No Door Left Unopened, Part III

Elementary School Mathematics Program Audit Report

For

Harrison Central School District

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Contents

Introduction

This audit report is the third part to the district's attempt to gain a clearer view of its mathematics program. In 2005 I reviewed the mathematics program at Harrison High School and in 2006 at LMK Middle School. Several of the recommendations I made in these report have been and are being acted on. For example, the district is providing staff development opportunities that are centered in the classroom by means of Lesson Study, the whole secondary program has been streamlined starting with the cohort of 2012 (2007-2008 eighth grade), and applied math strands are being developed which foster interdisciplinary links, such as with the technology program. In the middle school a structural reorganization of the schedule for 2007-2008 will allow many of my recommendations to take root.

In this third part I will report my findings and recommendations for the elementary school program and the transitional components that link the elementary and middle school programs. The district contracted my services for five days. I completed my visits between January 8, 2007 and January 12, 2007.

I restate a paragraph here from the introduction of the first report because it is equally valid here: I have thoroughly enjoyed this work and wish to express my gratitude to all who gave so graciously of their time—administrators, Supervisors, teachers, and students—and the high level of professional courtesy I received. Without exception, everyone I talked to was very open, articulate, and forthcoming about their ideas and feelings.

I am particularly grateful to Mr. Kent Leo for all the accommodations he made to assist me in doing an effective and efficient audit. In this report I do not represent the view of any one stakeholder, rather I represent the trends that I have seen in various areas and compare these to educational research on best practices in mathematics education.

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Method

I visited all four elementary schools, one day each, between January 8 and 11, 2007. During each visit I met with focus groups of teachers, students, and I met with the principal. I also observed classroom practice in grades 1-5 in all buildings. While some differences exists between the schools—just think of the vastly different buildings they are housed in—I intended to focus more on those characteristics that were common. Even in a single district, having four different schools may inherently create a sense of competitiveness. I did not sense this from administrators, teachers, or students in the schools. Different demographic factors may exist between the schools. My audit work was not intended to sort that out. But I would like to remark here that some differences in assessments might be explained by factors other than the mathematics program in the elementary schools.

a. Administrators

I met with the Principal of each school, except at Preston Elementary School where the principal was out on jury duty. Principals, particularly those in elementary schools, are instrumental to implementing a vision in a building, just as teachers are in their classrooms. I wanted to meet with them to explore that vision and to establish their (supervisory) role in the mathematics program. Supervisory structures are essential to successful implementation and continuation of programs. Therefore, I also explored the relationship of the principals and the K-5 Mathematics/Science Supervisor. I also wanted to explore the issues of state testing, professional development, and specialization/teaming in mathematics in grades 4 and/or 5.

I had scheduled interviews with the Assistant Superintendent for Curriculum and Instruction, the K-5 Mathematics/Science Supervisor, the Director of Special Education, and the middle school Principal on January 12. I explored similar issues with them as I did with the principals (See Appendix A).

b. Teachers

During my January 8, 9, 10, 11 visits, I interviewed grade 1-3 and 4-5 teacher groups for about 40 minutes per session (See Appendix B). I asked to talk with the grade 4-5 teachers separately because I was intent on learning more about the various configurations of specialization versus teaming, versus self-contained in these grades. I observed classrooms as much as possible of teachers who also participated in the focus groups. This allowed me to get a more complete picture. The teachers I spoke with included special education teachers, some of whom I also included in my observations. The teachers in the respective schools were aware that I might visit their classroom on the above dates. I did not always see entire lessons, but I was able to stay long enough in each class to get a good picture. I saw lessons on the following topics:

Grade 1: Addition story problems, doubles, counting strategies, money

Grade 2: Sorting on attributes, solving problems with mixed attributes, developing a sense of place value (grouping by 10 and then ten groups of ten is one hundred), addition and subtraction
Grade 3: multiplication and factoring, area
Grade 4: angle classification and measurement, classification of polygons, division, distributive property
Grade 5: fractions, decimals, and percents

During my observations it was not my objective to find out anything in particular about any one teacher. Rather, I wanted to compare what I saw with what teachers told me during the interviews. It is not fair to draw strong conclusions on a limited set of observations, but these did provide me with a good flavor of common practices within and across grade levels. I am ever so grateful to the teachers for letting me visit their classrooms, freely sharing their notes and handouts with me.

For my interviews with teacher groups (approximately 40 minutes each) I looked to see to what extent the teachers share the opening doors philosophy, what are the major demands and expectations they see placed on them, and the role and influence of the (new) Regent exams in grades 3, 4, and 5. I asked teachers to identify strengths and weaknesses in their program, and to identify what professional development would be beneficial to them. I was particularly interested in what types of collegial interaction opportunities were available for them and how they use these and how they experience working in a specialized or teamed setup. Due to limited time I was not always able to discuss all of these topics with each teacher group.

c. Students

I met with groups of about 6-8 students from grades 3-5 in each school. I informally asked children questions in grades 1 and 2 during my class visits. Each group appeared to be a mix of students. I developed a set of questions (see Appendix C) that probed into how students view and experience the everyday typical lessons in mathematics, what they like and dislike, and how they feel they best learn mathematics.

I took copious notes of all the interviews, observations, and focus groups. These notes are the basis for my analysis and findings. I will keep these notes secured in my home in a lockable file cabinet.

Findings

I begin this section by stating three overall findings that appear to be the foundation and reflect the deeper vision for the elementary program in mathematics. I found extensive evidence of these principles in every single classroom I visited, in my conversations with teachers and administrators, and in my conversations with students.

1. Teachers view and behave toward students with a deep respect for them as thinking human beings.
2. Teachers continuously and pervasively bring the mathematical thinking of students to the center of the classroom in a safe and caring environment.
3. Teachers hold students accountable for their mathematical thinking and consistently probe for students' mathematical articulation and explanation, allowing multiple, appropriate mathematical representations and strategies.

There is a strong congruency with the relationships between teachers and students and those between administrators (principals, the mathematics supervisor, and central administrators) and teachers. The above principles apply as follows:

1. Administrators view and behave toward teachers with a deep respect for them as thinking, professional human beings.
2. Administrators continuously and pervasively bring the professional thinking of teachers to the center of the school in a safe and caring environment.
3. Administrators hold teachers accountable for their professional thinking and consistently probe for teachers' articulation and justification, allowing multiple, appropriate work environments and strategies.

While much work remains to be done, it is clear to me that the above principles are very much alive in the daily work of all four schools. This is a very sound basis to start building from. In the remainder of the findings section of this report I will identify specific areas that need to be attended to in order to make good use of this sound foundation.

I focused much of my attention toward the various forms configurations in grades 4 and 5 regarding specialization/teaming. There are several underlying reasons for this focus. First, there is a clear national call for mathematics specialists in the elementary school (See, for example, Fennell and Reys, 2003, and Fennell, 2006). This practice has been going on in other countries for some time with great success. Second, the recent (2005) revision of New York State mathematics standard resulted in compacting traditional middle school topics into the elementary years. Third, the district also has compacted the curriculum further to accommodate Integrated Algebra in grade 8 for all students. And fourth, the transition from grade 5 to 6 is a crucial one. In grade 6, students are taught by specialists for all subjects. Taken together, this means that, for the most part, elementary generalists are not sufficiently prepared to teach such a curriculum, especially in grades 5 and 6. Knowing in advance that specialization structures coupled with intensive staff development and a strong supervisory support structure are present in Harrison, I was particularly keen to learn more about how this functions and might be improved.

I also realized that by using the Investigation in Number, Data, and Space text series, the district had chosen a path dominated by Cognitively Guided Instruction (See Carpenter and Fennema, Loef, Levi, and Empson, 1999). Because there is a close match between the above stated principles and these materials, I was very interested to learn about the experiences of the teachers (particularly the special education teachers) and students with these materials. This is because in this series there is not a strong formal

emphasis on the development of standard algorithms. I have noticed in other experiences that this causes a dilemma for teachers. They often interpret this to mean that they should not teach these formal standard algorithms. I wanted to see to what extent this was present. It is my professional opinion that teachers should make decisions about when to teach such algorithms. It is preferred that they do not take the algorithms as a point of departure, but as a destination. These algorithms are reliable and efficient ways to compute in mathematics and are based on important mathematical properties.

New York State emphasizes five learning processes in mathematics: communicating, problem solving, representing, connecting, and reasoning and proof. "Investigations" materials are extremely well suited to focus on these processes of learning mathematics. Over the past three years, much work has been done in the Harrison elementary schools to transition toward teaching these processes. And I believe these practices have been established sufficiently to move toward a deeper content focus while keeping a watchful eye on the continued development of these processes.

I will particularly recommend that the district focus on central aspects of learning mathematics in grades 3-5 as identified by the National Council of Teachers of Mathematics (NCTM, 2000):

> Interwoven through the Content Standards for grades 3–5 are three crucial mathematical themes--**multiplicative thinking, equivalence, and computational fluency**. The focus on multiplicative reasoning develops knowledge that students build on as they move into the middle grades, where the emphasis is on proportional reasoning. As a part of multiplicative reasoning, students in grades 3–5 should build their understanding of fractions as a part of a whole and as division. The concept of equivalence helps students learn different mathematical representations and offers a way to explore algebraic ideas. Students should develop computational fluency-- efficient and accurate methods for computing that are based on well-understood properties and number relationships. (See: http://standards.nctm.org/document/chapter5/)

I will also encourage the district to make good use of the NCTM (2006) publication *Curriculum focal points for prekindergarten through grade 8 mathematics: A quest for coherence.* Available at: www.nctm.org/**focalpoints.** In this publication further guidance is offered to assist schools in getting to the core content for each of the grades (thoroughness), the vertical coherence of that content (depth), and the connection between content areas (breath). I will frequently return to the components of a sound program and sound teaching: thoroughness, depth, and breadth. I believe that the perspectives explicated here can help the district make the current program more robust.

Sharing the Vision

I will not describe my findings in each area of this section school by school, but rather I will reflect patterns I found across the four elementary schools. In my introduction to the findings section of this report I have already indicated the overall principles that seem to be at the base of the elementary mathematics program. From my visits it is clear to me that the opening doors philosophy is shared pervasively.

a.1. Students

I observed students at work in grades 1-5 in each school. I interviewed grades 3-5 students in focus groups and more informally engaged with children in grade 1-2 while they were at work in their classroom.

For grades 3-5, I used the first two interview questions (see appendix C), *Please finish the sentence: Math is* _____, and, *Please finish the sentence: I use math for* _____, to form an idea what students' experience is of mathematics as a subject.

The students from the various schools identified that the content of math is:

- Operations such as addition, subtraction, multiplication, and division with whole numbers, decimals, and fractions. Working with factors.
- Learning about geometry: shapes (polygons), angles, and coordinates.

No students identified mathematical properties or relationships, but they did give other ideas about math that relate to mathematical processes, such as problem solving strategies and the social context of mathematics as a response to this question, Math is:

- A way to help you figure out how to put numbers together.
- Helps a lot of people understand addition and subtraction.
- That you can do things backwards if you forgot it.
- A giant puzzle where you need to fill things in the right places in more than one way.
- Where you solve story problems or make up your own.
- To show my own way to figure it out.
- Not too easy, not too hard.
- Where I like to work with a partner when the problem is hard.
- Like an alphabet with numbers in any order and combination.
- Thinking.
- Fun to learn.

It is not surprising that children are more detailed in their process experiences in mathematics, since that has been a major emphasis in the program over the past few years. I hope that as the program develops, children will not only identify content components but also the relationship among components (breadth). For example, children might identify the relationship between (repeated) addition and multiplication; often children will say that multiplication is like fast addition. Furthermore, while I saw evidence in the classroom that teachers work from mathematical properties (depth)—such as commutative, associative, and distributive properties—this does not seem explicit enough (thoroughness) such that this is an apparent characteristic of mathematics for the children I interviewed. This should improve with enhanced rigor in the organization of mathematical content.

When I asked students what they use math for, they could easily give me several examples without prompting. However, several remarked that they don't get to see much math outside of school because they spend a very large portion of their day in school.

The students I interviewed identified the following uses of mathematics: purchasing: getting the right change; sports: batting averages, football scores; cooking: working with an oven (timer, degrees), using measuring cups, arranging cookies on a tray in arrays; house construction: figuring out how much paint we'll need; playing games; sharing things; out for dinner: make sure the bill is added up right, figure out the tip. Students also identified uses specific to math class: tally marks for lunch choices; analyzing data during a class meeting to determine the best solution to a problem.

Most of the responses reflect the connections that are made with math in the real world through their work in school. This is not entirely surprising either, since connecting mathematics to itself as well as other subject matter and real world phenomena is one of the process standards that the Investigations series is focused on. In addition, the teachers have made this a point in their instruction. I saw this in several places. For example, in grade five, I saw lessons where teachers inventoried uses of fractions, percents, and decimals in everyday life and how each fractional format had its advantages in these specific situations. It is encouraging that students can make clear and varied connections of mathematics with the real world. This is an important aspect of developing breadth.

a.2. Teachers

In my conversations with grade 1-3 and 4-5 focus groups of teachers, I did not explicitly discuss their experiences regarding the opening doors vision of the district. Without trying to over generalize, elementary teachers in almost all circumstances welcome any child into their classrooms by the nature of teaching self-contained and their generalist background. I did not find the Harrison Elementary Schools to form an exception on this past experience. However, in all four schools there is some form of specialization or teaming in grades four and/or five. As I have stated before, I was keen on learning about teacher's experiences in this area because I hold that as one of the major keys toward opening doors for children's mathematics education beyond elementary school.

All groups that I spoke to identified full-time Academic Intervention Services (AIS) positions for mathematics in each of the schools as a very positive and necessary element of the opening doors vision. All schools also have special education (SPED) teachers as part of a packet of services to assist struggling students. Some of the schools have a larger population of students in need of AIS or SPED and English Language Learner (ELL) students. Obviously in these schools there were more concerns for opening doors for these groups of children. There, teachers were more concerned with finding and developing supplementary materials. I did not find that teachers felt that the mathematics program in the elementary schools would be limiting children in their later choices in mathematics.

a.3. Administrators

I opened the Findings section with three principles that seem to permeate the program and learning/working environment in the elementary schools. I formulated congruent principles for how administrators work with teachers in the schools. From these it should be clear that there is a consistent and shared vision at the administrative

level, and in fact at all levels of the organization. The principals I interviewed expressed a deep belief that all children are capable and extended this same belief toward teachers. All principals consult with teachers and involve them in decision-making processes, where often the teachers are the ones identifying clear solutions to problems. The general leadership style among the elementary principals is that by opening (their) doors for teachers through involving them and empowering them in decision making, they open doors for the children. I applaud this wholeheartedly. The principals have been and are relying on the K-5 math/science supervisor for much guidance with the mathematics program. They identified a deep appreciation for this support. For example, they identified their training in specific observation strategies and techniques for mathematics lessons as one of the key components in the support structure that the supervisor has provided. It has enabled them to implement the type of leadership that I described above.

Supervisory support is crucial in program implementation and improvement. The district should count itself very fortunate to have Mr. Kent Leo in this position for the K-5 mathematics program. I made my first acquaintance with him when I was doing the high school mathematics audit three years ago. The implementation of the elementary mathematics program had just started and I can say that remarkable progress has been made since that time. This is, in no small part, due to his efforts. Central to his approach are three main components: a) providing what teachers need to be successful, b) provide materials and services timely, and c) support the principals with supervisory roles and strategies during implementation. This approach demonstrates a keen strategic eye and a deep respect for those doing the work with children in the classrooms. While Mr. Leo builds this solid foundation for a support structure, he has not relented on high expectations and accountability. For this he uses several markers: a) performance data of students over time, b) grade level meetings with teachers, c) school visitations (direct observation of teaching, student work posted/shared), and d) feedback from principals. It is clear to me that Mr. Leo's structure building is consistently aimed toward opening doors for teachers and thus for children.

b. Expectations and Demands

In this section of the findings I will report on how students, teachers, and administrators experience the mathematics program and expectations and demands that are put on them both from the district as well as from outside pressures, such as state exams and parental influences.

b1. Students

I will represent the views of grades 3-5 students here. I will use their responses to questions 3 and 4 of Appendix C to address their experiences of learning mathematics and look at practices they identified as beneficial. I will represent this as a comparison of likes and dislikes, which often reveal how children experience demands and expectations placed on them.

Likes:

- Topics are interesting.
- It's a smooth experience.
- I like the math games, they are fun; they connect to the lessons; they are similar to games we play at home; I'm noticing I learn when I get good at the games; I like to have fun, this gives me a memorization key.
- I like thinking; you think a lot; you can't get away from it; I learn to be a good planner.
- It's challenging; it's fun getting to the bottom of things; it's hard but not impossible; there is always an answer.
- I like solving problems; I like solving equations; I like multiplication and division; I like working with landmark numbers.
- I like that I can work with others or discuss things with my neighbor; my peers sometimes explain it better than the teacher.
- I like how there are so many ways to solve things, I can express myself in my own way.
- My teacher tries to understand how I do it in my head; the teacher is enthusiastic, it helps me concentrate and feel good; the teacher gives fun assignments; I like it when my teacher uses Powerpoint to give us an overview; I like it when we use the Internet; when we get a wrong answer, the teacher gives you another way to think about it; the teacher gives us hints; the teacher inventories different answers on the board, then students explain how they solved it, this is how you learn from your mistakes; I like it when my teacher provides extra challenges when I get it quickly; I like it that we go a little faster.

Dislikes:

- It can be boring because it's too easy, because you need to wait for everybody; sometimes it's too hard and you get stressed (like with division problems); You want something that is just right; I don't like long things that are hard to figure out.
- Sometimes it can get a little overwhelming to try to understand how all the other children are thinking or solving a problem; some children get too argumentative in class discussions; it is not so enjoyable to listen to others' thinking when you already get it.

The students I spoke with all were very enthusiastic about mathematics. From their comments I find they speak very positively about experiences with the curricular materials and recognize the strong emphasis on thinking and other process skills. They recognize these same process skills and values in how their teachers work with them. This is exactly what the Investigations materials and underlying philosophy aim for. It is clear that not all children feel entirely comfortable in such a learning environment. A few expressed doing too much waiting or having a lack of interest in other children's thinking. These were often children that claimed that they would get things quickly. It seems to me that this is more related to instructional differentiation than a deficit of the program. I did not find much evidence of this during my classroom visits. In contrast I found children to be very engaged and interactive and eager to share their thinking. The "likes" were very obvious to me during my observations.

During my observations I did develop a few concerns. In grades 1-3, students sometimes, depending on the activity, spend a lot of their time coloring in different possibilities for, say, factors of 36 in an array. For some needier children this can take

quite some time to complete and it seemed to me that they may have lost the mathematical forest through the trees. In other words, some of the activities may take children a relatively large amount of time so that they forget to look for the mathematical patterns, ideas and do not come to generalize from their experience. While the children were not bored with these tasks (I asked them) and seemed engaged throughout the lesson, they did not seem to get to the core mathematical ideas.

It seems to me that this is not necessarily an issue of the curricular materials, but rather an instructional issue. The investigations program uses an inquiry-based approach to teaching and learning called Launch, Explore, Summarize (LES). It is crucial that in the Launch phase the teacher points students toward the mathematical ideas that they will be exploring, which he/she then returns to in the Summarize phase, where these ideas are lifted out explicitly and mathematically deepened. In classes that I observed where the Launch phase was done thoroughly and children were given a clear mathematical challenge I found that given tasks—for example, coloring in—were not in the way of the deeper mathematical ideas. In my visits to many other classrooms in schools around the US I have found that teachers let the Explore phase go on for too long and then often do not get to the summarize phase. This is a rather big problem, because that is where the mathematics is made explicit and generalizations occur. It is therefore crucial that teachers learn to assign adequate time to all three phases. Through my observations and discussions with the teachers in Harrison it became clear to me that they were not always sure how to balance the time assigned to all three phases. This sometimes led to incomplete summarize phases. The Investigations materials assume a 60-minute contiguous time for each lesson in the design. To this end all schools should have contiguous mathematics periods of 50-60 minutes each day from grade K-5. It is very difficult to effectively use the LES approach in less than 45 uninterrupted minutes.

Another aspect of the program that I particularly observed in grades 1 and 2 related to the emphasis on mathematical communication and multiple mathematical representations. In these grades children do a tremendous amount of solving of story problems. They generally are asked to explain their thinking in “numbers, pictures, and words.” I am very familiar with this aspect (Cognitively Guided Instruction) of the program and have witnessed this in many other places. I strongly promote it in methods courses I teach. In observing the children at Harrison I found that many of them spent considerable effort on representing their solutions in these three ways of mathematical representation and communication. I also found that they were very skilled at this. I asked them about which way they preferred to give their answer. Initially most children would answer “all three ways.” I had a feeling this was related to the fact that it is expected of them to show it three ways. After probing further many children explained to me that they prefer the number sentence. When asked why, they would say that this is how they do it in their head, because it goes quickly. The students I spoke with had a clear sense of efficiency of numerical representation. Nevertheless, they spent quite some time and effort also representing their solutions with pictorial diagrams and in words. I agree that this is good preparation for when they do the state exams where such communication is required, but the original intent of multiple representations is to provide all children with a point of entry into mathematical problems. Generally when students “get” a problem quickly the numerical solution lies firmly within their grasp. It is in situations where students do not quickly get the problem that they need alternative strategies, such as

drawing a diagram. It seems to me that in order for students to learn to use such tools, they will need differentiated tasks, such that what is asked of them is slightly out of reach (not too easy, not too hard). That is clear from the students' comments above. When a problem is too easy, children do generally not use conscious thought to solve it. We are often surprised that when we ask them to explain how they got their answer, they tell us, "I just knew it." This is actually precisely so. It means we have not sufficiently challenged the student so that a conscious effort is needed to solve a problem. It is in such situations when students are more likely to be able to articulate their thinking and will necessitate a need for other forms of expression besides numerical. This will link further with learning to read in mathematics. This is a specific area of which I will have more to say in the next section of the findings.

b2. Teachers

To investigate teachers' experiences with expectations and demands, I asked them what their view was on the district's demands for the program, their ideas regarding strengths and weaknesses of the current program and the influence of state standards/testing on the program. On several occasions teachers identified that in the third year of implementing these materials they are starting to have a higher level of comfort with the materials. Teachers also identified that this is the first year they can use supplemental materials, which some experienced as having been "given wings." While they acknowledge this "new found freedom," they also recognize that there is not a consistent approach within and across the schools nor did they identify clear guidance on what and how to supplement.

Due to the revision of the state standards for mathematics particular compaction has taken place from the state level in grades 5 and 6. The district is in the process of further compacting the mathematics curriculum by moving toward Algebra for all eighth graders starting in the 2007-2008 school year. In my observations and from what teachers and children told me this has caused an increase in pace in grades 4 and 5, but most obviously in grade 5. This is appropriate and possible because in all schools there is some form of specialization for fifth grade teachers of mathematics. I feel strongly that this specialization is necessary and effective for upper elementary grades. It has more advantages than disadvantages in my opinion. I will give five main reasons for this: a) making the connection between grade 5 and 6 more effective, b) making the compaction of the curriculum doable for all children, c) deepening mathematics content knowledge of teachers effectively, d) promoting deeper and more concentrated reflective practice, and e) efficient and effective staff development.

In my middle school audit report I made the following recommendation:

> Recommendation 11: The Mathematics Supervisors at the middle school and elementary school should facilitate regular opportunities for grade 5 and grade 6 teachers to align curriculum and instructional practices.

This type of exchange and alignment becomes far more efficient and effective when fifth grade teachers are specialized like the sixth grade teachers. This more likely will make such an effort a two-way street and not just a matter of what the sixth grade teachers expect from grade 5, as I witness in many places. Generalists usually do not enter subject

focused conversations on equal footing and rarely obtain that footing. This often makes such efforts fall apart. I will repeat my recommendation from the middle school report in this report.

Teaching has changed because of the state-wide instituted testing from grades 3-8. Teachers must now organize their curriculum in "pre-March" and "post-March." It is my understanding that the math/science supervisor has been working on aligning the program to this imposed schedule. Having good coordination between all grades is therefore a necessity. The advantage of this is that schools focus more on the longitudinal consistency of the curriculum. I find that the state's choices in pre- and post-March content has not been very thoughtful and schools are left with the challenge to create coherence, particularly in the post-March content, which is very splintered in almost all grades. This challenge is especially large between grades 5 and 6 due to the fact that, in the Harrison district, this also includes school transition. I find this another compelling reason to deepen and maintain the specialization of grade 5 teachers for mathematics.

Recent research (see Ma, 1999) points out very clearly that teachers' content knowledge in mathematics is crucial in their ability to understand student thinking and assist them toward understanding mathematics properly using sound mathematical explanations. Liping Ma (1999) calls this a Profound Understanding of Fundamental Mathematics (PUFM). Teachers who can specialize can develop this PUFM, because they are dedicated to this. They will not see their pedagogical efforts disconnected from their own understanding of mathematics. Thus they can be helped in this development. I am not speaking about any particular teacher or a group of teachers from Harrison here. I am trying to make the case that the practice of specialization in Harrison needs to be maintained and deepened. I have been thoroughly impressed with the content knowledge of the teachers that I observed and spoke to. In almost all cases I observed those that I spoke with.

Teachers who specialize have the opportunity, usually within the same day, to immediately act on what they learn from teaching a lesson repeatedly. This does not only promote reflection in the moment of teaching, but also promotes thoughtful alternative actions for strategies that did not pan out as intended. This allows the teacher to reflect deeper and more concentrated on his/her own practice. Reflection is diminished when teachers cannot act fairly quickly on the alternatives they formulate from this process. Reflection is at the core of improvement of teaching, particularly when the content to be taught becomes more challenging and is compacted. Specialists have more and deeper opportunities to use this core aspect effectively. This, then, provides an inquiry-based structure for the learning teacher and develops depth, breadth, and thoroughness in the daily practice of teaching, thus providing congruency in the system.

The last reason I offer for specialization is related to staff development. I will return to this in a later section, but here I wish to say that in my 15-year experience as a consultant to many districts in the Westchester area it has been very clear to me that elementary teachers who can specialize and focus on mathematics and develop/express their love toward the subject are far better able to open doors for all children. Having AIS teachers in each elementary school is a very wise choice and fits exactly in my argument. My effectiveness as a staff developer in mathematics teaching increases significantly if I work with specialized teachers in upper elementary (grades 4-6). This ultimately reflects in better results for children and more and higher math courses in their future.

In my conversations with teachers they identified the following strengths and weaknesses of the elementary mathematics program. I will present these first and then follow with an analysis.

Strengths:

- Adaptable to different needs; everybody can participate; every lesson is geared toward every level.
- Higher level thinking skills are promoted; there is a focus on thinking and explaining; leads to higher understanding; students are accountable for their thinking; it embraces divergent thinking.
- There are many ways to solve things, children become focused on their own ways of thinking; opens up more ways for children; many concepts are learned from concrete experiences; There is more than one way "to skin a cat."
- New work builds on prior knowledge using consistent structures (such as the hundred chart, which develops number concepts); there is consistency in structure and method from grade to grade and between modules within a grade.
- It reminds me of "corporate" math: It fosters collaboration around shared problems.
- The materials are designed in modules. This is an advantage in self-contained SPED classes, where instruction is more individual.
- A portion of the students enjoy the verbal part: sharing ideas.
- The majority of the class likes math and looks forward to it; kids are less frightened about math.
- Students' problem solving is improving.

Weaknesses:

- There is an over-reliance on the 100-chart; needier students have difficulty with the "jumps."
- The modular materials do not address all of the New York State mathematics standard, such as time and money; supplementation is needed; a connection needs to be made to the NCTM Focal Points publication with a focus on fluency with facts; upon entry in upper elementary grades students do not seem as fluent with number facts as desired; the program does not spend much explicit time on development of fluency with facts; the materials do not promote the development toward a formal algorithm.
- The modules are very language based, which may cause some difficulty for SPED and ELL students and poor readers; for struggling students topics may go by a little too fast; SPED students do not seem to pick up the basics and mathematical relationships through the program.
- There needs to be a better connection with the home, parents are not used to this kind of thinking.
- Not all manipulative materials are equally effective with children, for example, they tend to dislike centimeter cubes, but like Unifix (interlocking) cubes, which are larger and easier to manage; hands-on work does not necessarily lead to commitment to memory.
- The modules require a lot of preparation and re-learning on the part of the teacher.

Upon reviewing the experiences of the teachers it seems to me that there are several themes that are both strengths and weaknesses at the same time. Some of these themes are: **Longitudinal Consistency** (instructional methods are woven in from grade to grade, such as the use of the 100-chart), **Depth** (the materials promote higher thinking and classroom discourse), **Breadth** (the materials address a wide variety of needs in children's learning), and **Thoroughness** (the extent to which the materials assist in reaching the NYS standards and the need for supplementation, as well as the mathematical robustness of the program). At the same time teachers recognize some drawbacks of the choices that the materials make in these areas particularly for struggling students or special populations, such as language density, over-reliance on a limited set of methods over time (e.g. the hundred chart) and a reduced emphasis on developing fluency with computation.

While I understand and admire the tendency of teachers who work with special populations to want to diminish the struggles and frustration their students engage in, it is important to consider that children who struggle in reading should do more of it, not less. Therefore, a language intensive program is essential for such populations. It seems to me that the district has not paid sufficient attention to assisting teachers of these populations with developing strategies and methods to use language intensive materials. This is no small task, but quite necessary to make the opening doors vision true for all.

I discussed with the teachers their use of mathematics trade books for children. While the majority of the teachers indicated using such books in mathematics lessons, I did not find a systematic use of such books in reading instruction. Many of the materials used for reading instruction are social studies themed. I will suggest that mathematics (and also science!) trade books are systematically incorporated in reading instruction. I believe that this would be even more effective in self-contained classrooms, such as the primary grades (1-3) and SPED and ELL classes. Reading in the content area is a lynchpin in many doors that need opening.

Longitudinal consistency is essential to any quality program, however it cannot be so narrowly defined that no differentiation is possible. For example, I have witnessed over and over again that the 100-chart is extremely effective with students who can spatially handle and mentally manipulate two-dimensional structures. But many students in primary grades have difficulty with this. The research is very clear on this as well. In my own work with elementary teachers I have encouraged them to linearize structures for children as a scaffold (See Moone & de Groot, 2005; de Groot, 2002).

This school year the teachers at Harrison have been given the green light to supplement the program with other materials where needed. I suggest here that supplementing is not sufficient in and of itself. Supplementing often works as an add-on feature and not necessarily as an integrated feature. It is unclear in what capacity supplementing is functioning in the program at the time of my review, because teachers did not seem to be able to indicate to me a consistent direction for supplementation. Supplementing should happen with an eye on alternative methodological structures, such as replacing the 100-chart with the empty number line (See Moone & de Groot, 2005), and a maintenance of or enhancement of depth, breadth, and thoroughness. Therefore, supplementing should not happen with sacrificing longitudinal coherence, but rather with providing alternative structures that also have longitudinal strength, depth, breadth, and

thoroughness. It is clear to me that supplementation needs to be consistent across the four schools and that the teachers need substantial assistance and direction in this area.

The need for supplementation seems to be directed, for the most part, toward computational fluency, what appears to be identified by many teachers as fluency with facts or automaticity. Furthermore, I also recognize that the Investigations materials do not explicitly promote the development of formal algorithms and maintains that through the work in the program children will acquire fluency. The teachers' sentiments regarding this are strong and just in my opinion. I also believe that the district's choice of asking the teachers upon the implementation of this program to stick with it and not supplement was just. Otherwise, a clear assessment such as we are taking right now would not be possible about the program. It is also my opinion that no harm was done to children with this choice. Results on statewide tests are outstanding and furthermore the quality of the teachers at all four schools is such that they have been able to do the right thing for all children. Nevertheless, the district has reached a point where changes in the program can be made to make it stronger. Computational fluency is one such area that needs more explicit attention in the program. I believe this is necessary to address the four themes I have been using in this analysis: longitudinal consistency, depth, breadth, and thoroughness. I strongly suggest that the NCTM publication Focal Points is used to give guidance in this process. This means, for example, that in grades K-2 there is a major emphasis on additive structures and in grades 3-5 this is expanded to multiplicative structures.

It has come to my attention via follow-up conversations with the mathematics Supervisor during the writing of this report that the district has decided to purchase the updated versions of Investigations. This will address many of the concerns I have voiced above very effectively. These new materials do provide supplemental materials for practice as well as address the need to have a variety of methods available to address different learning needs. I applaud the district for this decision.

One last point of analysis in this area I'd like to make is that throughout all the above processes one thing that cannot be lost is the joy children at Harrison have in mathematics. Children's joy is in their learning: "I get it!" It is not born out of playing "games." This is an often-misplaced criticism toward work with concrete materials. In the elementary years children decide what they hold themselves capable of. What I mean by "joy" here is the development of a positive disposition and efficacy toward mathematics. The program provides this precious gift according to the children, teachers, and administrators I talked with. In all that follows from this report and from decisions made by adults in the school system, this joy must not be lost if it is desired to open doors.

b3. Administrators

Administrators generally see mathematics as a major "gatekeeper" that opens up many possibilities for children, especially in gaining access to a college education. From this point of view they are very supportive of setting high goals for children. While they have a deep appreciation for the fundamentals of mathematics as a necessary foundation,

they are adamant that the program needs to prepare children for higher mathematics. Principals, probably more than anyone in the school system, are very aware of parental influences. This seems to be very much drawn along a demographic divide. While the influence of parental pressures goes beyond the scope of my audit, they are real. Mr. Leo has taken the lion share in communicating with parents about the program. The principals have very much relied on his support in this area. They do recognize that this is an important aspect of implementing and improving the current program. Intensive efforts in this area need to continue into the foreseeable future, because parents' education in mathematics has been very different. Parents need to understand that the district's program is not just opening doors, but that it is opening the right doors. It is my assessment that the district is well on its way to doing this at the elementary level. Administrators have played a crucial role in this effort.

I asked the principals to identify strengths and weaknesses of the mathematics program. I will report these here and then follow with a brief analysis. From this inventory it will be clear that administrators and teachers are very aligned in their experiences with the program.

Strengths:

- It's a healthy change; emphasis is on thinking and using meta-cognition for children and adults; teachers come to admire children's thinking; teachers are more thoughtful about mathematics.
- Same program K-5 in all four schools is a major improvement over the past.
- Allows success for more children; provides activities that all children are involved in; hands-on component provides meaning for children.
- Allows for multiple ways of solving; the program goes beyond memorization; first develop the concept before a procedure or algorithm.
- Transfers well to best practices through the use of discourse and collaborative structures.

Weaknesses:

- It is very teacher prep intensive.
- The computation piece is weak; there needs to be a way that children are fluent with the facts; there needs to be a balance between skill and concept.
- We need better communication and sharing with parents

In the principals' experiences it seems clear to me that they recognize that the path taken is significant and "healthy," but that a balance needs to be struck in procedural and conceptual learning. I would even like to take this a step further. I believe that procedures without concepts and concepts without procedures does not make for the learning of mathematics. They cannot exist separate from each other. Teachers and students need to know *how* and *why* in mathematics. What makes mathematics different from any other discipline is the concept of proof. If children only learn how in elementary school they will never fully come to appreciate this fundamental aspect of mathematics.

We know very well that when children learn formal proofs in high school they resort to memorization and hope that the teacher will not ask for a proof on the test that they have not done (memorized) before. Yet, children who conceptually understand

multiplication—for example, as repeated addition—but do not have swift access to the tables of multiplication are equally at a disadvantage. When people realize this, the discussion then seems to turn to where to start. Again, this puts us in the trap of a false dichotomy. The how and why of arithmetic needs to be developed simultaneously and in an integrated manner. There is no contradiction in teaching the concept of multiplication, for example, through investigating arrays, and also, for example, using flash cards to assist children in learning the multiplication facts. These practices reinforce each other and should not be artificially separated. While the Investigations materials appear to steer more toward the why, they do not preclude the teacher from integrating the how. My comments here relate to the ones I made regarding supplementation. This needs to be done such that there is careful integration. Otherwise children will learn that "doing the math" will mean to calculate an answer, which is what it means to most people. I hope that the district will continue impressing on children that "doing the math" means so much more than that. The identified strengths of the program are a testament to that.

The principals did not view the state testing as an obstacle. They felt that good tests are helpful in pointing out strengths and weaknesses. With rather strong results on these tests, it seems that this is an appropriate point of view.

I also spoke with the principals about their views on specialization in grade 4 and/or 5. Each school has its own variation. While it is not clear to me which variant is more effective, possibly in terms of student results, they exist because the teachers and principal in each building together determine a configuration that is best suited to them. I have not been able to get clarity in the rationale for some of the choices, but some of it rests on teacher preference. I encountered several arguments against having teachers specialize in a single subject. These arguments related to scheduling difficulties, possible loss of interdisciplinary connections, the difficulty of finding subject specific substitutes, and teachers who teach one subject for a longer period may get "rusty" in other subject areas. While I recognize these, mostly logistical difficulties, I pose that these are not difficult to overcome. I do realize that when you specialize for one subject it most likely will be necessary to so for another as well. I strongly suggest connecting mathematics with science in such a configuration. In terms of substitutes, I suggest that the district develop partnerships with nearby teacher training colleges. Elementary teachers in New York State need to have a concentration in a teachable subject. There is a contingent that has mathematics as their concentration. These pre-service teachers can be actively recruited through such partnerships and advertising. I believe the price of "rustiness" is well worth paying. Quality teachers can reactivate their skills and knowledge in a very short time with proper support.

In order for specialized approaches to be successful teachers need to be placed in areas of their competences as well as interests. Developing competence profiles together with teachers can be a very productive way to establish assignments in which teachers work in their area(s) of greatest competence. This also is true for hiring strategies. I strongly believe that elementary teachers should not be hired because they "can teach everything." I have tried to argue earlier that this is not a realistic expectation. Rather teachers should be hired for how their competence profile adds value to the distributed competences in the school and their potential to develop and grow in this area.

I have avoided including special education teachers in this discussion, particularly those that work self-contained. There, obviously, specialization has been precluded by virtue of the self-contained organization. Let me state here that I was extremely impressed by the dedication and motivation of the special education teachers toward the population they work with and that my comments that follow are based in a deep respect for their very difficult work.

I envision that the district can institute a second form of specialization (I am not ignoring that special education is a specialization in and of itself). I suggest a push-in specialist with a strong background in both special education and mathematics, who works with self-contained special education teachers directly in the classroom. I believe this would vastly improve the mathematics instruction options in the SPED classrooms. Earlier, I mentioned that special education teachers need to confront reading rather than avoid it, but it is also clear to me that specialized assistance can help those teachers cross that bridge. Special education teachers are experts in dealing with special needs and specific learning disabilities in children, but generally do not have a deep, broad, and thorough mathematics content knowledge, because their education simply did not focus on that. During my observations I did notice more mathematical and instructional inaccuracies in SPED classrooms. This is not uncommon in my experience. I realize that teachers with competencies in both mathematics and special education are not easy to find. I suggest again that partnerships with nearby teacher education colleges are developed to recruit such teachers. In the meantime it may be feasible to find such a teacher within the current faculties of the four buildings in a similar way that AIS teachers have been identified.

This brings me to the third form of specialization that seems to be very fruitful in the district. Each school has AIS specialists. This is extremely crucial as a component of the opening doors vision. AIS teachers need to have a very strong content and curricular knowledge and must be very competent in adapting instruction for students who struggle significantly in the regular classroom. I strongly suggest the district do not abandon this component of the overall program.

c. Ongoing Processes

In this section of the findings I will report on structural areas that free up or constrain the learning and work environments in the schools. I was keen on learning about how the school transition from grade 5 to 6 works for children, what explicit collegial structures are in place for teachers and administrators, and what staff development structures and needs are present. I have addressed some issues regarding structures and ongoing processes in prior sections. I will reiterate some of these here where appropriate.

c2. Teachers

In the middle school report I made a prominent point of the issue of school transition. Research points out that when transition programs have multiple prongs—the more the better—school transition difficulties are significantly diminished. In the Harrison school district I became aware that several events were in place. They fell in the category of orientations, such as children discussing transition with guidance and the principal,

information to parents, and more personal connections through a buddy day and visitations to the middle school. While some principals explained to me that fifth grade teachers were involved in transition processes, I was not able to get enough detail to give a substantial assessment of what teachers do in grade 5. However, it was clear to me that the grade 5 and 6 teachers do not have sufficient connections to makes such a process effective. One program that I have found very effective is to do a teacher exchange, where grade six teachers teach mathematics lessons in grade 5 and the grade 5 teachers teach mathematics lessons in grade 6 (no substitutes needed). This accomplishes that grade 5 students become familiar with the grade 6 teachers in their own (safer for now) environment. Another opportunity for such an exchange is to design a lesson study group that has grade 5 and 6 teachers participating. Figuring out teachers and the culture in a new and much bigger school is a major transitional job for children and takes an enormous amount of their attention. This can have very negative influences on their performance.

I revisited the transition issues with the middle school principal. He also expressed a need to intensify the connection between grade 5 and 6 and was emphatic that this will be a two-way conversation. He identified collaboration on curriculum maps (identify and ameliorate overlaps and gaps), instructional strategies, and other programmatic alignments as mandated by New York State. He explained that grade 6 teachers need to learn more about what common learner characteristics children bring with them from the elementary schools and how they can build on these. Analysis of these issues may assist grade six teachers to determine how they might start the sixth grade with incoming students in mathematics, particularly given the fact that most students need to have substantial areas of their knowledge reactivated after the summer break.

Due to the compaction of the curriculum, both at the district and state level, grade five teachers need to have a clear idea of what practices most effectively promote school transition in mathematics, especially in the post-march time period. This aspect will require specific involvement of and coordination by the elementary and secondary mathematics supervisors.

Teachers in grades K-5 have five two-hour meetings per year for math and/or science by grade level. For the most part there is no cross-grade interaction. Generally teachers seemed to wish for more collegial interaction both within and across grade levels regarding the mathematics program. This need is heightened by a desire to implement consistent supplementation strategies within grades, across grades, and across schools. Teachers particularly would like to have more time to interact with other teachers at district-wide meetings, especially in a more vertically organized fashion. In grades where teachers were or are specialized collegial interaction occurs voluntarily before and after school mostly at grade level two to three times per week. In schools where teachers are teamed grade-level teams meet once per week in a structured fashion. All teachers identified informal interaction during preparation periods within grade level as well as informal interaction via phone and e-mail.

According to the math supervisor, cross-grade meetings take place in May. However, I do not have a clear picture of the scope and purpose of these meetings. My current understanding is that these meetings address curricular alignment issues and may

not explicitly address instructional issues. An important part of this vertical connection is the grade 5 to 6 transition. Mr. Leo explained to me that grade 5-6 articulation will take place in the spring. At the time of writing this report such meetings have begun, but I have no information regarding content and progress to report at this time. I do find this effort encouraging and important and I believe it should continue as a systematic component of the mathematics program.

As a last, and most crucial salient point regarding collegial interaction, I found that teachers identified very positive interactions with the mathematics supervisor. These interactions were characterized as: open, respectful of teacher expertise, reliable, based on teacher advocacy, knowledgeable, trusting, understanding (I am being listened to), responsive, and timely. Successful implementation of any program is vitally dependent on building such collegial and supportive relationships.

I inquired about staff development needs both from the perspective of teachers and administrators. There were several common themes. All groups were in agreement for a need to develop a structure for and the systematic use of supplementation based on identified gaps. There is a clear need to develop supplemental resources that enhance the conceptual learning and the collaborative adaptation of these resources to different learning styles coupled with strategies that are based in differentiated instruction. It also seemed to me that teachers were interested to investigate the effectiveness of certain methodologies promoted in Investigations (such as the heavy reliance on the hundred chart) and learn about alternative conceptual structures (such as the empty number line) that are accessible to more (special needs) students.

Principals and the mathematics supervisor also felt that staff development should be aimed at assisting teachers to develop a greater understanding of long-term benefits of the mathematics program and to maintain contact with the philosophical underpinnings of Investigations.

Mr. Leo explained to me that he plans to focus staff development toward mathematical fluency (automaticity, efficiency, and accuracy), to assist teachers with proper supplementation of Investigations materials in such a way that the integrity of the program is left in tact. He also identified the importance of continued development of pre- and post-march articulation, which affects curricular organization and coherence.

I also spoke with the director of special education. She confirmed the need for more intensive staff development in the mathematics program for SPED teachers, particularly regarding teachers' own content knowledge. This matches with what I observed in the SPED classrooms. I have suggested a push-in model earlier in this report where math specialists work with SPED teachers directly in their classrooms.

c3. Administrators

A very strong collegial structure exists for the elementary administrators. As far as the mathematics program is concerned this structure is provided by the math supervisor, but also takes place at cabinet meetings. The math supervisor provides staff development for principals, which provides a very consistent and smooth implementation of the program in all four schools. The major advantage of having a common math program is strengthened by having common supervisory structures in the schools. The

principals strongly and gladly rely on the math supervisor for direction and guidance. I find this structure highly effective and have no further recommendations besides maintaining it.

Summary and Recommendations

I began this report with identifying three principles that describe the foundation of the mathematics program at the elementary schools in Harrison. I hope it is clear that it is my assessment that the program is in outstanding shape and largely fulfills the desire to open doors for children in mathematics. I have been extremely impressed with everything I have seen and would gladly invite anyone to see for himself or herself what excellence looks like. The central key to the success of the program is the trusting and professional relationship between district leadership, especially the Mathematics Supervisor, and the teachers. Ultimately this translates in maximum opportunities for the children of Harrison. The recommendations that follow were born from this deep admiration and I hope that they will push the envelope in Harrison. I feel everyone involved is ready to move even further. The recommendations are not listed in any priority. It is the task of the district to assign priority and feasibility of these recommendations.

An educational program that is comprehensive, challenging, purposeful, integrated, relevant, and standards-based.

As I stated earlier, the mathematics program excels in the process skills aspects of learning mathematics. Over the past three years this has been well established at all schools. By introducing the option of supplementation the district has already recognized that the next step is to more deeply integrate the content standards into the program where conceptual and procedural learning is integrated. By purchasing the revised Investigations materials the district is and will be addressing many of the recommendations below. Through an intensive staff development program and outstanding support by the mathematics supervisor the district already has in place structures to further enhance and deepen the quality instruction and program in the elementary schools. While I respect the various needs of the different elementary schools, it seems to me that the district can benefit from a more systematic approach toward specialization of teachers in mathematics in grade 5 and in the future possibly also in grade 4. I have outlined the major benefits and advantages in this report. In many of the recommendations that follow I use the word systematic to indicate that fundamental structures and processes, already in place and functioning well, can be enhanced to high levels of excellence through consistent approaches in the areas indicated. One should read these recommendations as a recognition of the outstanding program that is present in Harrison Elementary Schools and as a stimulus to continue on the path taken.

> *Recommendation 1: To enhance the mathematics program the district should shift the curricular and instructional focus toward mathematical content at both the conceptual and procedural level. This effort should focus on the thoroughness, depth, and breadth of the curriculum and instruction.*

Recommendation 2: To enhance the mathematics program and to provide the opportunity for all students to take higher mathematics courses, the district should continue its curriculum compaction efforts being guided by the National Council of Mathematics Teachers publication Focal Points.

Recommendation 3: To enhance the mathematics program the district should develop a systematic approach to supplementing the Investigations materials that is consistent within and across the elementary schools.

Recommendation 4: To enhance the mathematics program and to provide the opportunity for all students to take higher mathematics courses the district should continue a systematic approach toward specialization of teachers in mathematics for grade 5.

Recommendation 5: To enhance the mathematics program the district should develop a systematic alignment of curriculum and instructional practices across grades and schools, especially between grades 5 and 6.

Recommendation 6: To facilitate a reading intensive mathematics program, especially for special needs populations, the district should develop systematic ways in which mathematics trade books and other mathematical content-based reading is incorporated and integrated in the reading program at the elementary schools.

Professional learning for all staff that is ongoing, planned, purposeful, and collaboratively developed.

There appears to be broad agreement that the shift toward a deeper and thorough mathematics content focus will need significant support for development in that area. This needs to be coupled with the supplementation effort. This seems to be even more necessary in special education and for those who work with second language learners in the district. Enhancing content knowledge directly impacts teachers' ability to maximize student thinking in their classrooms. Since the focus on student thinking is a well-established value in Harrison elementary schools, there is a lot to be gained by this.

Recommendation 7: The district should continue to provide long-term staff development opportunities to teachers to enhance their mathematics content knowledge to enhance the thoroughness, depth, and breadth of their knowledge.

Recommendation 8: The district should continue to provide opportunities for teachers to collaboratively (within grade/school and across grades/schools) implement supplemental resources that allow for differentiated instructional approaches.

Recommendation 9: The district should continue to provide opportunities for teachers to investigate the effectiveness of specific instructional methods in Investigations and develop differentiated approaches that address a broader section of the population.

Recommendation 10: The district should continue to work toward increasing the opportunities for cross-school and cross-grade interaction regarding all aspects of the mathematics program.

The district has clearly recognized the need for an increased effort in providing a smooth transition between grades five and six. This is even more important because the compaction of the curriculum is affecting the elementary program. Careful deliberations are necessary in order for the elementary program to be able to address the unique needs of its students and not to become subservient to downward pressure. One possibility is to create the opportunity for shared lesson study between grades five and six.

Recommendation 11: The Mathematics Supervisors at the middle school and elementary school should continue facilitate regular opportunities for grade 5 and grade 6 teachers to align curriculum and instructional practices.

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APPENDIX A

Administrator Questions

Principals:

1. I understand that the central administration and the board of education have a philosophy of "Opening Doors." What is your understanding of this vision and to what degree do you share this vision?
2. What do you see as important expectations for district-level mathematics program?
3. What would you identify as the strengths/weaknesses of the mathematics program in Harrison? This includes the text series, but is not limited to it. What would you change, what should not be changed.
4. What is the influence of the state-wide tests on the mathematics program? Do you see this as an obstacle or a gateway to increased student performance? What processes of standards alignment have you conducted?
5. What is your experience with departmentalization in mathematics in grade 4 and/or 5? What are advantages and disadvantages?
6. In what areas do you feel your teachers would benefit from professional development? What types of professional development do you prefer or feel you need to assist teachers in teaching mathematics?
7. What opportunities do you have for collegial interaction (with fellow administrators, supervisors, and others) to improve your practice? What opportunities would you like? How is the transition to the middle school developed in your school?
8. How would you describe the student population in your school?

Mathematics Supervisor (K-5):

1. Discuss the issue of departmentalization in grades 4 and 5.
   1a. Discuss data from past and last year's test for these grades.
   1b. Discuss this also in the context of school transition.
2. Discuss needs for further staff development (include special Ed, particularly issues related to content).
   2b. Discuss the larger plan for the implementation of Investigations.
3. Discuss the use of time for and with teachers to coordinate work and learn together. Focus also on the grade 5-6 connection and the vertical connectedness
4. Discuss job experience. What needs does supervisor have? Probe about the connectedness between math and science.

APPENDIX B

Teacher Questions:

1. I understand that the central administration and the board of education have a philosophy of "Opening Doors." What is your understanding of this vision and to what degree do you share this vision?
2. What do you see as important expectations for district-level mathematics program?
3. What would you identify as the strengths/weaknesses of the mathematics program in Harrison? This includes the text series, but is not limited to it. What would you change, what should not be changed.
4. What is the influence of the state-wide tests on the mathematics program? Do you see this as an obstacle or a gateway to increased student performance? What processes of standards alignment have you conducted? How have the new standards changed your teaching?
5. In what areas do you feel you and/or your colleagues would benefit from professional development? What types of professional development do you prefer?
6. What opportunities do you have for collegial interaction to improve your practice? What opportunities would you like?
7. How would you describe the role of the school leaders (supt., asst. supt., principal, math supervisor) with regard to your practice? Could you comment on how productive you feel the relationships between these leaders and you and/or your grade level or school are. What sort of changes would you propose?
8. How would you describe the student population in your classes?

APPENDIX C

Student questions

1. Please finish this sentence: Math is _____
2. Please finish this sentence: I use math for _____
3. Describe a typical math lesson to me. What do you like/dislike about it?
4. What way do you learn math best? If you could tell your teacher how to teach you, what would you tell him/her?