sam Vance provide mathematics instruction on pace with our mathematics curriculum. During our math workshop block, we include differentiated grouping with the same group of students. Just next door, Joe provides instruction on a pace which is needed for his specific group of students. During a typical week, he is two to three days behind the rest of the grade. This is an example of why our collaboration is the key to success. In addition, all support staff (aides, intervention teachers, etc.) are sent to Joe’s room to provide additional individualized instruction to these students. We have found this process has led to higher test scores on our classroom and district
benchmark assessments, and has increased student understanding of content. By providing additional opportunities and time with concepts, students who have struggled in the past are now able to understand and explain their thinking.

**Incorporation of Math Talk**

One focus of our school this year has been to increase time for “math talk.” We are encouraging math talk by providing students more opportunities to convey their mathematical thinking in written and verbal form, incorporating the greater use of mathematical vocabulary within lesson planning, and using guiding questions to encourage students to communicate about mathematics in ways that address the *Mathematics Standards of Learning (SOL)* process goals for students [1].

Critical to developing our understanding of how to encourage math talk have been Virginia Department of Education (VDOE) resources, including documents on its website and the Principals’ Partnering Institutes offered under the auspices of the Virginia Mathematics and Science Coalition. After our principal, Nan Bryant, attended the VDOE Principals’ Partnering Institute during Fall 2011 and the winter of 2012-13, she brought back articles for our staff to read and study together, resources from VDOE, and activities for practicing math talk during our staff development meetings at John Kerr Elementary.

Bryant says, “I credit the teachers for taking the initiative to increase math talk from there. The teachers embraced the connection between achievement and students demonstrating ownership of their learning through math talk.” She also noted, “Teachers are seeing the benefits of the instructional strategies and resources made available through VDOE as students display increased depth of knowledge during math class.”

In order to provide students more opportunities to convey their mathematical thinking, we are including math talk as a key component in our lessons. Students are frequently asked to share with a neighbor how they arrived at their answer or to write an explanation. We have reduced the number of problems given during our lesson and increased the time for students to share their rationales with the class. Often, students are asked to teach some part of our lessons to their classmates. They are able to explain what the problems are asking, provide step-by-step explanations of their mathematical thinking, and defend their final answers to the class with very minimal prompting. We have observed students enjoying multiple ways to solve problems and developing their own strategies to solve increasingly rigorous problems. This has led to a deeper
understanding of the content and an ability to apply the mathematics skills to real-life problems. Students can create a variety of responses through collaboration and math talk when asked to solve a multiplication story problem (see Appendix A).

We have also increased the amount of time spent on mathematical vocabulary. Students have their own math glossaries to which they add their own definitions, examples, and pictures of mathematical terms. We play many math vocabulary games to help students retain understanding of mathematical content. For example, a favorite game in our grade is a mathematical version of Pictionary™. On one slide is a brainstormed list of all math words we have discussed so far this year. Volunteers from teams come up and pick a word to draw. Teams must guess the word and share how they know it was the correct word to win a point. This is one activity that encourages students to think about what the words mean and explain their thinking in choosing answers, rather than simply guessing.

Support from administrators has allowed us to encourage math talk within our rooms to an even greater extent. After multiple professional development meetings concentrated on increasing mathematical understanding for our students, our administrative team provided us with guiding questions to use with our students. These questions are derived from the five mathematics process goals in the Mathematics Standards of Learning for Virginia Public Schools [1]. These questions can be related to problem solving, communication, reasoning, connections, or representations. Having these questions available allows us to focus on one specific math goal for our class. For example, if one class is struggling to make connections from one math topic to another, the teacher could concentrate on using those guiding questions during math time for the next few weeks to address this need. This can be even more individualized by giving specific questions to workshop groups or individual students. We feel this process allows us to address the particular weaknesses within our classes without changing the mathematical content.

Our team collaboration, the restructuring of our students, and the components of our lessons have made teaching mathematics much easier and enjoyable for each of us. We see our students making connections and thinking at a deeper level. Our amazement continues as we teach our math lessons and hear our students using math talk to explain their answers. “So I guess we can talk during math class, but it has to be about math,” said one of our students. “Darn, I had a whole story I wanted to share about my favorite vacation.”

“Yes, dear, it does have to be about math.”
Reference

Below is an example of students using multiple strategies to solve the same problem. Each child explained how they figured out the answer and shared that with the class.

The Smith family is on vacation for 3 weeks. How many days are they gone?

Student 1: skip counted

Student 2: made an array

Student 3: drew equal groups

Student 4: added

3 × 7 = 21

Student 5: multiplied

Student 6: created a numbered array

Student 7: listed out the days of the week

Think: What information do you need to know to solve this problem?
Introduction

For the first twenty-four years of my career, I taught elementary school in Bedford County, Virginia. Bedford County is geographically the third largest county in the Commonwealth. It is a rural area between Lynchburg and Roanoke, made up of three different attendance zones, with each zone containing five elementary schools, a middle school, and a high school. There are approximately ten thousand students in our school division. The Town of Bedford is located at the center of the county. Our central office, the technical vocational school, and our alternative school are located there.

At the fourteen-year mark in my career, I began to study mathematics and why students struggle with learning mathematics. This prompted me to seek out a Master’s in Curriculum and Instruction and the graduate mathematics coursework to obtain the licensure endorsement as a Mathematics Specialist. In 2006, I was hired by my school division to work in the fully funded Title I elementary schools as a division Mathematics Specialist. After four years in this position and another Master’s in Administration and Supervision, I became the Supervisor of Mathematics, Science, and Gifted Education. I had pursued the administrative degree because first as a Specialist and then as a supervisor, I worked in every building in my school division. I felt that it was really important for me to know all of the things that a principal knew. In my roles as a Mathematics Specialist and a division-level administrator, I was able to collaborate with talented and committed educational leaders to do some amazing things to promote the success of all students. Two years ago, my former principal decided to retire. I applied for and returned as the principal of the school in which my career began. I am excited to continue on this journey to create a professional and instructional climate that supports student learning and teachers’ professional growth.

Partnering to Support Professional Development Opportunities

Through my training to become a Mathematics Specialist, it became more and more apparent to me that to be a successful instructional leader, a principal must encourage teachers to
improve their content knowledge. One of the biggest challenges to teaching mathematics well is having teachers feel comfortable with the content. To be effective, teachers must know and understand the mathematics they are teaching, and be able to draw on that knowledge as they skillfully choose their teaching tasks. Professional development must provide teachers with curriculum goals and the big ideas across the content. Teachers also need to focus on how students learn and use a variety of techniques and materials to meet individual student needs. Teachers need to view mathematics as connected and coherent. They must encourage and enjoy the questions that their students ask, recognizing that they can find the answers and help students connect their own understanding over time. Working together, the building principals, central office administrators, and the Mathematics Specialist can provide leadership and support for the school’s mathematics program by providing ongoing opportunities to teachers for mathematics professional development.

In my years serving as the district Title I Mathematics Specialist and the Division Mathematics Supervisor, I worked with several principals to promote effective mathematics professional development in their buildings in different ways. Having a building principal who encourages consistent and sustained mathematics professional development is one of the fastest ways to improve teacher knowledge, as well as teacher confidence and competence. Since Title I funding supported my salary as a Specialist, I was not able to work in many elementary schools during the day. To bring professional development after school for these teachers, one principal and I collaborated to run a mathematics course. Since I work as an adjunct professor for the University of Virginia, we facilitated for-credit coursework in the evenings. Thirteen of her teachers, several teaching colleagues from another school, and I studied two of the *Developing Mathematical Ideas* books [1, 2]. We read cases that explained how students thought about mathematics; then, the teachers returned to their classrooms and tried out the problems from the cases. They brought back student work to share all that their students could do, and we watched videos from classrooms across the country that showed real teachers posing problems to real students. The cases prompted discussions on how to get students to discuss their ideas, questions, and strategies. Teachers found evidence of students collaborating to explain thinking and defending mathematical arguments. These teachers learned to listen to the ideas of students and were amazed at what they could do. They shared this excitement for student learning weekly with their colleagues and in the reflective papers that they wrote. These opportunities to reflect on and refine their instructional practices led to changes in the decisions they were making in the classroom. Many more teachers are asking our central office staff to continue to offer this professional development coursework.
Another principal in whose building I worked weekly as a Title I Mathematics Specialist designed her master schedule so that grade-level teams of teachers had common daily planning time. This allowed for consistent professional development time for me to work with the members of every grade-level team. This creative scheduling gave classroom teachers, the special education support team, and the building's mathematics Lead Teacher forty minutes at least twice a month. This time was used to solve a mathematics problem using a new manipulative or mathematics tool, discuss the common errors that they would expect their students to make, share student work done since the previous mathematics session, and talk about areas where their students were struggling mathematically. Working with teams in these bimonthly grade-level meetings allowed me (the Mathematics Specialist) to know how to help individual classroom teachers with lesson support, manipulatives, modeling, and planning. It also provided insight into the next problem or tool that the principal and I would use in grade-level meeting time together. The principal and I met weekly to discuss the data we generated as we worked to give all students access to quality mathematics instruction that aligned with the standards. This data was also used at the monthly leadership team meetings to discuss schoolwide expectations for best practices.

During my last year as a division Mathematics Specialist and continuing through my tenure as the division Mathematics Supervisor, I regularly attended mathematics department meetings at one of our high schools. Collaborating with colleagues regularly to discuss teaching practice and student thinking is a powerful form of professional development. I worked with the department chair and the principal to design sessions of problem solving, with rich mathematical tasks given to partner pairs of teachers who did not teach the same course. After teachers found a solution and two different ways to explain the mathematics, they discussed the connections from this problem to the course content that they taught. Over time, these teachers began discussing how rich problems, a positive learning climate, and access to different representations help students learn. Sharing the different strategies and representations used in the problems solved during these departmental meetings gave teachers other ideas and the means to have students demonstrate their understanding. This helped to promote engaging strategies in mathematics classrooms. The teachers talked about remediation strategies that would support learners who were struggling at every level. This vertical teaming across teachers of all levels of coursework helped to promote trust and respect across the department, lessened a sense of working in isolation among colleagues, and focused on using teaching practices that would increase every student’s achievement. As the division-level Mathematics Supervisor, this vertical team
problem-solving collaboration became our quarterly model of professional development for all teachers of mathematics in our division.

From Mathematics Specialist to Principal: Applying Lessons Learned

Since becoming a principal in an elementary school, I have used my knowledge of best practices from my Mathematics Specialist coursework in many ways. Since I do not have a Mathematics Specialist who works daily in my building, I use many of the tools that are available on the Virginia Department of Education (VDOE) website to foster daily conversations about teaching. The Student Look-for observation tool uses the attributes of the process goals to observe what students are doing in classrooms [3]. This tool has helped me facilitate conversations about lesson design for student engagement and differentiation. The videos are posted on the VDOE website [4]. They are great to use at the end of a faculty meeting to discuss best teaching practices for a specific strand of mathematics. These ten-minute video clips generate rich conversations about best teaching practices, and give immediate tools and strategies that can be used in classrooms the very next day. Since I show them to my entire faculty, all staff is involved in these conversations of how students learn mathematics.

Since we have started this practice of using videos to discuss teaching practices, beaded number lines and fraction games began to appear in all of our classrooms, and the conversations during grade-level meetings about building number sense have increased. Fractions were earmarked as a struggle for several grade levels, and the music teacher got involved by creating lessons with quarter note and sixteenth note rhythms that students could beat on drums, see in measures, and sing. Students started exercising in gym class to skip counting multiples that helped to improve their multiplication and division fluency. Snowflake folding, cutting, and measuring in art class directly correlated to the 6, sixty degree angles in a 360° circle. This art activity is one where finding the center matters, and has sparked rich conversations with students about other places where the center matters. Ownership for student learning across all staff has increased in our building, and is supported in lesson plans and conversations that occur daily. There are many wonderful resource libraries of videos that a principal can use to target the needs of their specific faculty. A Mathematics Specialist working with the principal who shows videos can help to support the connections made in the follow-up conversations so that all faculty is encouraged to support mathematics learning.

My experiences as a Mathematics Specialist and as a supervisor have shown me the significant influence that principals have as they collaboratively lead professional development in
their buildings. When principals open up their building to the support that a Mathematics Specialist can give, they move the learning opportunities from one of using “activities that work,” to one of analysis of teaching practice. The positives from the collaborative support of a Mathematics Specialist are found in the daily conversations that occur, the boost from in-classroom coaching opportunities, and the expectations for regular grade-level or department learning that is focused on student learning and evidenced in student work samples. These are crucial to improving mathematics teaching and student achievement in any building.

References


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Virginia Mathematics and Science Coalition
RECRUITMENT, RETENTION, AND REPLACEMENT OF PARTNER SCHOOL DIVISIONS

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Introduction

The National Science Foundation (NSF) grant, "Researching the Expansion of K-5 Mathematics Specialist Program into Rural School Systems," is adapting and transporting to smaller remote divisions a promising established elementary (K-5) model for preparing Mathematics Specialists from large urban and suburban school divisions. The grant was awarded in August 2009.

Since then, a total of fourteen Virginia school divisions have participated at some time in the rural elementary school grant. Twelve of these divisions have National Center for Education Statistics (NCES) identifiers as Rural Distant, Rural Fringe, Distant Town, or Rural Remote; the two remaining divisions are identified as either Small City or Large Suburb [1]. The NCES provides district details for the 2010-11 school year, including locale designation used for the two NSF grants. In FY11-12, eight divisions fell below .3000 on a state index of relative wealth. The index, discussed later in this article, is capped at .8000.

An overlapping NSF grant, "MSP Institute: Mathematics Specialists in Middle Schools," built on the same promising established K-5 model, is preparing Mathematics Specialists for placement in middle schools. A total of sixteen divisions have participated in this grant since its award in July 2009. More than half of these divisions have NCES identifiers as Rural Distant, Rural Remote, or Rural Fringe. Five fell below the .3000 level on the state index for FY11-12. Eight divisions have participated in both the rural elementary and middle school grants. All eight of these divisions have NCES identifiers as Rural Distant, Rural Remote, or Rural Fringe. All eight were below the .3000 level for FY11-12.

With primary focus on these NCES-identified rural divisions, this article analyzes matters of recruiting partner divisions to participate in the projects, retaining their participation through the period of the grants, and replacing original divisions that withdrew with new divisions.
Extensive effort has been expended on these tasks by members of the project management team and local school division personnel. Most changes occurred during the early years of the grants. Issues related to division entrance and withdrawal are state policy-related. They involve compliance with Virginia Standards of Quality provisions, such as staffing ratios and educational mandates, as well as the Virginia Standards of Accreditation and the federal No Child Left Behind legislation as implemented in the Commonwealth. Compliance with state policy has considerable economic cost at the local level.

There have been additional local issues that have influenced rural partner divisions' abilities to maintain their grant commitments. These include remote locations, challenging physical geography, sparse populations and low tax bases, as well as few accessible higher education and occupational opportunities. Furthermore, the economic crises of recent years have adversely affected state and local public education budgets, limiting discretionary spending. This article reviews and analyzes the participation of the thirty divisions that took part at some time between the initial recruitment efforts and the conclusion of the grants. The discussion is in two sections: Participation by NCES Code and Participation by Selected State Economic Factors.

**Participation by NCES Code**

**Recruitment: Actively Seeking Participation**

As the opening moves in sparking local division interest in these two Mathematics Specialist projects, the primary investigators designed a pair of attractive brochures and distributed them statewide to division superintendents and mathematics supervisors. The brochures encouraged school divisions to participate in one or both of the grants. They made it clear that many school divisions in Virginia are making use of well-prepared Mathematics Specialists to support and coach teachers in developing teaching approaches leading to greater student success in mathematics. Furthermore, these efforts have been supported by both state and federal agencies. Research from a prior NSF grant investigating the impact found that overall, students in schools with elementary Mathematics Specialists for three years had statistically significant higher scores on the *Virginia Standards of Learning* mathematics tests than those schools without such Specialists [2].

The brochures outlined clearly and specifically the grant commitments to school divisions, such as Specialist-in-training salary support in the initial school placement year, the offering to teacher participants of a Mathematics Specialist master’s degree program, and
stipends for the participating teachers. The expected commitments of the school divisions also were detailed. The divisions were expected to identify schools and teachers for participation, provide additional salary support for one to two years, require principals to attend two, 1-day workshops to learn about supporting their Mathematics Specialists, and designate an individual to serve on the Partners Steering Committee. Steering Committee members advise the grant management team on how the project might support the Mathematics Specialists and their principals in their schools.

Project team members, most prominently the two principal investigators, were energetic and persistent recruiters. They traveled throughout Virginia calling on numerous personal contacts they had developed over the years, visiting superintendents and central office personnel, and also attending gatherings of potential school division candidates. Targeted recruitment efforts were focused wherever interest was expressed. Links to on-line information were provided, as were lists of school divisions that had participated in previous NSF-supported Mathematics Specialists' studies and those divisions that had already committed to one or more of these new opportunities. Particular attention was paid to identifying pairs of comparable schools which would subsequently be randomly assigned to either treatment- or control-school status for the research component of each grant project.

Moreover, the principal investigator for the elementary grant foresightedly recruited one alternate pair of comparable schools and six additional Specialists-in-training from partnering divisions. Such vision was crucial to maintaining the number of school pairings necessary to ensure the validity of the project's statistical analysis. Contacts with other Mathematics Specialist training programs were made and maintained to establish reservoirs of individuals in non-grant training who, if needed, could be called upon to replace any Specialists-in-training who might withdraw from the program in the early months of professional development prior to in-school placement as Mathematics Specialists.

Despite genuine interest on their part, a number of divisions declined to participate in the grant activities. The decisions not to participate stemmed from two factors. One was the requirement that the divisions pay a large portion of the salary costs associated with their employees admitted to the training program. This requirement primarily discouraged the less affluent divisions. The second factor was that a number of more affluent divisions were stymied
in their participation by already having a number of Specialists positioned in their schools. This precluded their inclusion in the treatment/control school research.

**Recruitment: Successes**

The principal investigators' perseverance ultimately produced a roster of eighteen distinct participating school divisions, with twelve divisions in the middle school grant and thirteen in the elementary school grant. Seven divisions were participating in both. Pairings of comparable schools based on size of student enrollment and percentage of students eligible for free and reduced meals were determined for the research component, with some pairings crossing division lines; and, Specialists-in-training were selected.

Specialists in the elementary grant cohort began coursework in the winter of 2010 and were placed in their schools in Fall 2011. The middle school grant's first cohort of Specialists began coursework in Summer 2010 and were placed in their schools in Fall 2012. The middle school grant's second cohort began coursework in Summer 2012 with placement expected in Fall 2014.

Both the size and the composition of the rural school and middle school cohorts differ. The rural school grant had twenty-one pairs of schools (treatment/control) and one cohort of twenty-one Specialists-in-training. The expectation was for each of the trained Specialists to serve in one of the twenty-one treatment schools, supported by a combination of NSF grant money and local division funds for two years.

The middle school grant began twelve pairs of schools (treatment/control) and two cohorts each with twenty-five Specialists-in-training. Twelve Specialists-in-training in Cohort I were identified as research subjects to be placed in the treatment schools; twelve Cohort II Specialists-in-training are being prepared for placement in the control schools at the conclusion of the research study. The partner divisions agreed to provide the additional Specialists-in-training, who are not expected to be placed in the schools participating in the research effort, with opportunities to serve as Mathematics Specialists in other division schools upon successful completion of the training program coursework.

**Retention: Systems, Schools, and Specialists**

As the grants have developed and progressed, considerable attention has been placed on retention: retention of partner school divisions, retention of school pairs, and retention of
Specialists-in-training. These three units are tightly linked, and recruitment efforts continued whenever attrition occurred.

Retention of adequate numbers of Specialists-in-training has been the prime focus. The loss of a Specialist-in-training threatened the continuation of a pairing of participating schools, and thus the integrity of the research component of the study. In the case of a partner division with only one Specialist-in-training, the continuation of the partner division was in jeopardy should the Specialist-in-training not be quickly replaced. Moreover, the loss of a school required re-examination of the pairings of comparable schools prior to assignment to treatment-control status, frequently requiring the recruitment of another school or the activation of a waitlisted school. This was necessary in order to maintain the research design. Furthermore, the loss of a partner division put at risk not only the research portion of the grant, but also the placement of grant-trained Specialists in that division's schools. Therefore, efforts were also made to recruit replacement divisions.

Retention: A Closer Look

An examination of the participating school divisions, schools, and Specialists reveals a variety of forces influencing ongoing presence in the two projects. Three original partner divisions withdrew during the implementation period of the grants. One division withdrew from the rural grant; two divisions withdrew from the middle school grant; and, two other divisions withdrew from the research portion of the middle school grant while continuing in the Specialist-in-training portion.

Three of the five withdrawing divisions are considered rural. These rural partner divisions discontinued their grant participation when each of their sole Specialists-in-training withdrew. Concise descriptions of the reasons for these withdrawals follow.

The sole Specialist-in-training withdrew from the elementary school grant for personal reasons at the end of the second of 10 sessions of planned study. The timing of this withdrawal coincided with the start of the small division's new school year and the partner division was obliged to withdraw its participation. Similarly, the sole Specialist-in-training abruptly withdrew from the middle school grant just before the first round of coursework began with the Summer Institute, an intensive five-week residential program. Replacement of this Specialist-in-training was not possible, as the timing coincided with the beginning of the training program, so the
partner division necessarily withdrew its participation. The withdrawal of a partner division from
the middle school grant was triggered by the unexpected job-related family relocation of the sole
Specialist-in-training to a distance away in another school division.

In addition, one of another rural division's two middle school Specialists-in-training
withdrew from the program. The withdrawal was triggered, again just before the school year
began, by an administrative decision changing that Specialist-in-training's teaching assignment
from mathematics to English. The Specialist-in-training understandably considered this subject
matter switch an impediment to her completing mathematics content and pedagogical course
assignments, as well as becoming an effective mathematics presence among the faculty. However, the division continued its partner participation with its one remaining middle school
Specialist-in-training.

Two urban/suburban divisions each separately made administrative decisions that
effectively ended their participation in the research portion of the middle school project. As the
2011 school year drew near, each division elected to provide additional mathematics instruction
resources to each of its middle schools. The infusion of this extra support meant there were no
longer any schools in these divisions able to serve as controls, and thereby provide the necessary
promised research data. Nevertheless, the two divisions remained participants in the preparation
portion of the grant. The Specialists-in-training were thus able to complete their studies and
continue in division middle schools, some in leadership roles as Mathematics Specialists at the
start of the 2012 school year.

Administrative decisions occurred in another division participating in the middle school
grant following the departure of a strong mathematics supervisor. Months after the grant's
initiation and prior to this significant personnel change, the division had chosen to increase its
grant participation by adding a pair of schools and an employee engaged in non-grant Specialist
training. This addition offset a withdrawal elsewhere in the grant triggered by a division decision
to change a Specialist-in-training's school placement. Sometime later, the participation of one
Specialist-in-training was nullified by a local administrative choice regarding placement. Again,
this individual was replaced with another division employee engaged in a non-grant training
program, again maintaining the research commitment. These movements reinforce the
importance of having a strong bench.
After one year of data collection in the rural grant, two divisions that were participating in the research project closed a total of three elementary schools due to declining student enrollment. School boundaries were changed within the divisions. As a result of these actions, two school pairings were lost from the rural grant.

Replacement

At the onset of the projects, the principal investigators actively recruited more than the minimum number of divisions, schools, and potential Specialists required. These efforts maintained the integrity of the research program and sustained the number of participating divisions at satisfactory levels.

Thirteen divisions were on board at the start of the elementary grant and thirteen divisions are participating at the present time. Because one division left and one division joined during the early stages of this grant prior to data collection, a total of fourteen have participated at some time during the duration of the grant. The middle school grant began with fourteen divisions and currently has twelve. Sixteen divisions have participated at some time during this grant as four withdrew and two joined.

The withdrawal of a Specialist and subsequent withdrawal of a division early in the rural school grant was offset by the recruitment of another division. This new division brought a pair of schools to the research portion of the grant, as well as a teacher who was currently participating in a Mathematics Specialist training program not affiliated with the rural school grant.

In the middle school grant, the withdrawal of two Specialists-in-training led to the withdrawal of two rural school divisions. The two losses were balanced by the recruitment of one division that brought two pairs of schools and two teachers also engaged in Mathematics Specialist training outside the NSF grant.

Also in the middle school grant, as noted previously, two divisions left the research portion of the grant when their administrations added mathematics support personnel to the control schools. The two losses were compensated by the recruitment of one division with a suburban/urban coding. This late-joining division was able to contribute two pairs of schools and
two teachers engaged in non-NSF grant training, covering both the two lost Specialists-in-training and the two pairs of schools.

Participation has stabilized. There has been no further attrition of Specialists or divisions in either grant since the first half of 2011. Clearly, the success in maintaining adequate numbers of cooperating school divisions, schools, and Specialists has been due to the grant leaders' immediate and continuing emphasis on encouraging retention, and their ability to replace Specialists-in-training from several sources, as well as their ability to recruit replacement divisions already involved with Mathematics Specialists.

**Encouraging Retention**

Retaining Specialists-in-training and enabling divisions to benefit from these in-school coaches have been keystones of grant activities since initiation. Promoting equitable access to Mathematics Specialists by rural and less wealthy divisions throughout the Commonwealth has been a driver of many decisions made along the way. Demonstrating that training and support for Mathematics Specialists can be feasible in every Virginia school division—from the far western mountains to the Atlantic Ocean—is critical to gaining local and state political and financial support for school-based Mathematics Specialists and training programs. Therefore, from the beginning, several strategies were implemented to enable school divisions and Specialists-in-training to maintain their commitments and efforts. These successful strategies, first developed for the rural school grant based on lessons learned from prior NSF Mathematics Specialist preparation projects, were largely replicated by the middle school project, which has had an overall majority of rural divisions participating. These strategies are outlined below.

**Initial Recruitment of Waitlisted or Alternate Pairs of Schools and Specialists-in-Training** — Alternate Specialists-in-training were recruited and fully engaged in the professional development program to increase the likelihood that all participating divisions would have Specialists, despite attrition, as well as to support the qualitative research study in the K-5 grant. Thus, a reservoir of alternate Specialists-in-training existed to replace Specialists who might discontinue participation. There was awareness of Mathematics Specialist training programs independent of the grants.

**Instructional Designs and Technology Support for the Master's Program** — Great attention was paid to adapting the master's degree training program to meet the challenges of delivering content and pedagogical training to individuals scattered throughout Virginia. Participants in previous training programs had been located geographically closer to each other. These students had met
regularly in classes and worked together on assignments, and therefore were able to develop personal relationships and support groups.

However, with the wide geographical dispersal of the K-5 and middle school grant students, the reliance on instructional technology increased dramatically. There was more on-line instruction, including on-line break-out group work and electronic submission of assignments. A blended format, which included several face-to-face weekend meetings for the content and leadership courses otherwise conducted on-line, was developed and used. The Specialists-in-training appreciated these weekend meetings for the opportunities to become personally acquainted with other students and with their instructors.

Focus on Supporting the Specialists-in-Training through Tailored Coursework and Interpersonal Connections — Considerable effort was made to find useful teaching formats and to support the students technologically and personally in their remote locations. The three residential Summer Institutes, which had been developed during the prior grant, were improved and continued, and were highly valued by participants.

Facilitating strong student-student relationships, as well as effective student-instructor relationships was important in maintaining enthusiastic Specialist-in-training participation. Relationship building, working with principals and colleagues, and doing independent research and study were particularly emphasized in the three educational leadership courses. Goals were to foster the independence of widely-dispersed Specialists working separately in their schools, and to assist them in building personal support networks in their school communities that would continue after placement. For example, the first such collaborative project required the Specialist-in-training to meet with the receiving principal if moving to a new building; or if remaining in the current location, to have a meeting with the current principal to focus on the transition from classroom teacher to the role of Mathematics Specialist.

Principal and Central Office Administrator Participation in Regional Workshops and School-Based Activities — A series of workshops was developed for all elementary treatment school principals because many rural school divisions do not have supervisory positions dedicated to mathematics. Grant personnel offered intense and interactive instruction during two 2-day and one 1-day sessions which addressed topics, such as the division and school visions for mathematics instruction, the role of the Mathematics Specialist, and planning for the Mathematics
Specialist's entrance into the school community. Principal attendance and participation were enthusiastic and central administrators with responsibility for instruction also frequently attended. After the overwhelmingly positive response from the rural group, this program was modified and offered to the middle school principals and administrators who responded with similar positive feedback.

Retention by NCES Division Descriptors: Data

Data were collected on the retention of the original partner divisions during the terms of the two grants. The data were examined by participation in the middle school grant, by participation in the elementary grant, and also by participation in both grants. Categories of analysis included "Continued Full Participation," "Continued Reduced Participation," and "Withdrawn." ("Reduced Participation" is defined as the division's continuing in the grant, but with fewer than the original number of Specialists and/or original school pairs.) Percentages of "Continuing Full Participation," as well as "Continuing Full or Reduced Participation" were calculated.

When the data from both the rural and middle school grants are combined, we find a total of twenty-two divisions, thirteen of which continued full participation. Five of the ten urban divisions in this combined group continued full participation (50%) as did eight of the twelve rural divisions (67%). Nineteen of the twenty-two original partner divisions (86%) continued full or reduced participation during the terms of the grants. Only three divisions, one in seven, withdrew.
Table 1

COMBINED RK-5 AND MS GRANTS ORIGINAL PARTNER DIVISION
PARTICIPATION OVER TIME BY NCES CODES

<table>
<thead>
<tr>
<th>Combined RK-5 &amp; MS Treatment divisions only*</th>
<th>Original: Continued Full Participation</th>
<th>Original: Continued Reduced Participation</th>
<th>Original: Full or Reduced Participation</th>
<th>Original: Withdrawn</th>
<th>% Original Continuing Full Participation</th>
<th>% Original Continuing Full or Reduced Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural 16</td>
<td>9</td>
<td>4</td>
<td>13</td>
<td>3</td>
<td>56%</td>
<td>81%</td>
</tr>
<tr>
<td>Urban 10</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Combined 22</td>
<td>13</td>
<td>6</td>
<td>19</td>
<td>3</td>
<td>59%</td>
<td>86%</td>
</tr>
</tbody>
</table>

*Any division participating in both grants is counted twice in this combined section.

NOTE: All five control-schools-only divisions continued according to the terms of the agreement.

There are cautions in drawing conclusions from this data. It must be kept in mind that the N's in these categories of analysis are small. Thus, the analyses could be skewed by the action of one division in a small group. There were thirteen original divisions in the rural grant and fourteen in the middle school grant, with some divisions participating in both grants.

Moreover, while the contributions of the control schools are vital to the research portions of the grants and thus greatly valued, these analyses do not include the actions of the divisions that provided only control schools to one of the research studies. None of these divisions discontinued participation, enabling the integrity of the research investigations.

To summarize, five of the ten original divisions in the middle school grant have rural NCES descriptors and five have urban NCES descriptors. Five divisions (three urban and two rural) have continued full participation (50%). Two rural divisions withdrew. One rural division and two urban divisions reduced participation. The sole middle school division to maintain full participation has a rural descriptor.
Two-thirds of the 12 original divisions in the rural elementary grant (eleven divisions with rural NCES descriptors and one division with an urban NCES descriptor) have continued full participation (67%). Three have continued with reduced participation. One division became ineligible to continue after losing its sole Specialist-in-training. Although percentages are misleading when numbers are small, for the record, the participation of Rural Remote, Distant Town, and City Small divisions was 100%.

Retention by NCES Division Descriptors: A Closer Look at the Data

Decisions leading to divisions either withdrawing from grant participation or reducing participation from the original levels were either policy-driven or Specialist-driven. The policy decisions were made equally by divisions with urban and rural descriptors. All of the Specialist-driven decisions were in rural divisions.

Two urban divisions made similar and independent decisions to end participation in the research portions of the middle school grant. Responding to requests from principals and parents, the school boards and administrations of these two divisions agreed to provide additional mathematics instructional assistance in each of its several middle schools. Of course, these actions resulted in the divisions having all treatment schools and no control schools.

These two divisions are similar in their relative wealth compared to most other divisions in the state. They are also similar in their access to many schools of higher education, large populations, and considerable numbers of well-educated citizens who are involved in their local schools. They are similarly desirable locations for teachers due to salary levels and amenities of urban living. They are geographically compact.

A third division-level policy decision was necessitated by declining enrollment and subsequent redrawing of school boundaries across several elementary schools in this geographically large rural county during the second year of Mathematics Specialist placement and data collection. As a result, two school pairings were lost. This decision did not reflect dissatisfaction with the mathematics grant. The division continued to participate in the elementary grant with its remaining pairs of treatment/control schools. The decision was driven by the constraints of low enrollment, rugged geography, and low local wealth.
Another policy-driven change was related to an effort to improve student performance on tests of English language skills. The assignment of a participant in the middle school grant training program was changed from mathematics in an effort to boost language arts achievement.

Three Specialist-driven decisions to discontinue participation in the training program forced the withdrawal of their rural divisions. One division's sole K-5 Specialist-in-training abruptly withdrew after the professional development sessions were well underway, but before school placement. Another division's sole middle school Specialist-in-training withdrew just as the first summer session began. Another division's sole middle school Specialist-in-training withdrew unexpectedly mid-year due to family relocation.

The timing of the resignations stymied finding suitable replacements among division personnel in training Mathematics Specialist training programs. Twice before, when rural Specialists-in-training had resigned at the end of the school year, replacements had been secured. However, in the three cases described above, these sparsely populated Rural Distant/Rural Fringe divisions did not have the "bench strength" to replace the abruptly resigning personnel.

**Participation by Selected State Economic Factors**

**Retention by Selected Economic Factors**

This section presents data about both elementary and middle school partner divisions in order to provide context for the funding and policymaking landscapes present when decisions about their Mathematics Specialists programs were being considered and enacted. The segments that follow outline policy requirements for state and local elementary and secondary education funding, analyze changes and trends in partner divisions related to the state funding formula for public schools known as the local composite index, and describe recent state and local funding for education. The final segment addresses the impact of these policies and funding mechanisms on staffing, one of the most important and costly components of public school operations, and considers staffing decisions made in grant divisions.

**State Policy: The Constitution of Virginia**

Article VIII of the Constitution of Virginia sets forth the framework for governance of public elementary and secondary education in the Commonwealth of Virginia; it is appropriately known as "the education article." Article VIII Section 1 reads:
The General Assembly shall provide for a system of free public elementary and secondary schools for all children of school age throughout the Commonwealth, and shall seek to ensure that an educational program of high quality is established and continually maintained.

Article VIII, Section 2 reads:
Standards of quality for the several school divisions shall be determined and prescribed from time to time by the Board of Education, subject to revision only by the General Assembly. [Note: The members of the Board of Education are named by the Governor and confirmed by the General Assembly.]
The General Assembly shall determine the manner in which funds are to be provided for the cost of maintaining an educational program meeting the prescribed standards of quality, and shall provide for the apportionment of the cost of such program between the Commonwealth and the local units of government comprising such school divisions. Each unit of local government shall provide its share of such cost by local taxes or from other available funds.

Herein the General Assembly sets the floor of the educational program (that is, the above-mentioned Standards of Quality, familiarly known as the SOQ), determines the amount of funding required for the floor program, and then obligates the local governments to pay a portion of the legislatively-determined costs.

In 1992, after several years of debate, the General Assembly approved the direct election of the school board in a locality if a majority of the qualified voters in such a referendum vote in favor of changing the method of selection to direct election. Prior to passage of this legislation, all local school board members were appointed by members of the local governing body; i.e., the county board of supervisors or city/town council, or in a few cases, a school board selection commission appointed by the circuit court. Eleven years later, 85% of the Commonwealth's 133 local school boards are elected and 15% appointed, according to information from the Virginia School Boards Association in 2013. The proportions are similar to the situation with the grants' partner divisions: 86% elected, 14% appointed.

Local school boards, elected or appointed, do not have fiscal autonomy. That is, they do not have taxing authority and are dependent on the local governing body for transfers of local
funds to support school division operations. Every year, the local governments and local school boards have important and frequently lively discussions over the level and purpose of the school division funding request, as well as the sufficiency of local revenue sources to support K-12 education, and other services and programs provided by the local government. These discussions typically generate considerable citizen interest and pressure regarding the appropriate levels of educational programs and staffing, local funding, and local taxes.

Complicating these negotiations are state limitations on local governments' access to sources of revenue. Local real estate property taxes provide by far the majority of local revenue. Business, sales, and lodging and meals taxes contribute much smaller amounts. State legislators have been reluctant to grant additional taxing authorities to local governments. Thus, this over-reliance on local property taxes in the absence of other significant revenue sources strains local budgets, especially in times of declining or stagnant property values. It also places locally-elected governing body members in the crosshairs of voters should they vote to increase local taxes to support school operations.

State Policy: The Local Composite Index

State education funding policy, as enacted during the early 1990s, is that for Virginia as a whole, the state assumes 55% of the statewide costs of funding the Standards of Quality (SOQ), leaving 45% of the funding to be provided collectively by the local governments. It is the legislature’s policy to provide proportionately more funding to those school divisions judged by it to be less able to fund the so-called local share than it does to those school divisions judged more able.

These funding adjustments are provided through a controversial formulaic measure of the local ability to pay, widely known as the local composite index (LCI). The LCI compares a trio of local measures of wealth—real property values, adjusted gross income, and local option sales taxes—to the statewide averages of these same measures. Adjustments are made according to both student and total populations [3]. This index ranges from just under .2000 at the less affluent end to .8000 at the more affluent. The state budget adopted by the General Assembly enumerates provisions for calculating the LCI, with new LCI figures being calculated every two years to be in effect for the upcoming state two-year budget period.
To understand how this formula works, consider the following example. A local government with an index of .2000 would receive 80% of required SOQ expenditures from the state and would be responsible for the remaining 20% of the floor program. At the other extreme, a local government with an index of .8000 would receive 20% of its required SOQ expenditures from the state and be obligated to provide the other 80%. Thus, an SOQ-mandated teaching position estimated by the state to have an annual cost of $36,000 requires those divisions with an index of .2000 to come up with $7,200 in local dollars and those with an index of .8000 to find $28,800 in local funds.

Although the funding formula methodology is sometimes criticized for not reflecting variations in local revenue sources and local needs for services, as well as for using dated wealth indicators, it has remained in place for forty years [3]. These local perceptions are supported by the finding that local spending efforts have exceeded by far the amounts the legislature has determined as sufficient to meet the local share of SOQ costs. According to Virginia Department of Education figures, local government education funding during the last few years has exceeded the amount deemed by the state government as necessary to meet the required local share by more than $3 billion annually. This amount illustrates the stark difference between the state and the local government’s views regarding elementary and secondary school funding requirements on the part of both the state and local levels.

**Participating Divisions and the Local Composite Index**

Table 2 shows ranges into which the calculated LCI for both elementary and middle school partner divisions fell for both FY11-12 and FY13-14. The LCI figures are recalculated every two years using data from the three wealth indicators previously noted as well as student/total populations from previous years. The LCI for FY11 and FY12 was calculated in November 2009 using 2007 data. The LCI for FY13 and FY14 was calculated in November of 2011 using 2009 data. The LCI calculations for these fiscal years are used in this presentation as they span a majority of the RK-5 and middle school grant periods.
Table 2
LOCAL COMPOSITE INDEX (LCI) OF ELEMENTARY (K-5) and MIDDLE SCHOOL (MS) PARTNER DIVISIONS
Fiscal Years 2011-12 and Fiscal Years 2013-14

<table>
<thead>
<tr>
<th>LCI RANGE</th>
<th>Number of K-5 Partner Divisions FY11-12*</th>
<th>Number of K-5 Partner Divisions FY13-14</th>
<th>LCI RANGE</th>
<th>Number of MS Partner Divisions FY11-12**</th>
<th>Number of MS Partner Divisions FY13-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than .2000</td>
<td>5</td>
<td>3</td>
<td>Less than .2000</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>.2001 to .3000</td>
<td>2</td>
<td>4</td>
<td>2001 to .3000</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>.3001 to .4000</td>
<td>3</td>
<td>3</td>
<td>.3001 to .4000</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>.4001 to .5000</td>
<td>2</td>
<td>2</td>
<td>.4001 to .5000</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>More than .5001</td>
<td>2</td>
<td>1</td>
<td>More than .5001</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

*One elementary school division (NK) became ineligible to participate in the grant research and is included only in the K-5 Partner Divisions FY11-12 column above.

**Four middle school divisions that became ineligible to participate are included only in the MS Partner Divisions FY11-12 column above.

NOTE: School divisions added as partners to the MS project are included in both columns.

For FY13 and FY14, more than 80% of the Commonwealth’s 136 school divisions have an index below the midway point of .5000. The indexes for the thirteen partner school divisions in the elementary project, with the exception of one division, are below .5000 for FY13 and FY14. This means that these low-index local communities are responsible for less than half of the costs of the state-recognized foundation education program required by the state. At the same time, the local communities are responsible for all additional costs incurred if they choose to provide educational programs above this state minimum.
As noted in the opening paragraphs, one of the key pieces of the local composite index calculation compares the wealth indicators (real property values, incomes, and sales taxes) of a particular locality to the statewide averages for these indicators. Such a comparison often yields surprising results not readily understandable by the layman or by the local governing bodies. For the thirteen elementary partner divisions, the LCI for FY13-14 increased from the previous FY11-12 calculation in ten of the divisions, indicating these localities became relatively richer as measured against state averages. For the three divisions whose LCI decreased, each of the three measures of wealth declined.

However, in those elementary divisions that experienced LCI increases purportedly reflecting relative increases in wealth, three saw drops in all three indicators. Five divisions saw increases in either one or two measures. Only one division whose LCI jumped had increases in all three measures of wealth.

For the middle school partner divisions, a review of Table 2 also shows the dispersal of the LCI to be distributed similarly to the elementary divisions. Three-fourths of the middle school divisions show indexes below .4000. For the twelve existing middle school partner divisions, the LCI for FY13-14 increased from the previous calculation in seven of the divisions and decreased in five divisions. It is notable that the divisions where the LCI dropped experienced declines in all three measures of wealth. Two other divisions with declines in all three measures of wealth nevertheless saw their composite index increase slightly.

Two middle school partner divisions that became ineligible to participate in the research portion of the project continued to participate in the Specialist-in-training component. Their decisions to provide enhanced mathematics instruction resources to all middle schools, not just the treatment schools, obviated their continuing as controls. These policy decisions hinged, practically speaking, on the financial ability of each division to provide additional funds for these efforts.

As noted in the “Recruitment” section of this article, some less affluent divisions that were approached about participation in the project were unable to do so because of the requirement for a local financial commitment. The analysis above indicates that, nevertheless, school divisions that did sign on and stay with the elementary or middle school projects are more evident at the lower LCI (less affluent) ranges. Specifically, more than half of the elementary
partners (seven of thirteen) and nearly half of the middle school partners (five of twelve) had very low LCIs of less than .3000.

Furthermore, by recalling that more than 80% of school divisions in Virginia have an LCI below .5000, we may conclude that a majority of grant partners tended to be among the state's markedly less affluent school divisions. Making such a considerable funding commitment to enhancing mathematics instruction while facing limited financial capabilities was a difficult, albeit commendable, policy decision for such local school boards to make.

**Funding Trends**

In the previous section, we devoted much attention to the local measures of wealth that drive the apportionment of state and local public education funding. From this discussion, it is apparent that local wealth and thus local educational programs vary markedly in the Commonwealth of Virginia.

In this section, we turn our attention to analyzing dollars spent on K-12 operating expenses for FY09 and FY12. During FY09, local school divisions were making their decisions about whether to take advantage of the grant opportunities for improving local mathematics instruction. Thus, this year is a meaningful time to look at the state and local funding in these divisions.

During FY12, there was stability in grant participation by divisions. This stability permits the benchmarking of funding trends over the previous three-year period during which state and local budgets were severely stressed. This analysis is based on information presented in the 2009 and 2012 Superintendent's Annual Reports (Table 15—Sources of Financial Support for Expenditures, Total Expenditures for Operations and Total Per Pupil Expenditures for Operations), excluding the estimated sales and use tax revenues returned to the locality on the basis of school age population [4].

State dollars for public elementary and secondary education decreased from FY09 to FY12 in every partner school division in the two grants, with the exception of one middle school partner. This situation is consistent with the overall statewide decline in state education dollars during the so-called "great recession," when state funding dropped from $5,274 per pupil in FY09 to $4,546 per pupil in FY12. This situation forced school divisions across the state to examine
their local educational offerings, and make budget and policy decisions to deal with the new state funding reality. During this period, local funding increased to make up for the loss of state dollars in some, but not all, of the partner school divisions.

During this time period, local funding increased in seven of the thirteen elementary partner divisions. Most of these divisions increased local dollars by several hundred thousand dollars. However, two divisions increased local funding by $4 million or greater. In both of these cases, sizeable jumps in two or three wealth indicators drove the increase in the amount of required local funding.

The seven elementary divisions also saw decreases in year-end average daily membership (student enrollment). Three had decreases in the LCI, with year-end average daily membership holding steady in two divisions and increasing slightly in one. It is significant to note that in the three divisions where the LCI decreased, thus signifying a lesser local funding obligation, local funding nonetheless increased.

Among the existing middle school partner divisions, local funding increased in all but three divisions during this time. Of the divisions that increased local funding, the LCI also increased or remained relatively stable in seven. Student enrollment increased in three of these divisions, while remaining steady or dropping in the other four. It is significant to note that in two divisions where the LCI decreased (thus less local funding for education being required by the state), local dollars appropriated to the school divisions nonetheless increased. Student enrollment also increased in both of these divisions.

Economic factors and the resultant educational policy decisions affected not only the recruitment partner school divisions, but also forced some partner divisions to withdraw from grant participation. In contrast, they enabled the participation of replacement divisions.

As noted earlier in this article, a total of five partner divisions became ineligible to participate in the research projects for various reasons. Three of these five divisions had LCIs below .4000. Though these divisions had shown both the willingness and the ability to participate in the research projects, their relative poverty, small populations, and rural locations combined against ready replacement of the departed Specialists-in-training.
The other two were relatively large school divisions with extensive existing instructional and support resources available. In each division, both student enrollment and the amount of additional local dollars spent on their schools increased between FY09 and FY12 when state dollars dropped. As noted previously, the policy decisions that resulted in their ineligibility revolved around the desire and financial ability of the two divisions to provide additional dollars to address mathematics instruction and achievement needs across all of their schools.

In the middle school project, two school divisions having Specialists-in-training in non-grant programs were able to step in. These replacement divisions had an LCI in the .3001 to .4000 range, and again, notably, were large school divisions with considerable instructional resources in many schools, as well as increasing student enrollments. Quite significantly, both also had local populations voting with their pocketbooks to support their local schools. Each locality dipped into local coffers to the tune of tens of millions of dollars above the state’s required local funding effort.

**Staffing**

It was noted earlier that the state shares the costs of funding the SOQ with local governments, providing more funding to those localities less able to support their schools. In this section, an analysis of funding of instructional and support positions in partner school divisions, as reported by the Virginia Department of Education, reveals that the state shares, with the local governments, the costs of just under 2/3 of the total positions in the school divisions (pupil transportation positions are excluded, being funded through a different mechanism). The salary and benefit costs of the additional positions in excess of those required by the SOQ are borne entirely by the locality. They result from local choices to provide, for example, lower pupil-teacher ratios or additional course offerings not required by the SOQ.

Due in part to the varying sizes of student enrollment of the participating school divisions, the number of total personnel employed by the middle school grant divisions is much larger than in the elementary partner divisions. Despite these differences in size, the percentages of shared and local positions are remarkably similar across both the RK-5 and middle school partner divisions, and are consistent with the statewide figure of 64% of all positions reported being SOQ positions (see Table 3).
Table 3

<table>
<thead>
<tr>
<th>Partner Divisions</th>
<th>Total FY12 SOQ-Funded Positions (state and local share)</th>
<th>Total Positions Reported on Annual School Positions Report (FY12)</th>
<th>State and Local Shared Positions (percentage)</th>
<th>Locally-Funded-Only Positions (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural K-5</td>
<td>6,564</td>
<td>10,399</td>
<td>63.1%</td>
<td>36.9%</td>
</tr>
<tr>
<td>Middle</td>
<td>32,054</td>
<td>49,888</td>
<td>64.3%</td>
<td>35.7%</td>
</tr>
</tbody>
</table>

Going deeper into the numbers, we find that the percentage of shared positions ranged from 56.3% to 75.1% in the elementary partner divisions. In the middle school partner divisions, the percentage of shared positions ranged from 50.4% to 74.6%.

For comparison, a similar analysis of FY10 funded positions among elementary partners found about forty more total SOQ-funded positions in FY10 than were reported in FY12. However, the total number of positions reported (which also includes those locally funded) had declined by nearly 2,000 by FY12. In existing middle school partners, SOQ-funded positions increased over 1,700 from FY10 to FY12, while the total positions reported decreased by nearly 4,800.

With the exception of one small school division, every partner school division reported a smaller number of total positions for FY12 than for FY10. A faltering economy and the resulting smaller school budgets during the period likely are to blame for the cutbacks in the number of school personnel being employed during this period. Class sizes may have gone up; elective courses may have disappeared.

Local governing bodies and school boards across the state typically view the state-required staffing levels as a “minimum” and, in many cases, not sufficient to carry out educational programs to the level and degree desired locally. They utilize locally-generated tax revenues to fund a higher level of staffing, which can be seen in the form of lower class sizes and expanded course offerings. So that the state education budget is not driven by the costs of such local aspirations, state policymakers reasonably do not contribute a share of funding to every position a local school board chooses to have in excess of those required by the Standards of Quality.
Among the elementary partner divisions, it is noteworthy that the highest percentages of “local only” positions were found in three divisions with LCI below .3000. Of the employees in these divisions, 41-44% fit that bill. Among middle school partners, the four divisions having the highest percentages of “local only” positions had an LCI below .3200. Thus, despite their low ability to pay, these divisions have made policy choices to employ personnel in greater numbers, solely at local expense, to meet educational needs and desires.

Statewide, an overall increase in the number of shared funding positions over the two-year period and corresponding decrease in the number of total positions reported, may be driven by policy decisions taken by local school divisions during tight economic and budget times. First meeting the SOQ requirements to fund mandated positions (for which the funding obligation is shared) decreased the number of positions funded solely by local dollars.

Also of note is a state policy decision during this time period that could be driving a shift to more shared funding positions. In 2009, the state capped its funding for school support personnel positions. The change amounted to a more than a 30% pull-back in state funding assistance for positions such as central office positions, as well as clerical, technical, and maintenance personnel. This abrupt change likely contributed to a reduction in the number of total personnel as local dollars were shifted to fund the costs of paying a larger share for support personnel positions.

Examples of local positions above those mandated by the state would be those necessary to reduce or maintain class size, especially when the division chooses to have smaller classes than those dictated by state staffing ratios. Additional positions accommodate changes in student enrollment, needs or location, allow supplemental (not required) courses of instruction, and address other educational goals of the community. Furthermore, support positions are needed to meet additional administrative requirements identified by the local school board as necessary to meeting local educational goals as well as state educational mandates. In recent years, increased needs for technical computer and network support are key examples of critical support positions, as are support personnel needed to assist in implementing the state-mandated testing program.

Employment of school personnel always is a critical policy decision for school boards because employee salaries/benefits typically comprise the bulk of any local school division
School divisions that had agreed to participate and remain in the grant projects were quite cognizant of the local financial commitment required for such participation. In tough times, these divisions necessarily weighed continuing the local supplemental funding for Specialists-in-training involved in the research project against employing the costs of other instructional or support personnel.

**Economic Factors Roundup**

In the face of the economic pressures of declining state dollars for public education and the relatively low wealth of many participating partner divisions, the school divisions that participated recognized the important benefits to their students and communities of increased student achievement in mathematics. School divisions that did sign on and stay with the elementary or middle school projects continued their commitments to preparing mathematics coaches that would enhance the capabilities and capacities of classroom teachers to deliver instruction in mathematics.

These enduring commitments are demonstrated by the following analysis. As a result of local initiative and/or being required to increase local funding for schools through the state formula, nearly 2/3 of the partner divisions in both research projects increased local dollars to their schools during the time in which state dollars were declining.

Making such a considerable funding commitment to enhancing mathematics instruction while facing limited financial capabilities was a difficult, albeit commendable, policy decision for such local school boards to make. The two National Science Foundation research projects—"Researching the Expansion of K-5 Mathematics Specialist Program into Rural School Systems" and "MSP Institute: Mathematics Specialists in Middle Schools"—have benefited greatly from the choices of the participating partner school divisions to use increased local funds to train local Specialists, and to provide research data for analyzing the benefits and challenges of training elementary and middle school Mathematics Specialists.

**Conclusion**

Goals set out in the middle school grant proposal included the following two objectives: 1) preparing a group of fifty exemplary middle school teachers to provide intellectual leadership as school-based Mathematics Specialists; and, 2) determining the extent to which a quality Institute experience results in transforming the participating teachers from effective classroom teachers to disciplinary leaders. Among the goals in the proposal focused on elementary school
systems at the K-5 level were these two: 1) scaling a promising model for preparing and supporting K-5 Mathematics Specialists across rural settings; and, 2) determining the impact of these Specialists on student achievement, on teachers' beliefs and instructional practice, and what factors influence the impact of these Specialists in rural schools.

Meeting these goals required the recruitment of divisions, schools, and Specialists-in-training. Changes occurred in the composition of all three groups over the several years the grants were active, but project team members were resourceful in their efforts to retain or replace most of the few divisions, schools, and Specialists-in-training which became ineligible to continue.

The strong motivation of divisions to persevere in dedicating funding and personnel to training Specialists, employing Mathematics Specialists, and participating in data collection and research investigations throughout the grant years was the foundation on which the grant work moved steadily forward. As important was the persistent dedication over the course of several years of the Mathematics Specialists to complete the rigorous coursework and school leadership training required. With them, the research and training goals of the two grants were completed. With them, new models and methods for providing strong mathematics instruction at the K-5 and middle school levels have been advanced.

References


AIMS & SCOPE

Articles are solicited that address aspects of the preparation of prospective teachers of mathematics and science in grades K-12. The Journal is a forum which focuses on the exchange of ideas, primarily among college and university faculty from mathematics, science, and education, while incorporating perspectives of elementary and secondary school teachers. The Journal is anonymously refereed.

The Journal is published by the Virginia Mathematics and Science Coalition.

Articles are solicited in the following areas:

- all aspects of undergraduate material development and approaches that will provide new insights in mathematics and science education

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