PART III: PROFESSIONAL DEVELOPMENT

This section describes the design of professional development programs for Mathematics Specialists. Articles by national experts address the issues relating to what Mathematics Specialists need to know and how to train them to acquire the content, pedagogical, and leadership skills necessary for their roles in the schools.

DESIGNING PROFESSIONAL DEVELOPMENT ACTIVITIES FOR MATHEMATICS SPECIALISTS

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Introduction

In response to calls for the improvement of mathematics instruction on national, state, and local levels, many school systems have begun to develop programs in which a key player is a mathematics specialist, mathematics teacher leader, or mathematics coach. While each system defines the work of these educators in slightly different ways, these terms generally indicate an educator who has been given the responsibility for supporting other teachers as they seek to improve their mathematics instruction. For the purpose of this paper, we will use the term Mathematics Specialist to refer to these educators. The work of Mathematics Specialists may include conducting professional development activities, working with teachers in their classrooms, interpreting local curriculum goals in the light of national standards and published curriculum, and communicating with parents and the general public about the purposes and accomplishments of the school's mathematics program.

Mathematics Specialists and Professional Development

Given this description of the work of Mathematics Specialists, questions arise. What do Mathematics Specialists need to learn to take on these responsibilities? What kinds of learning opportunities should be provided on an ongoing basis as they do their work? What areas of interest should be studied?

Much has been written about the professional development needs of both pre-service and in-service teachers [1-5]. In our work, we examine the connections between designing professional development for teachers and for Mathematics Specialists. What is it that Mathematics Specialists should learn in their professional development experiences and how might that learning take place?

The following journal responses provide a glimpse into the learning of two Mathematics Specialists, Beth and Jolene, who are reflecting upon questions posed to them in the context of their professional development: How would you describe an effective mathematics class? How has this vision changed since you began this work?

> My vision of an ideal classroom has changed considerably. Before, I did not focus on children's thinking as much. If the right answer came up, most of the time I moved on to the next thing at hand. We did not take much time to explore other ways to solve problems or express other ideas. I still find myself doing that from time to time—not allowing for other ideas to surface. I realize it will take some time to break old habits. ... I had been a procedural type of teacher, now in my teaching I try to create meaning. This has been the biggest change of all.
>
> Beth, November 2001

> It [my vision] is still changing. Before, a math classroom that had manipulatives and centers would have been enough. Now I see planning important questions ahead of time is needed. What is the math concept we will work on? What do I want the children to know? Where do I want them to go with this idea?
>
> Jolene, November 2001

These responses indicate the changes Beth and Jolene are in the process of making. These include changes in their views of what mathematics is, how children come to understand it, and how a classroom might be organized to support and develop children's mathematical ideas. These shifts are consistent with the goals of their professional development work. Now consider one more journal response:

> I always had the personal belief that you just can't hand somebody knowledge. They need to have experiences to work through something themselves. I have always believed this about students. Now I have the same belief when working with teachers.
>
> Marie, November 2001

Marie's response indicates that her ideas about how to work with teachers are changing. She now sees that the same principles of learning that she considers for students should also ground her work with teachers.

These journal responses provide a glimpse into the shifts of thinking of three Mathematics Specialists as a result of their professional development experiences. Some of these shifts are similar to what teachers might learn in professional development work and some are appropriate for Mathematics Specialists.

This raises a set of interesting questions. What is the connection between the kind of professional development designed for teachers and the kind of professional development that Mathematics Specialists might need? How are the goals for professional development for teachers and Mathematics Specialists the same or different? What additional goals should be considered in designing professional development for Mathematics Specialists?

We will examine this set of questions based on our experiences working with the Houston Mathematics Initiative, a collaboration between the Southwest District of the Houston Independent School District, the Houston A+ Challenge, and the ExxonMobil Foundation. The Houston Mathematics Initiative currently involves thirteen schools and fifteen Mathematics Specialists. The Mathematics Specialists work in project schools Monday through Thursday. On Fridays, they meet for professional development work.

Although there are many components built into the Friday professional development work, we will focus only on a subset of those activities. In this paper, we are particularly interested in examining how goals for the professional development of teachers and Mathematics Specialists intersect and how materials originally designed for classroom teachers can serve as a resource for the professional development of Mathematics Specialists.

Goals of Professional Development for Classroom Teachers

The *Developing Mathematical Ideas* (*DMI*) professional development curriculum serves as the basis for this work [6-7]. The *DMI* curriculum currently consists of five modules, each focused on a specific set of related mathematical ideas: *Building a System of Tens*, *Making Meaning for Operations*, *Examining Features of Shape*, *Measuring Space in One, Two, and Three Dimensions*, and *Working with Data*. Each module includes a casebook, facilitator's guide, and a set of video cases. The casebook consists of eight chapters. The first seven contain narratives written by teachers in which they describe and analyze the mathematical thinking of their K-6 students. The eighth chapter is an essay, "Highlights of Related Research," which connects the mathematics examined in the cases with educational research.

The facilitator's guide includes discussion questions focused on the print and video cases, mathematics activities at an adult level related to the mathematics topics in the cases, and reflective writing assignments. The guide also includes components designed to support facilitators in their use of the *DMI* materials. One such support is called "Maxine's Journal," a reflective journal written from the viewpoint of a seminar facilitator. In the same way that the *DMI* cases offer seminar participants the opportunity to experience a classroom through the thoughts, questions and reflections of the classroom teacher, "Maxine's Journal" provides seminar facilitators with the opportunity to view a seminar in action through the thought processes of the facilitator.

Much professional development in the past has been based on an "expert" model in which an individual who is particularly knowledgeable about a certain subject presents his/her ideas to the participants. The *DMI* seminars embody a different vision of professional development with the following set of goals for participants:

- Understand that mathematics is about thinking and that they themselves are capable of thinking mathematically;
- Recognize their students as mathematical thinkers with ideas worth listening to and thinking about;
- Learn how to make sense of their students' ideas and then connect these ideas to their instructional and curricula goals;
- Engage students in discussions in which their ideas about mathematics are analyzed and refined; and,

- Experience these goals for themselves in a supportive learning community.

The *DMI* curriculum is designed with the idea that individuals learn when they articulate their own ideas, compare them with the ideas of others and then refine those ideas to take into account these new experiences. Discussions among participants are valued and encouraged whether the topic at hand is mathematics or pedagogy. Negotiating these discussions by providing both support for and challenge to participant ideas is an integral part of the work of any *DMI* facilitator. Components of the facilitator's guide such as "Maxine's Journal" are designed to support *DMI* facilitators as they take on this role. For a more detailed analysis of the work of a *DMI* facilitator, refer to "Active Facilitation: What Do Facilitators Need to Know and How Might They Learn It?" [8].

Principles Underlying Professional Development for Mathematics Specialists

Our work designing professional development for the Mathematics Specialists began with the goals that *DMI* establishes for teachers. However, as we considered the additional demands of the work of Mathematics Specialists, we expanded on these goals. Four principles guided our work as we designed professional development activities for Mathematics Specialists using the *DMI* materials as a resource.

Mathematics Specialist Is a Teacher in the Process of Changing His/Her Teaching Practice — The Mathematics Specialist is first and foremost a teacher in the process of changing his/her own teaching practice. Even though the Mathematics Specialist has additional responsibilities, a key part of the work remains teaching. In general, teachers currently serving as Mathematics Specialists have not had the opportunity to learn mathematics by considering their own ideas and developing their own approaches to mathematics problems. Yet, they are expected to establish classroom practices so that students may learn this way. The Specialists need opportunities to consider what it means to organize instruction around student ideas and also to come to see mathematics as a set of coherent ideas which students are capable of developing. In addition, the work of creating a classroom culture that both supports and challenges students' thinking requires roles for both teachers and students that are different from past practices in schools.

This work involves both mathematical and pedagogical challenges. For instance, teachers must be able to follow the logic in students' mathematical thinking and to link their

students' ideas to the mathematical goals of the curriculum. This requires mathematical knowledge deep enough to enable teachers to make connections between related mathematical ideas. At the same time, there are also new pedagogical tasks. For instance, teachers must help students learn how to participate in discussions; students need to see discussion involves both offering their ideas and analyzing the ideas of others. Since Mathematics Specialists must also take on this work of refining their teaching, the first four goals listed for the professional development for classroom teachers which address these needs are necessary and appropriate when planning professional development for Specialists.

Mathematics Specialists Need to Have a Deep Understanding of How Mathematical Ideas Develop Over Grade Levels — Before taking on the role of Mathematics Specialists, teachers may have had experience teaching one or two grade levels. However, their new work requires they develop knowledge of the mathematics of the entire K-5 curriculum. They need to know the connections among the pattern block work in the first grade, the geometry activities in the third grade, and area work in the fifth grade. This is essential as Mathematics Specialists are called upon to help teachers move from looking at mathematics as a series of activities students do, to a set of ideas students think about. While their own work as classroom teachers provides one resource for this work, they also need to be able to envision the interaction between student ideas and the district curriculum for every grade level and to see how mathematical ideas relate to the work at various grade levels. Their professional development must offer opportunities for them to deepen their mathematics knowledge, to understand the ways children encounter and develop mathematical ideas over time, and to connect children's ideas with the district K-5 curriculum. This need represents an expansion of the third goal listed for classroom teachers.

Mathematics Specialists Need to Be Able to Create Learning Communities — Mathematics Specialists need to be able to create learning communities for the various groups with whom they work. Most educators have not had opportunities to participate in a community of learning, a setting where inquiry into ideas is the norm. In a learning community, discussion and analysis of each person's ideas is the mechanism for learning. One of the goals listed for teachers states that they need to have the experience of participating in a learning community; this goal remains appropriate for Mathematics Specialists as well. However, the work of Mathematics Specialists requires even more; they must learn how to establish and cultivate such communities, not only with students, but also with adults. Working on their own teaching practice and learning to facilitate *DMI* seminars are two contexts in which Mathematics Specialists can work on

developing learning communities. In these two formal settings, it is a part of the work to create a supportive environment in which each person's ideas are to be articulated and also challenged.

However, these formal settings are only part of the work of a Mathematics Specialist. Mathematics Specialists also work with teachers as a classroom coach or as a leader of grade-level meetings. They work with principals; for instance, in considering how district curriculum connects with student thinking or how the principal can support teachers as they work to develop classroom practices built on analyzing student ideas. Mathematics Specialists need to learn how to approach these kinds of interactions with the same focus they bring to the formal settings, that of an active facilitator responsible for the learning of others. For example, in a *DMI* seminar, participant's questions are seen as starting points for discussion rather than demands for the facilitator's answer. Mathematics Specialists need to learn how to adopt a similar stance toward inquiry as a basis for their work when coaching or leading grade-level meetings or in conversations with their principals. Their professional development work must include opportunities to examine what it means to create a school culture that is a community of learning and to consider possible ways of responding to teachers and principals that are compatible with such a community.

Mathematics Specialists Must Have a Stance of Inquiry Toward Their Own Work — They need to see themselves as learners, to see each other as a support, and to see that together as a group they are also a learning community. Mathematics Specialists need to experience their professional development as a community of learners. They must have the opportunity to learn mathematics, to examine children's mathematical thinking, and to consider district curriculum goals in terms of children's ideas. Then, they need to examine and analyze the conditions under which their learning took place so that they can create similar environments for students, teachers, and principals. In addition, the professional development should also provide opportunities for the Specialists to recognize that they can serve as a resource for each other.

Just as a *DMI* seminar participant's question is seen as a springboard for discussion, so too, the questions that Mathematics Specialists pose should be seen as the starting point for inquiry for the whole group. The professional development work should provide the context for the Mathematics Specialists to develop this sense that they, as a group, are a part of a systemwide

program working in concert for the improvement of mathematics instruction. The work must include opportunities to develop this shared vision.

Examples of Professional Development for Mathematics Specialists

In this section of the paper, we provide four examples of professional development activities used in the Houston Math Initiative. Each example is also an instance of designing professional development for Mathematics Specialists using the *DMI* materials as a resource. The description of each activity includes:

- the primary goals of the activity
- the *DMI* excerpt that was used as a resource
- the structure of the activity
- the assignment sheet
- a brief analysis of how the activity addresses the professional development needs of the Mathematics Specialist

These professional development activities describe learning opportunities that embody the four principles we have established. By participating in these activities, the Mathematics Specialists will: 1) develop images and practices to support their teaching; 2) work on their own mathematical ideas; 3) consider how to engage with teachers and principals; and, 4) create a learning community and analyze how that community operates to support learning.

Examining the Work of Facilitating *DMI*

Since part of the work of a Houston Mathematics Specialist is to facilitate *DMI* seminars, one component of their professional development work is focused on supporting the Specialists as they take on the role of becoming a teacher of teachers. There are three specific ongoing activities devoted to *DMI* facilitation: *DMI* Leadership Institutes, practice facilitation sessions, and shared debriefing discussions. The *DMI* Leadership institutes take place in the summer while the facilitation sessions and debriefing discussions are incorporated into the Friday professional development work.

In practice facilitation sessions, pairs of Mathematics Specialists conduct a *DMI* session with the rest of the group as participants and then the entire group holds a feedback discussion that includes comments both about the mathematics content of the session and the facilitation process. In shared debriefing sessions, the Specialists discuss the *DMI* seminars they are offering to system teachers to bring facilitation concerns to the group. The discussions might be focused

on working to understand participant ideas, responding to teachers' journal writing, the mathematical content of sessions, issues about connecting the *DMI* work with local curriculum goals, or questions individual Specialists bring about their facilitation work. Thus, the professional development work provides an ongoing support structure to help the Mathematics Specialists offer the *DMI* seminars. Example one builds on this background of working on facilitating *DMI* seminars.

Example One—Primary Goals of the Activity

- To consider the connections between one's personal beliefs about teaching and learning and one's actions as a facilitator of other teachers' learning.
- To examine the underlying mathematical ideas of a variety of approaches to computing multi-digit subtraction problems and to examine the pedagogical value of exploring those strategies with students.

Example One—*DMI* Excerpt Used as a Resource

A passage from "Maxine's Journal" is described and incorporated into the assignment sheet, "Examining Multiple Strategies."

Example One—Structure of the Activity and Assignment Sheet

Mathematics Specialists read and discuss the assignment sheet questions first in small groups, and then as a whole group.

Examining Multiple Strategies

Consider this situation as described in "Maxine's Journal" for session two. The seminar participants are discussing the video clip in which several children explain their ways for calculating 40 - 26 or 35 - 16. At this point in the seminar, participants have read the print cases, which also show children sharing a variety of strategies for two-digit subtraction problems. In the journal, Maxine reflects on a comment by one participant, "I thought we would spend a few minutes talking about Becky's logic, but Sheila [a seminar participant] blurted out, 'I don't see why those teachers are teaching so many different ways to subtract. Why don't they just do one way, and then they can all do it?'"

There are three points of discussion about this passage.

One has to do with Sheila's interpretation of the print and video cases.

What are your reactions to Sheila's comments?
What does her comment suggest about her ideas of teaching and learning?
What is it you, as her facilitator, would like Sheila to understand about the strategies in the cases? How might you bring that into the conversation?

Another has to do with your role as a *DMI* facilitator or as a Mathematics Specialist.
What is the difference between your personal answer to questions such as those about the value of multiple strategies and how you might respond in a *DMI* seminar when this issue comes up?
In general, what is the interaction between your own beliefs and your responsibility for supporting the learning of the teachers with whom you work?

The third has to do with the role of multiple strategies.
What are your answers to the following questions:
Why should teachers encourage a variety of solution strategies?
What does sharing multiple strategies offer within a classroom setting?
Is it your expectation that all children will understand all of the strategies? If not, what is it you do expect to happen as a result of sharing? If so, what do you need to do, as a teacher, to accomplish that?

Example One—Addressing the Professional Development Needs of Mathematics Specialists

This activity addresses the professional development needs of the Mathematics Specialists on several levels simultaneously. The first two discussion points focus on the role of a *DMI* facilitator. As the Mathematics Specialists participate in the discussion about Sheila's ideas and how to work with them, they can refine their ideas about what it means to take on responsibility for the learning of teachers and how to create a community of learners. Just as learning to listen and analyze student ideas is a practice classroom teachers need to develop, so is learning to listen and analyze teachers' ideas a practice that Specialists need to develop. The second set of discussion points continues this focus on the role of a facilitator. In this discussion, the Mathematics Specialists can explore the relationship between their own ideas and the ideas of the *DMI* participants, thus considering what it means to provide a learning opportunity for the teachers with whom they work. This addresses a shift Specialists must take on, they must move from thinking of themselves as simply colleagues sharing their ideas to considering themselves

responsible for the learning of teachers.

The third set of discussion points, about the value of multiple strategies, provides a context for the Mathematics Specialists to examine both their mathematics and their teaching practice. As they work to explain the math ideas that underlie the subtraction approaches, they can develop deeper understandings of that math topic. As they discuss how they can organize class discussions based on sharing multiple strategies to support the development of these mathematical ideas, they can articulate and refine their instructional methods.

Finally, since these points are explored through a process of small- and whole-group discussion with the Mathematics Specialists voicing their own ideas and then listening to the ideas of each other, the activity itself provides the means for the Mathematics Specialists to work together as a learning community.

Example Two—Primary Goals of the Activity

- To examine the mathematical ideas involved in division of fractions and to consider how those ideas are developed in various grade levels.
- To consider how to analyze and use the thinking of teachers as a basis for classroom coaching.

Example Two—*DMI* Excerpt Used as a Resource

Case #27 is taken from *Making Meaning for Operations*: "Who says that's not the right equation? My own experience vs. students' thinking." [7] In this case, the classroom teacher, Sarita, describes a class working on the following problem. "You are giving a birthday party. From Ben and Jerry's™ ice cream factory, you order 6 pints of ice cream. If you serve 3/4 of a pint of ice cream to each guest, how many guests can be served?" In this case, Sarita analyzes the students' number sentences and written explanations. She states she is confused because her students did not write division sentences to express their solutions, but rather wrote equations which used addition, subtraction, and multiplication. She groups the student responses into two categories: those that seem to match the situation and those for which she could not follow their logic. The following are examples of students' work which Sarita thought "had impressive reasoning to justify their thinking."

$24 \div 3 = 8$	There are 24 pieces, 3 pieces to a serving, 8 people can be served.
$8 \times 3/4 = 6$	8 servings of 3/4 of a pint each gives you 6 whole pints
$3/4 + 3/4 + 3/4 + 3/4 + 3/4 + 3/4 + 3/4 + 3/4 = 6$	3/4 each gives you 6 whole pints

The following are examples of students' work about which Sarita said, "I could not follow their logic."

$24 \div 3/4 = 6$ or 8	There are 24 pieces altogether, and each serving is 3/4 of a pint, so there are 6 pints or 8 servings (depending on what you are looking for.)
$3/4 \div 8 = 6$	3/4 pint is the serving; there are 6 pints of ice cream, so 8 servings.

Example Two—Structure of the Activity and Assignment Sheet

The Mathematics Specialists read the full case and participate in small- and whole-group discussions, focusing on questions posed on the following assignment sheet.

> Sarita's Division of Fractions Dilemma
>
> What mathematical issues does this case bring up for you? Do you agree with Sarita's opinions of her students' work? Consider each student's response.
>
> What is the mathematics in this case that you would want to explore with your students? How would you go about bringing out those ideas? What questions would you ask? How might you structure the work?
>
> Suppose you were working with this teacher. How would you engage the teacher about this set of mathematical ideas and how to work with students? Why do you see that as a next step for this teacher?

Example Two—Addressing the Professional Development of Mathematics Specialists

In this activity, Mathematics Specialists are working on a particular skill essential to teaching mathematics; that is, how to analyze student work to determine what it is that the students understand and to determine what next steps would be good for each student. As they work through the mathematics problem for themselves and then analyze each of the student responses, the Specialists are also increasing their own ability to make sense of fractions, of operations with fractions, and what it means to represent a story situation with a diagram or arithmetic expression.

In addition, the Mathematics Specialists also examine the way mathematics ideas develop over time. In the small-group conversations, the Specialists consider the mathematics in the grade they teach to identify the connections between the mathematics at that grade level and the mathematical ideas they detailed in the case discussion. In whole-group discussion, the mathematical ideas about fractions are collected in grade-level order, allowing the group to generate a map of fraction ideas as they are addressed across the K-5 curriculum.

This activity also engages the Mathematics Specialists in considering their role working with teachers as classroom coaches. As they discuss possible goals and approaches for conversations with Sarita, they articulate and analyze their own ideas about coaching and then compare them with the thoughts of their colleagues. They are able to consider a variety of possible actions and to discuss the potential impact of various interventions. In this way, they are examining which actions will support the learning of the teachers with whom they work and so are able to develop strategies that are both supportive and challenging. Finally, this work is an example of a group of Mathematics Specialists serving as resources for each other, and so is an example of working as a community of learners.

Example Three—Primary Goals of the Activity

- To explore the mathematics of division.
- To examine a mathematical discussion among students.

- To examine the links between project structures and goals, and consider how project structures can be used to support work with students and teachers.

Example Three—*DMI* Excerpt Used as a Resource

This activity uses both print and video cases: the print cases of chapter four of *Making Meaning for Operations*, "When Dividing Gives an Answer Less than One"; and the video case from session six of *Building a System of Tens.*

Example Three—Structure of the Activity and Assignment Sheet

The activity has five components: an introduction in which the framing questions are posed, a mathematics activity in which the Specialists analyze each other's mental mathematical strategies for the problem 159 ÷ 13, a video analysis of students' approaches to solving 159 ÷ 13, a case discussion, and a concluding whole-group discussion based on the framing questions.

A Discussion about Discussion

> The work today will have two components. One part will be focused on a set of mathematical ideas and cases. This will allow us to expand our own mathematical thinking and to consider our own teaching. Another part of the work is designed to allow us to consider those ideas in light of the larger project work. The following framing questions will guide our final discussion. Keep these framing questions in mind as you work today.

Framing questions:

- What does it mean to explore, develop, and use students' mathematical thinking?
- How does today's work help you think about what you want for the students in your classroom?
- How does today's work help you think about what you want the teachers in your school to understand?
- What are ways this project can help you reach these goals?

Focus questions for the case discussion:

- Talk through the mathematical ideas about division that you see in these cases.
- How do the cases help you see what a mathematical discussion might look like?
- How does the teacher use the children's ideas?

- How do the children use each other's ideas?
- What questions does this raise for you?

Example Three—Addressing the Professional Development of Mathematics Specialists

This activity is designed to engage the Mathematics Specialists on many levels, both as teachers and as teachers of teachers. There is an opportunity to deepen their own mathematics as they examine the mathematical principles that underlie computation methods in division, both as adults might view them and as children develop them. The video focuses on strategies for division computation while the case focuses on what the operation of division entails. Discussion of both the video and the case provides the means for making connections between computation strategies and conceptual understanding of division.

The focus questions are designed to support the Specialists in analyzing the mathematical conversation in the cases and to examine the role that both teachers and students play in the development of the mathematical discussion. This leads to two potential learning opportunities for the Specialists. One is their continued learning on how to support and encourage such mathematical discussions in their own classrooms. The other is related to their ways of working with teachers in classroom coaching situations. The conversations analyzing the student thinking in the cases provide a model for the kinds of debriefing conversations they want to develop with the classroom teachers they are coaching.

Finally, the framing questions include the opportunity to examine how the Specialists' individual goals—both for their students and for the teachers with whom they work—can be seen in the context of the projectwide work. The framing questions begin with an examination of the Specialists' own ideas about how teaching and learning takes place, then move to a consideration of how to implement those ideas in their own classroom, and finally, support a projectwide perspective. This allows the Mathematics Specialists to consider how they can use project structures such as mathematics leadership teams or grade-level meetings to further their work. The activity also supports the development of a shared vision for the project as the Specialists' work together to describe classroom practice that is built on students' ideas.

Example Four—Primary Goals of the Activity

- To discuss issues that arise from working as a Mathematics Specialist.
- To provide opportunities for the Mathematics Specialists to provide suggestions, comments, and support to each other in the context of their work.

Example Four—*DMI* Excerpt Used as a Resource

The *DMI* structure of writing cases.

Example Four—Structure of the Activity and Assignment Sheet

A week before the session, Mathematics Specialists receive the assignment sheet describing the writing assignment. In the session, there are two sets of small-group discussions and two whole-group discussions. In the small groups, Specialists read and discuss each other's papers. The first whole-group discussion is based on the content of the papers: What did you see as common in the papers? What struck you as different? What are the issues that came up for individuals and for the whole group? What are ways of working on those issues? The second whole-group discussion is focused on the process of writing and discussing the papers: What was it like to write this paper? How did you feel about having others read and discuss what you had written? What would you do differently the next time we have this kind of assignment?

Writing a Case of Your Own

For the next meeting, we'd like you to write about your work with teachers. It might be about working with your co-teacher or with other teachers in your school or within the *DMI* seminar. This writing doesn't have to be long—3 to 5 pages is fine—and it doesn't have to be polished, but it should be detailed enough that readers can interact with the ideas about which you write. It should also be reflective enough so that readers understand your thinking and the questions you are raising. The specific subject of the writing is up to you, but it should be about interacting with teachers. This writing will be most useful to you if you write about something that puzzles you. Here are some examples:

- Perhaps there was a point in a class discussion or in a conversation with a small group of students or teachers when it wasn't clear what they understood and what would be a good next step.
- Perhaps there are examples of student work or teachers' writing that you find confusing when you try to determine what is it that they understand.

- Perhaps there were moments in a conversation with a co-teacher when you each had a different reaction to a given situation, student comment, or work.
- Perhaps you made a decision in a class or in a conversation with a teacher to say or do a particular thing, and now you wonder what else you could have done or said in that situation.
- Perhaps there was something in the mathematics of a lesson that you are curious about. You might consider the mathematics either for yourself or in terms of how the students or teachers approached it.

Of course, you can't describe everything that happened. You will need to make a choice about what particular aspects of the class, student dialogue, student work, or teacher interaction you will share. Think about what information your reader will need in order to talk with you about the situation you have described.

Please bring eight copies of your writing. We will meet in groups of four to read and discuss what each participant wrote. We'll do this twice so you'll have a chance to participate in two different groups.

Example Four—Addressing the Professional Development of Mathematics Specialists

This activity was designed to encourage the Mathematics Specialists to present their questions, issues, confusions, and dilemmas with one another, and to gather suggestions and comments from each other as colleagues. Sharing difficulties, seeking advice, and brainstorming possible solutions becomes a part of working in a learning community. This kind of activity also serves the goal of helping the cohort of Mathematics Specialists develop a sense of being part of the project as a whole. The issues in the papers might range from mathematics questions, to questions about interacting with teachers and principals, to questions about teaching or students. The discussion of the process of writing and discussing the papers provides the opportunity for continued reflection and learning and sets the stage for writing reflection papers as a source for professional development work in the future.

Summary

These examples illustrate the way we used the *DMI* materials to design four kinds of professional development activities for Mathematics Specialists. One method was to use passages from "Maxine's Journal" as a source for discussion. The discussions include both mathematical ideas and also issues that arise in facilitating *DMI* seminars. A second approach was to revisit cases, first to examine the mathematics more deeply and then to consider possible approaches to working with the teacher in the case. These activities provided support for the Specialists in developing strategies for classroom coaching and holding classroom-debriefing conversations based on examining student thinking. A third method was to use *DMI* material as a means to highlight a project goal. This provided support for the Specialists in developing a shared vision of mathematics instruction and in determining how project structures can be called upon to serve that vision. Fourth, the case writing structure of *DMI* was used as a basis for reflective writing and discussions of issues that the Mathematics Specialists brought to be examined by the group.

Each activity provides the opportunity for the Mathematics Specialists to continue to explore mathematical ideas and to consider how those ideas develop over time. Each provides the opportunity for the Mathematics Specialists to continue to develop his/her own teaching practice; that is, how to organize classroom instruction so that it supports and develops students' ideas and links those ideas to the system curriculum. Each provides the opportunity to consider how to work with teachers to help them develop a similar interest and desire to learn how to understand and use their students' mathematical thinking as a basis for their mathematics instruction. Each provides the opportunity to connect their own ideas about teaching and learning to the larger project goals and structures, and to come to see each other as support for that work.

In this paper, we have laid out the principles we consider as we design professional development work for Mathematics Specialists. We also detailed some specific activities and what it is that Mathematics Specialists might learn by participating in them. However, it is important to note that the activities, like any curriculum, do not contain the ideas; they provide a structure in which ideas may be examined. It is the work of a teacher to engage his/her students with the ideas embedded in the curriculum; and so, it is the work of those of us that use these activities to keep the goals for the activity in mind. As we facilitate, we must listen to the thinking of our students who are the Mathematics Specialists and use their ideas to reach the

goals we have set for their learning. The activities provide an opportunity, but the learning comes from the interaction between the Mathematics Specialists' ideas and the facilitator's goals.

Concluding Comments

It has been an interesting journey to move from designing professional development for teachers to designing professional development for those whom we might think of as teachers of teachers. One common thread is that of a learning community. This concept has meaning at every level of the work: in an individual classroom, within a *DMI* seminar, among the staff in a school or district and among a cohort of Mathematics Specialists. It also applies to those of us who design and offer professional development at this level. In the spirit of a learning community, we offer the ideas of this paper to educators who are engaged in similar work and look forward to engaging with you.

References

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