ACCOUNTING FOR AGENCY IN TEACHING MATHEMATICS:

UNDERSTANDING TEACHERS’ USE OF

REFORM CURRICULUM

by

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CHAPTER I

INTRODUCTION

This study focuses on the relationship between teachers’ instructional practices and the curriculum materials they use in their classrooms. Specifically, I address the role that reform curriculum plays in supporting teachers’ reconceptualization of their practice. The analysis centers on professional experiences of three middle school (fifth-grade) teachers during the beginning of the academic year in which they began to use the curriculum. These teachers had participated in a series of professional development sessions geared toward placing students’ reasoning at the forefront of their instructional practice. The data concerning the teachers’ use of reform materials is taken from individual interviews and classroom observations. Each teacher was interviewed before and after teaching a lesson. Classroom observations of the lesson were conducted, during which relevant information was collected regarding the teachers practice and how they implemented the curriculum. These modified teaching sets (Simon & Tzur, 1999), including both the lesson observations and the interviews, were designed to make sense of the teacher’s current instructional reality (Zhoa, Visnovska, & McClain, 2004) and how it influenced the ways in which the teachers enacted curriculum. In this paper, I highlight the importance of accounting for agency in the process of supporting teacher change. That is, I demonstrate how these teachers gave agency to the curriculum as the authority on not only what they considered new teaching practices, but also on student thinking. This result has implications with respect to ways in which teachers must be
supported in changing their practice.

This study is a part of a larger project regarding an ongoing interdisciplinary collaborative that is currently investigating student reasoning about statistical thinking. A series of professional development sessions for teachers was provided on student learning around concepts such as measurement, volume, fractions, as well as statistical distribution. The ongoing professional development began in the spring semester of 2004 and continues to be an important aspect of the project. One goal was to support teachers’ understandings of student reasoning as a resource for instruction by introducing reform curriculum prior to the first full year of the project. This curriculum was offered at the teachers’ request, and its use was strongly encouraged by the principal of the school. The expectations were that the teachers would be learning to use, borrow from, or adapt it during the first year of the project. The professional development sessions were also oriented toward supporting teachers throughout the year as they implemented the new curriculum.

My goal in this study is to document the experiences of three fifth-grade teachers as they struggled over this first year to make sense of their current instructional practice in relationship to the incorporation of the new curriculum. I address two central questions. First, how is teaching conceptualized from the perspective of the teachers? More specifically, what were the teachers’ current understandings of their mathematics instruction and the underlying rationale behind their daily instructional decision-making? Second, how did the teachers’ current understandings of their instructional practice influence the implementation of the new curriculum? The major conjecture derived from the analysis is that researchers must pay close attention to the current perceptions
teachers hold in reference to their mathematics instruction. It is important for professional development goals to be founded on detailed interpretations of teachers’ current perceptions of their own practice. Moreover, attempting to understand the institutional context in which teachers’ instructional practice is based is critical if one is to provide the pedagogical support needed to make reform a reality.
Reform efforts in mathematics education are increasingly challenging traditional teacher-centered, procedural-oriented mathematics instruction and calling for a more conceptually based, open-ended method of teaching (Smith, 2000; Baxter, Woodward, & Olson, 2001). However, as this shift gains traction in the mathematics education community, there remains the issue that practicing teachers experience a considerable amount of pressure due to the substantial demands regarding the enactment of such reform efforts in their classrooms (Lloyd & Wilson, 1998). Part of this enactment implies an appropriate and highly effective use of the types of curriculum materials that teachers are encouraged to implement. These reform-oriented mathematics curricula have a substantial impact on teachers’ perceptions of their current mathematics instruction, as well as how their students reason about mathematics. The implementation of an innovative curriculum can have a significant influence on teachers’ classroom practice because current instructional practices are not always aligned with the intentions of reform documents and materials and how these intentions should play out in the classroom (Smith, 1996). Most teachers tend to believe that implementing innovative curriculum into their classroom practice translates into the establishment of the instructional goals promoted by reform. However, it is often the case that teachers’ instructional practices, prior to the use of reform curriculum, remain intact and unchanged, even for the most dedicated teachers (Lloyd, 1999).
Although the intentions behind reform are socially and historically beneficial, in the sense that they dispute traditional orientations to mathematics instruction, they provide unique challenges for the mathematics education community. From an instructional standpoint, perhaps the most significant challenge is supporting teachers as they implement reform curriculum in their current classroom practice. The necessary means of supporting teachers not only to meet the elaborate and multifaceted visions of reform in mathematics, but to sustain these visions as well, are extremely difficult (Kazemi & Stipek, 2001). This may be due to the fact that instructional recommendations based on reform agendas require complex pedagogical shifts that may not always be recognized by teachers. While some may expect that new and innovative curriculum can afford the necessary support needed by teachers, curricula themselves do not serve as a catalyst for major change. As Saxe, Gearhart, & Nasir (2001) note, “Although good curriculum materials can provide rich tasks and activities that support students’ mathematical investigations, such materials may not be sufficient to enable deep changes in instructional practice” (p. 56).

Teaching mathematics in a way that resonates with reform requires more than a simple change in the types of curricula teachers that use. It requires, among other things, a deep understanding of how students interact with the materials and one another; it requires that teachers pose meaningful questions that elicit student engagement and enhance mathematical discourse; it demands that teachers learn, or become familiar with, effective assessment practices that move beyond checking worksheets, homework, and tests. While most teachers believe they successfully employ the necessary instructional practices that align with reform in their classrooms, only certain aspects of practice
undergo any real change, such as placing students in groups during class time as opposed to individual seats, or implementing more activity oriented tasks to students (Spillane & Zeuli, 1999). Aspects of classroom practice relevant to reform that tend not to get implemented are using student reasoning as instructional leverage and developing classrooms norms of participations where students are expected to justify their solutions and develop arguments for their own thinking. Beyond the actual classroom, implementing reform depends upon the broader policy environment in which classroom are situated. If districts do not provide opportunities for their teachers to revise their instructional practice around reform agendas, they will be less likely to enact reform in their classrooms (Spillane, 2000; Spillane & Thompson, 1997). Therefore, because instruction is complex and multi-dimensional, teacher change toward reform ideals requires more than following curricular guidelines.

One way to enhance the learning opportunities for students in mathematics classrooms is to substantially improve professional development for teachers of mathematics. This goal is becoming increasingly urgent now more than ever, due to mathematics reform efforts over the past decade (Even, 2005). Effective professional development demands that teachers reorganize their understandings of what it means to teach mathematics in the context of reform. Effective professional development requires that a) teachers engage actively in professional development and consistently reflect on their own practices, b) professional development projects must be oriented toward presenting mathematics that is problematic and challenging, and c) projects should provide teachers with alternate models of teaching and learning that are viewed as relevant and meaningful to pursue (Zaslavsky & Leikin, 2004). What is missing from
this picture, however, is that professional development projects for teachers of mathematics must also offer a considerable amount of support, both in pedagogy and in content knowledge. Incorporating new and innovative material resources into classrooms to advance reform ideals requires that professional development provide long-term support throughout implementation. Long-term, professional support is needed because the implementation of reform curriculum requires substantially new learning experiences for the teacher. As Remillard & Giest (2002) note in reference to professional development and supporting teacher change, “Considerable evidence suggests that the kind of learning that supports fundamental change in teaching occurs over a long period of time, with extensive support and multiple opportunities to experiment and reflect” (p. 8). Further, professional development should be based on an in-depth understanding of teachers’ current perceptions of their practice, their understandings of mathematics, and the institutional context of the school and school district because these factors have a considerable influence over the ways in which teachers organize their daily lives in schools.

Despite the major instructional challenges that teachers face in the enactment of reform, professional development can serve as a context for promoting and sustaining the types of changes teachers must undergo in order to meet ambitious reform agendas. Within professional development settings, researchers can develop an understanding of how teachers incorporate reform materials into their classroom practice. However, in order to understand the conditions that promote effective implementation of reform values, professional development must be rooted in teachers’ current classroom practice (Kazemi & Franke, 2004). For example, traditional approaches to professional
development assume that teachers can be trained to enact instructional text with relatively little consideration of teachers’ current practice. Under this view, teachers implement new materials with the hope that the materials will ultimately lead to increased student achievement and, to some extent, better teaching practices. This orientation toward professional development places agency with the curriculum as the linchpin for instructional change. The presumed endpoint is that teachers will enact material resources with fidelity. However, as curriculum developers all too often experience, fidelity is difficult to achieve and even more difficult to sustain.

In opposition to the traditional view of professional development, the design research approach (cf. Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) emphasizes professional development that builds from teachers’ current understandings of the content of mathematics, their present mode of mathematics instruction, and the rationale behind their daily instructional decision-making. When the emphasis of professional development builds from teachers’ current understandings, the engagement is necessarily responsive and cannot be scripted. An account of current practice constructed by researchers serves as the starting point for the future engagement. In design research, a hypothetical learning trajectory (Gravémiejer, 1994; Simon, 1995) may be established early on while working with teachers. A learning trajectory includes learning goals that constitute the general direction of professional development, the learning activities that formulate an approximation of meeting these goals, and the “hypothetical” learning process that teachers might engage in throughout professional development. By no means are hypothetical trajectories static in that teachers’ participation is constantly compared to an exemplary trajectory, which might be
established *a priori*. This is precisely why design research approaches to professional
development are different from traditional approaches. The assumption in design
research methodology is that researchers start by *first* understanding how teachers
conceptualize their own practice, how they reason on particular mathematical concepts,
and what assumptions they may hold regarding how their students learn. This
assumption implies that researchers can never establish a priori trajectories due to the
diversity in teachers’ instructional practices and their understanding of mathematics as a
disciplinary domain. Given this assumption, conjectures about how to proceed with
teachers are constantly compared with data collected from sessions, thus giving rise to
new learning trajectories and new ways to engage teachers in the general goals, activities,
and learning processes. It is in this sense that researchers cannot script sessions because
they cannot predetermine teachers’ participation and the specific perceptions they hold
toward their practice.

From a design research approach, professional development cannot be reduced to
manuals, text resources, or guides. This sentiment is captured by Carpenter and
colleagues when they claim, “Teaching is complex, and complex practices cannot, in
principle, be simply codified and then handed over to others with the expectation that
they will be enacted or replicated as intended” (Carpenter, Blanton, Cobb, Franke, Kaput,
& McClain, 2004, p. 10). The complexity of teaching makes the notion of codifying
professional development and handing it over to others untenable as an image of reform
spread. The notion of codifying professional development and handing it over to others
leads to the assumption that all teachers engage in similar instructional practices. To
encourage the development of reform agendas, therefore, is *not* simply a matter of
training teachers “the one best way” to do reform. Because teaching is an inherently complex, multidimensional practice, researchers must be constantly aware that there is no one, best way to design professional development. Constant revision of learning trajectories is a necessity, and this based on ongoing analysis of collected data. Parallel arguments are made about the need for teachers to be responsive to student learning. Teachers must adjust and adapt in the course of both teaching and planning because there is more than one way for students to navigate particular mathematical tasks. Teachers’ awareness of the diversity of student reasoning constitutes a departure from the notion that there is one way for students to solve a problem.

Supporting the design research approach of professional development, Simon and Tzur (1999) write, “Our commitment is to articulate how teachers organize their experiential realities with respect to teaching. Toward this end, we strive to create a coherent account of each teacher’s practice by explaining the teacher’s perspective from the researcher’s perspective” (p. 254, italics in original). The distinction between teacher’s and researcher’s perspectives is critical because it implies a shift away from a deficit-based account of mathematics teachers’ practice toward an approach that assumes teacher’s instructional decision-making is rationale and coherent. That is, the focus is not on what teachers lack or are not able to do in their daily mathematics instruction; rather, it is on understanding and articulating teachers’ approaches to instruction, as they currently exist from the perspective of the teacher (Tzur, Simon, Heinz, & Kinzel, 2001). An account of teachers’ current perceptions allows researchers to revise and refine learning trajectories for participating teachers. Therefore, researchers must assume that any teacher’s perspective of teaching and learning and the specific instructional practices
they develop in their classrooms are always reasonable and coherent. The avoidance of deficit perspectives is useful in pursuing new avenues for the development of theoretical models of teacher learning and change. By assuming teachers’ practices are rational and coherent, researchers can develop a better understanding of where teachers are currently in their thinking about both content and pedagogy, and how they make sense of the connection between the two. This can provide insights into the construction of revised and refined learning trajectories because knowledge of teachers’ initial instructional approaches can be analyzed and compared with their prospective engagements in professional development, or other related research projects. In the process of explaining whether or not change actually occurs over time, or what change might entail, the above approach can lend insight into the challenging question of change from what. This central question of change is beneficial because it can clarify potential learning trajectories for teachers. Knowledge of how teachers currently understand their own practice provides useful information in terms of how to proceed in professional development, ultimately leading to the critical goal of enhancing professional practice.

The primary purpose of this paper is to focus on what it means to be a teacher within a particular institutional setting from the perspective of a teacher (Tzur, Simon, Heinz, & Kinzel, 2001). In doing so, the focus is not on characterizing the structural features of schools in a top-down sense, nor on how changes in these conditions might produce changes in classroom practices. Instead, efforts are concentrated on teachers’ perceptions of their own teaching methods while concurrently treating those perceptions as situated in and at least partially constituted by the institutional settings in which they work (Cobb, McClain, Lamberg and Dean, 2003). That is, the institutional contexts
significantly affect teachers’ perceptions of teaching and the processes involved in how students learn. This premise provides a useful resource for researchers when attempting to explain what teachers do in the context of their own classroom and the reasoning behind why they do it (Elmore, 2000; Spillane, 2001). This orientation is especially helpful when working with a number of teachers in the same school or school district, because researchers can gain a more coherent and detailed picture of teachers’ instructional practices by paying close attention to the similarities and differences across teachers. If there are extreme differences in how individual teachers organize their practice around mathematical concepts, developing conjectures to account for these discrepancies can uncover new and more useful details of practice, for both individual teachers and the collective. Indeed, this has been helpful in the ongoing work with the teachers in this study because we are particularly interested in looking at the connections between how teachers organize and manage their current practices and the institutional spaces in which they work (Elmore, 2002).

In the next section, I briefly clarify the theoretical orientation that guides the analysis in this paper. In doing so I attempt to clarify my general assumptions regarding professional practice from a theoretical perspective and make explicate how my interpretations are influenced by these assumptions (cf. Cobb, 2000; 2001). It is important to note that I do not make any claims as to whether or not the teachers in this study have undergone change. Nor do I make any direct contributions to developing theoretical models of teacher learning. My purpose in analyzing the data is to make it explicit that researchers can make great strides in teacher learning and change by first and foremost working closely with teachers to conceptualize what it means to teach from the
perspective of the teacher. There are possibly several ways in which to make this general argument, but in this study I use the relationship between teacher and text. Because teaching is accomplished within institutional spaces, researchers must examine the nature of these spaces, as they might be understood from perspective of the teacher. It is beyond the scope of this paper, however, to formulate a methodology for carrying out the types of analyses of the institution. Following the theoretical orientation, I then provide a brief overview of both the new curriculum the teachers implemented during the 2004-05 academic year and the previous curriculum. Finally, I provide an analysis of the teaching sets and conclude with a discussion.

Theoretical Orientation

There are two central theoretical constructs that I incorporate in this research to help better understand the complex nature of teaching. First, in developing accounts of practice from the perspective of the teacher, I view teaching as a *social practice* (Fairclough, 2004). By using the term social practice, I mean that teaching does not occur isolated in the confines of individual classrooms, nor do teachers develop and refine their practice detached from the organizational aspects of schools. Teaching concerns the ongoing modifications of instructional goals where teachers incorporate a range of mathematical activities and resources as well as interpreting assessment tools to make sense of student reasoning. In accomplishing these tasks, teachers must stretch beyond the physical boundary of their classrooms and collaborate with other members of the school.
Second, teaching is conceptualized as a *distributed activity*, in that it is not restricted only to the interactions between teachers and students in supporting mathematical learning and development (Cobb, McClain, Lamberg and Dean, 2003). To understand the complexities involved in any given teachers’ instructional practice it can be useful to take into account the institutional settings within which teachers work. Looking outside the classroom to the organizational aspects of schools can allow researchers to gain a better understanding of how teaching is accomplished in schools. Taking into account the formal and informal social networks provided for or created by teachers enhances the overall image of practice for any given teacher. This is especially the case with curricular materials because teachers spend much of their planning and instruction time achieving the goals embedded in the materials they implement in their classrooms. The daily organizational lives of teachers are partly a result of the institutional constraints they attempt to satisfy (Ball & Cohen, 1996; Brown, Stein, & Forman, 1996; Feiman-Nemser & Remillard, 1996; Senger, 1999; Stein & Brown, 1997).

Thus, analyses of instructional practice need to be coordinated with the institutional setting in which it is enacted. This is necessary in order to portray the intertwined system involving teachers’ instructional practices and perspectives together with their experiences as they are trying to accomplish certain instructional goals. Such experiences highlight the immediate challenges that teachers encounter, the frustrations they go through and the valuations they hold towards specific aspects of their instructional reality.

The contention that teaching can be viewed as a *distributed activity* provides a considerable amount of leverage in gaining a coherent picture of instructional practice,
both from individual teachers and groups of teachers. This argument is taken up by Cobb, McClain, Lamberg & Dean, (2003) when they note that teaching as a distributed activity “becomes more plausible when we shift our focus from the competencies and actions of individual teachers working alone in their classrooms to the functions of teaching as they are accomplished in schools and school districts” (p. 14, italics in original).
CHAPTER III

SUMMARY OF CURRICULUM

The teachers in this study were selected because their focus was on the implementation of a new curriculum, *Investigations*, a reform mathematics curriculum for elementary school developed by Technical Education Research Center (TERC). This mathematics curriculum was entirely new to all of the participants, who had previously relied on a more traditional curriculum, *Math Advantage*, published by Hartcourt Brace. Also, a supplemental resource called *Focus on Achievement* was incorporated along with the *Math Advantage* textbook. During the first year of the research project, a content analysis was conducted on all curriculum materials used by all teachers in the project. This informal study was used to inform researchers in the major project of the current curriculum materials used by the teachers. The studies main purpose was to document the mathematical topics, the proportion of the book that each topic covered, and the assessment tools provided.

Two members of the research team (myself and another graduate student) categorized *Math Advantage* by major mathematical topics and counted the amount of pages devoted to each topic. We also developed sub-topics that corresponded to the procedures and processes in which major topics were presented. For example, we found that roughly 22% of the pages in *Math Advantage* were devoted entirely to the basic operation of whole numbers. Whole numbers was considered a major topic, and the sub-topics embedded within this were: addition, subtraction, multiplication, division, and
place value, in that order. Similarly, we found no pages devoted to the major topic of algebraic equations and expressions, by which the sub-topics were: inequalities, integers, quadratic, functions and polynomials, roots, exponents, radicals and irrational numbers, and trigonometric functions ratios. Therefore, Math Advantage for the fifth-grade level did not devote any pages on algebraic equations and expressions.

From a mathematical perspective, the study found that Math Advantage focused on presenting topics in mathematics as mainly procedures and algorithms. This conclusion was derived from an analysis of the assessments tools provided in Math Advantage. We analyzed the assessment tools presented in Math Advantage by focusing on the chapter and unit tests that students were expected to complete. By chapter and unit tests, I mean the cumulative reviews that were presented at the end of each chapter and unit. These reviews were focused on a variety of problem types that were representative of the mathematical topics covered in each chapter.

We developed five assessment categories for Math Advantage: knowing and using vocabulary, using complex procedures, investigating and problem solving, mathematical reasoning, and complex communication. These categories were created to help us better understand how teachers evaluated student learning assuming the use of Math Advantage as a primary assessment tool. Roughly 75% of all assessments types within chapter and unit test were based on students knowing and using the vocabulary presented in each chapter and unit. That is, students were expected to know vocabulary terms and use them readily throughout the reviews. Roughly 25% of the assessment types were dedicated to engaging students in complex procedures. By complex procedures, I mean an emphasis on having students practice algorithms and procedures presented throughout chapters and
units. Therefore, a bulk of the assessment tools for the end-of-chapter and –unit tests were constructed such that students would recall important vocabulary terms and state what these terms could be applied to and complete a large number of problems, grouped by concept presented throughout the chapter. The assessment tools provided did not engage students in investigating and problem solving (i.e. formulating and clarifying problems and situations, developing and verifying strategies), mathematical reasoning (i.e. generalizing, conjecturing, justifying and proving), or complex communication (i.e. relating representations, modeling, and critiquing).

Focus on Achievement was a booklet comprised only of a series of multiple-choice questions. At the beginning of each math class, the students were required to complete a certain number of pages before the lesson of that day. The teachers mentioned they used this more for warm-ups that anything else and chose sections based on the day’s mathematical lesson. Because the teachers were in self-contained classrooms and were responsible for teaching all major subject areas, they relied heavily on the Math Advantage for the preparation of their lessons.

The reform curricula, Investigations, presented mathematics very differently than the curriculum previously used by the teachers. Although we did not perform a similar, detailed content analysis as with Math Advantage, we did present some information to the project regarding the fact that it presented mathematics in a very different way\(^1\). As with the original content analysis, we began by counting pages to generate the amount of

\(^1\) The decision to perform a detailed content analysis on Math Advantage was to develop general knowledge of materials that teachers used in their classroom. The same content analysis was performed on eleven other textbooks, including three science textbooks form 6th, 7th, and 8th grades. Originally, the main purpose for conducting the content analysis was to obtain information regarding the access that teachers’ currently had to mathematics, from a content perspective. I use the results here only to provide the reader with general information as to what curriculum the teachers were using prior to Investigations.
space devoted to topics, but found that because the text was structured differently, this was not very useful. We, therefore, attempted to provide a general description to the members of the project team of how sections within *Investigations* were structured.

Below I explain the general aspects of the *Investigations* curriculum followed by a brief format of the individual sections. It is important to note that for each grade level, or Curriculum Unit, *Investigations* is broken into a series of booklets that cover specific topics within the much large grade-level topic. For example, the fifth- and sixth-grade curriculum unit entitled *Investigations in Number, Data, and Space* is composed of nine total booklets, each of which covers a specific topic. The two booklets the teachers in this study were using at the time of the study were *Mathematical Thinking at Grade 5* and *Building on Numbers You Know*. The former booklet covers factors and multiples, while the latter covers a range of strategies dealing with computation and estimation for multiplication and division. At the time of this study the three fifth grade teachers were using these books specifically focusing on factors and multiples and using estimation procedures to decompose whole numbers into factors.

*Investigations* embodies the national standards and requirements developed by the *National Council of Teachers of Mathematics* (NCTM). It is designed for the elementary grade levels (K-5). The *Investigations* curriculum is based on an extensive body of research on how students learn mathematics. We found that the lessons on mathematical topics were presented to encourage students to create their own problem solving strategies, and represent their thinking in a much more qualitative manner. That is, this curriculum introduces topics by encouraging students to develop their own thinking strategies and openly discuss their thinking through the use of models and graphs.
*Investigations* also provides teachers with potential ways their students might think about certain topics and engage in activities. In each of the sections, dialogue boxes in which hypothetical interactions between teachers and students are used to provide teachers with potential questions pose during the lesson. These examples of students’ talk help teachers anticipate student responses to unfamiliar tasks and routines. In general, *Investigations* orientates the teacher to allowing students the appropriate time to develop a conceptual understanding of mathematical topics by presenting only one activity per section. Activities are explicitly connected with previous ones throughout the curriculum and students are not given exercise sets in which they complete a series of individual problems relying on algorithms and procedures.
CHAPTER IV

METHODS

Participants

Eight teachers participated in the professional development workshops. Two of the teachers specialized in teaching mathematics, three in science, and three taught in self-contained classrooms spanning all major subject areas. The three teachers who worked in self-contained classrooms are the participants in this study. These three were chosen for the current study because all of them taught the same grade, all were working to understand and effectively use the same curriculum materials, and all worked together as part of their daily practice. These collaborative arrangements were visible to researchers and thus available for analysis as important structural conditions. In addition, they produced dense opportunities for teacher conversation that would make the process of teacher change more publicly observable for researchers.

Setting

The school (Iris Hill) in which the teachers work is a newly formulated mathematics and science magnet school for grades five through eight. This school is old and fairly rundown and located in a poor and struggling neighborhood located in the mid-south. At present, the population is predominately African American and serves mainly neighborhood children. A preliminary analysis of the school indicates that there are several informal communities in place; however, there are no formal ones. As an
example, no designated content chairs, specialists, or grade level chairs have been structured within the institution. The lack of organizational structure enables the development of informal groups or communities based on common interests and needs. As an example, the three fifth-grade teachers developed informal meeting sessions during their lunch periods. We are therefore particularly interested in the fifth-grade teachers since they are the only group of teachers in the building who collaborate on their mathematics instruction. This collaboration is primarily based on creating efficient ways to organize classroom instruction. For example, each of the three teachers is responsible for a content area, creating copies of all worksheets and distributing them to the other two teachers. The teachers have common planning time as well make sure that they are all are covering the same material at the same rate. Although there is no designated leader in the group, the most experienced teacher (Gloria) acts as the representative for the other teachers during meetings with the principal as well as the principal investigators for the research project. Gloria’s seniority within the school and district is recognized by the other two teachers in the group as an asset.

The school district, like many in the United States, is involved in a high-stakes accountability-testing program. Principals are re-assigned if they do not achieve expected test outcomes. This policy prevents their extended opportunities to create a supportive climate or culture within the school. Teachers do not know from one year to the next who will be principal. Further, teachers are also judged by their students’ test scores. This use of test scores as an evaluation tool of principals and teachers has created a situation in which preparation for the test dominates instruction time. Curriculum materials in mathematics are therefore chosen mainly on the basis that they will adequately prepare
students to be successful on standardized tests. The principal, along with a curriculum coordinator, is the primary individual in charge of choosing curricula. However, in the case of adopting *Investigations*, the teachers were included in the decision and actively encouraged use of the curriculum. In professional development sessions, the teachers discussed how this particular reform curriculum would support instruction around student reasoning. In the 2003-2004 academic year, Iris Hill achieved passing marks on all parts of the state test at all grade levels. The teachers viewed their approach to preparation as productive and effective and thus felt confident about the effectiveness of their existing instructional approaches. Their decision to change to Investigations was based on the notion that they believed implementation of such a curriculum would only further enhance their current instruction. The principal is a former mathematics teacher in the district and has a strong commitment to the teachers and the students. He welcomed the collaboration with the research team and has, according to the teachers, “strongly encouraged” them to participate in the professional development work sessions. He also welcomed the adoption of Investigations as a replacement for *Math Advantage*.

**Data Collection**

The data reported in this study consists of *modified teaching sets* in which the unit of analysis is a set (cf. Simon & Tzur, 1999). A set refers to three separate data collection processes for each individual teacher: a pre-interview, subsequent classroom observation, and follow-up interview. The sets are modified because they consist of only one classroom observation rather than a combination of multiple lessons over time, as in the
original Simon and Tzur study. Modified sets were important because they had to be completed while all three teachers were at the same point in the *Investigations* curriculum. It was important for the teachers to be on the same lesson to provide enough consistency to support comparisons across teachers. The teachers in this study were all planning lessons around factoring and multiples. Specifically, at the time we conducted the interviews, these lessons had to do with deconstructing the numbers 1000 and 1100 to find as many factors as possible. We did not deliberately time the sets to be conducted during the lessons on factors; rather, it happened to be the lesson that the teachers were covering during the time we implemented the sets. The sequence of interviews and observations sequence was designed to characterize the teachers’ stance toward instruction or what Zhao, Visnovska and McClain (2004) define as *instructional reality*. Instructional reality refers to the factors that influence teachers’ decision-making processes, such as perceived institutional demands, constraints, and affordances.

There were two separate times throughout the academic year that we performed teaching sets. One was conducted at the end of October during the 2004-05 academic year. The other was conducted later, during March 2005. We chose October to perform the first teaching set because we believed this would provide sufficient time, from the start of the year, for the teachers to familiarize themselves with the curriculum. We chose March as the second time because we assumed that the teachers would then have been using the curriculum for approximately a full academic year. We also chose to conduct the second set at this time because the teachers were involved in preparing their students’ for the end-of-year test that would be administered in April. We were particularly interested in their perceptions of the curriculum at this point because we
wanted to know whether or not *Investigations* was perceived as a suitable device for preparing students to take the end-of-level test.

All sets were video-recorded. The video data of the interviews and classroom observations were all downloaded from cameras onto a single computer. Each of the pre- and follow-up interviews lasted between 30 minutes to 45 minutes. The classroom observations were conducted during the periods in which the teachers taught mathematics. These class periods were roughly an hour and ten minutes long. Available data also include video from each of the bi-monthly professional development work sessions and more extended initial interviews with the teachers. However, for the purposes of this study, I restrict most of the analysis to the first teaching set performed in the fall of 2004. I briefly analyze the second set only to illustrate that the teachers perceived *Investigations* as an ineffective tool in preparing their students to be successful in the required end-of-the-year test. I use this data to revise the initial conjecture that the teachers’ gave agency to *Investigations* and argue that the teacher gave agency to the curriculum in general.

The pre-interview was geared toward developing an understanding of how a teacher anticipated the lesson would unfold. The interview was structured around five main questions. These questions were intended to address teachers’ perceptions of how previous lessons taught were connected to the lesson observed, the planning process involved in preparing for the observed lesson, and the rationale behind the construction of those plans. Teachers were also asked about the mathematical content of the lesson. The five general questions posed to each teacher were:

1. What is the lesson that you are teaching?
2. How does this lesson connect with others you previously taught?

3. How did you prepare for the lesson?

4. What are the big mathematics ideas in the lesson?

5. What do you think the students will learn from this lesson and do you think they will understand the mathematical ideas?

6. What is different about the curriculum used this year as opposed to last year?

These questions were designed to gain some understanding of the teachers’ thinking, both about their own practice and their students’ reasoning. The main goal was to develop a dialogue with the teachers so they felt comfortable discussing their experiences. It was assumed that whatever they discussed as a result of the above questions would be important and meaningful to them. At several points during the pre-interviews (and also the post-interviews), the teachers would begin discussing something that, from a research perspective, might not seem to be a pressing issue, but on further consideration, turned out to be important to the teachers. For example, all three teachers mentioned the difficulty of attending to the needs of their students’ parents. The teachers believed that the parents were unhappy because the students were not assigned an appropriate amount of homework. The teachers interpreted parental concerns as a need to cover more material during class so they could assign more homework. In turn, considering faster coverage caused added stress because the teachers were not entirely comfortable with the curriculum. The issue of attending to the needs of students’ parents, therefore, constituted an important aspect of the teachers’ instructional reality because it was a factor in how the teachers organized their practice.
In the post-interview, there was a greater focus on engaging in a reflection with the teacher on the lesson that had been observed. Because it focused on events that occurred, and because these varied from class to class, the post-interview was less scripted than the pre-interview. During the lesson observations, the researchers recorded questions that would later be asked to provide clarification of instructional decisions and reasons for those decisions. In all the classes observed, we pulled out instances in which the teachers worked with groups of students so that we could later ask them to reflect on what their students were thinking. We were interested in instances where the teachers actually asked their students how they developed certain strategies and the rationale behind them. The general questions in the interview following the classroom observations were:

1. How do you think the lesson went?
2. What do you think the students learned?
3. What were some important moments for you in this lesson and why?
4. Was there anything in the curriculum that you thought needed to be presented differently?
5. In general, what are your thoughts about the curriculum in terms of how you would teach similar ideas with the curriculum you used last year?

Data Analysis

I made three independent passes through the data (both interviews and classroom observations) for each teacher. The first time through, I simply transcribed each interview and took notes summarizing major episodes and interpretations in the classroom.
observations. Although I did note interesting responses from the teachers, I was more focused during this first pass on transcribing the interviews than analyzing them in detail. After transcribing each interview, I began to interpret the data by taking each set as an isolated unit of analysis. That is, for each teacher I worked through their respective set chronologically, beginning with the pre-interview, subsequent classroom observation and the post-interview. My focus during this second pass was on identifying thematic patterns that could serve as evidence establishing important components of that teacher’s instructional reality. During the third, and final, pass through the data I considered each isolated set as nested in the collective sets. It was during this phase that I began a comparative analysis for all three teachers (Lloyd, 1999).

During the second pass through the interview data I annotated transcripts with what I believed to be important themes for each teacher. By theme, I mean specific instances in the interviews when a teacher referenced the institutional setting, their own understanding of the mathematics within the curriculum, their perceptions of how their students were reasoning on content in the curriculum, and how they scheduled their class time to teach lessons. These themes were then interpreted as general categories of talk pertaining to the factors that I believed influenced the teachers’ instructional decision-making. During the second phase of analysis, I came up with a total of four categories of talk, which I characterize as follows, based on the content of the concern that teachers expressed: institutional context, teachers’ perceptions of content, structure of class and scheduling, and student thinking.

Institutional context was a category to make sense of the teachers’ perceptions of the institution within which they taught. Perceptions of content referred to moments in
the interview when the teachers talked about their understanding of the mathematical content of the lesson they taught. Student thinking referred to the teachers’ understandings of how their students reasoned about mathematics, the assessments tools they implemented, and their reactions to classroom conversations between students and moments where the teachers interacted with their students. Time structure and scheduling was a category developed to make sense of how the use of the new curriculum influenced the ways that teachers structured their class schedules.

After constructing these categories I discussed them with my research partner while we looked at representative video samples together, along with the annotated transcripts. We did not work together through the entire corpus. The final decision about the constitution of the descriptive categories and the illustrative utterances from teachers was ultimately up to me. The third and final time that I watched the interviews, I compared the themes from each individual teacher’s set with those sets from the other two teachers. If a theme remained consistent across teachers then it was considered as a final category for the entire set. If a theme did not hold across all three teachers then it was discarded from the data set for this study. Therefore, we were more concerned with shared perspectives across teachers’ practice than in variability.

My goal in analyzing video data from the classroom observations was to generate conjectures regarding the relationship between teachers’ instructional practices and the curriculum materials they used in their classrooms. Conjectures were based on moments in classroom practice which I inferred to correspond to the themes I constructed in the interviews. Any claim that was made on my part about the relationship between teacher and text was always cross-referenced and collated with the categories I constructed from
the interviews. My research partner and I adopted a method of analysis generated by Cobb and Whiteneck (1996), who refined what Glaser and Strauss (1967) called the constant comparison method. This method of research begins with analyzing data episode-by-episode in a chronological order. Sample episodes are used to illustrate how inferences are made. These samples are then compared to other episodes in which inferences are subsequently refined. This method of analysis was employed to make sense of all three components of each set taken together. That is, in the first pass through the interview data I did not support the themes I constructed with evidence from classroom observations. It was in the final analysis where I took stock of all three sections of each set and began comparing them with data from the observations.

The categories of talk discussed above were used to make conjectures regarding the teachers’ stance to instruction in relationship with the curriculum. These conjectures were compared with classroom observations and continually revised over time while working through the data sequentially. Once a conjecture was made about a classroom event, for example, how a teacher interacted with a particular student, I went back to interview transcripts and searched for evidence that would further support any claim made about that particular event. Thus, conjectures derived from either the classroom observations or the interviews were constantly compared with the other two sources of data as well as continually refined over time. This does not mean, however, that if there were no support in either pre- or post- interview data, in the form of explicit discussions pertaining to the exact event, that conjectures were dropped from the analysis. Rather, I was interested in the teachers’ perceptions of student-teacher interaction in general. Therefore, making a claim about a teacher’s particular interaction with a student in the
classroom observations meant locating support for her general perception of the meaning behind teacher-student interaction.
CHAPTER V

RESULTS

In this section, I focus mainly on the first teaching set, conducted in October of 2004, to gain a sense of the teachers’ instructional reality and explicate the role *Investigations* played in how the teachers organized their practice. The next set, performed in March 2005 was initially analyzed with an eye toward making sense of how the teachers implemented the new curriculum over the course of the academic year. We were interested in developing claims about teacher change in their use of the new curriculum. I discuss this second set to describe an important, collective decision made by the teachers to incorporate the previously used curriculum, *Math Advantage*. That is, the teachers expressed the need to revert back to the original curriculum in order to meet the “computational” needs of their students. While the teachers believed *Investigations* to be more effective in enhancing student reasoning around important mathematical ideas, it was perceived as insufficient for teaching students procedures and algorithms. This finding is discussed to substantiate the claim that the teachers gave agency to the curriculum because it was in this curriculum that appropriate teaching methods could be found.

From Instructional Reality to Agency
Although all the teachers spoke throughout the sessions and the interviews about the importance of integrating student reasoning into their instructional practice, our observations of their classroom practice suggested that student reasoning was a peripheral feature to their online mathematics instruction. As an example, in each class we observed, students were investigating factors and multiples. The three fifth grade teachers we studied were all working on the same lesson because they were all using the new curriculum for the first time. In one class (Karen’s), students were asked to work in small groups to find all possible factors of 1,000 and 1,100. The goal was for students to construct patterns of factors using multiplication and division. For example, one possible way in which students could create factors was to start by dividing 1,000 by 2 resulting in the equation $2 \times 500 = 1,000$. From there, a group of students could collaborate by deconstructing 500 into smaller parts. These smaller parts could be recombined with operators to eventually get back to 1,000 (i.e., 500 could be further broken down to $250 \times 2$, which could be used to obtain the equation $250 \times 4 = 1,000$). The intentions within the curriculum were that students would be able to recognize that deconstructing 1000 through division could lead to the discovery of new factors by later using multiplication.

In Karen’s class students employed a variety of procedures and strategies. We observed groups of students making modified factor trees, a diagram representing the process of breaking larger numbers down into smaller numbers. The relationship between smaller numbers is that they can be multiplied together to make larger numbers. We also observed students using their calculators to divide the numbers 1,000 and 1,100 by every number beginning with one until it “started repeating.” In this strategy students would also multiply two random numbers together to see if the product was 1,000 or
1,100. While these strategies were common across all the classroom observations we made of all three teachers, there were unique strategies within classrooms as well.

During the regular class time, the teacher (Karen) walked around the classroom observing the groups of students working together to come up with factors of 1,100. When she stopped at each group, she documented the students’ strategies in a notebook. The practice of documenting student thinking in the context of classroom activities had been discussed in several professional development sessions. In these sessions, the teachers noted that this year was the first time they developed written records of how students were thinking during class time. The teachers were encouraged to keep notebooks and share these with one another not only within the sessions, but also in informal meetings outside their regular classroom time. An important feature of using notebooks in such a way is that teachers can keep track of student strategies that can later be brought up during whole-class discussions with their students. By documenting the diversity of thinking, teachers can challenge students to consider different forms of reasoning on similar tasks. But doing so requires that the teacher bring student thinking to the foreground of whole-class discussions.

During the whole-class discussion of Karen’s class on factors of 1,100, it was clear that she was more interested in how many factors were discussed than the patterns involved in uncovering those factors. In the *Investigations* curriculum, the lesson on factors was presented to encourage teachers to focus on students’ developing patterns in factors rather than finding all the factors. The goal for the lesson in *Investigations* was to promote student reasoning about patterns by using factors. Finding all possible factors
was therefore not the end goal of the lesson; rather, the concept of factors was the means for teachers to promote reasoning about patterns in number.

Karen broke her students into groups of four and each group chose colors to represent their respective teams. She asked each of these groups to develop strategies for finding factors and that these strategies would be presented to the whole class during whole-class discussion time. In the context of whole-class discussion, the students were asked to describe all possible factors\(^2\). Karen wrote these factors on the dry erase board. After all factors were written on the board, each group was asked to clarify their strategies to the entire class. The transcript below is taken from Karen’s lesson on factors where she asked a representative from the orange team to describe their strategy, Sarah (S). Karen (K) stood opposite the white board in her classroom, at the back, next to the group that presented:

K: Alright what I wanna do now is I wanna hear from the groups and I wanna hear the group strategy okay. I wanna hear about how you, ah, I asked you to write about the strategy for finding each factor pair and then how you know if you have found all the factor pairs…Orange, do you have yours ready? Okay let’s read it, please.

S: We used our calculator to help find most of our answers. But on 11 times 100 we just multiplied 11 and 10 and that equaled, and that equaled 110. So we added another zero to both 110 and 10 so that can equal 1100. For 1 times 1100 we already knew that answer because in every factor pair you would need to put 1

\(^2\) All possible whole-number factors that the students found for 1,100 were: 1 x 1100, 20 x 55, 22 x 50, 25 x 44, 100 x 11, 110 x 10, 2 x 550, 5 x 220, 4 x 275. These factors were listed on the dry erase board in the front of the classroom.
times that number anyways, because whatever times 1 equals that same number by multiplication by that number.

K: Alright, good, good. I like that, and I like the way that you explained everything. Good job, Sarah. Alright, Blue, let’s read your strategy please.

In this interaction Sarah described a strategy that incorporated more than the procedure of randomly multiplying numbers together to arrive at 1,100. The team first recognized that 11 X 10 was equal to 110. Then, they added an additional zero to the ten in the equation 11 X 10 and its respective product. By doing this, they were able to recognize that 11 X 10 X 10 (1100) was equivalent to their description of adding “another zero to both 110 and 10.” Our interpretation of the utterance by Sarah is that the group, or at least Sarah herself, understood that adding an additional zero to a number means multiplying that number by ten. This is a useful strategy for recognizing patterns in factors because it assists in understanding that numbers can be decomposed into more manageable parts. This decomposition into smaller numbers can be utilized in later recombining them to arrive at the original number being factored.

Karen’s response to this strategy, from our perspective, indicates that an “explanation” suffices as a valid and meaningful contribution to the whole-class discourse of factors and multiples. In this context, we interpreted Karen’s use of the word explanation as referring to the student’s description of the processes involved in their strategy. What is important here, in this episode, was that Karen did not make any efforts to get Sarah, and the other members of the group, to clarify their thinking. Sarah only explained what she did and that was all. That is, Karen did not challenge her mathematical description to the entire class. Nor did she point out what was
mathematically about it. Nor did Karen determine whether or not other students in the class understood the strategy. In this case, our interpretation of Karen’s perspective on what it means to incorporate student reasoning into classroom instruction, is that simply getting students to talk about how they solved a particular problem in a public forum suffices for effective use of student thinking.

Some of the teams employed more complex strategies, however, that were not “scripted” in the *Investigations* curriculum. After the interaction with Sarah, Karen responded to another group’s strategy by stating, “Alright, alright. I like the way that you wrote, it sounds like they [team Rainbow] had some additions that the group didn’t agree with. But I like the way that you explained exactly what you did on the calculator.” In this case, “additions” meant that members of the group did not agree with the way the strategy was presented by the representative from team Rainbow. The important issue here is that although the group of students disagreed about the presentation of the strategy, Karen’s response was simply to acknowledge that there was a disagreement without clarifying what exactly the disagreement was.

As students described their unique approaches, they received neither critique nor suggestions from the teacher. When each student finished presenting strategies for their group, Karen signaled to move on to the next group, and no communication between the groups was sought (nor did any occur). The discussions, therefore, took on characteristics of a show-and-tell in which each contribution was equally valued. Students were praised for being able to explain their strategy, an achievement that was apparently sufficient from the perspective of the teacher. It is important to note, however, that on this occasion, Karen’s instructional approach was different than when
the project first began eight months prior to conducting the teaching sets. Early in the year it was not common for Karen to provide time in her lessons for students to present their thinking in the context of whole-class discussion. Therefore, the above analysis should not be interpreted as suggesting that Karen lacked the capacity to move beyond show-and-tell. Our perspective is that she is, indeed, incorporating student reasoning into her instructional practice. However, her perception is that students’ explanations are sufficient for the entire class to understand what other students’ strategies are and, therefore constitute the use of student thinking.

In the pre-interview, when Karen was asked to describe her thoughts about the new curriculum. In relation to student engagement, she noted:

I tried to explain that it’s very important to keep your, your thoughts in order, and sequence the thoughts. So its like, we talk about, ‘what do you do first, ya know, what’s the first thing you do, how do you start, and then what’s second and what’s third…’ because we talked about, ‘ok, so when we write down strategies the first thing we do is this, what do we do second,’ and things like that.

In this utterance, Karen points to the importance of writing strategies and how they need to be structured and sequenced. But in this context of the interactions above, Karen did not emphasize this to her students during the class discussion. That is, she did not engage in a dialogue concerning how important strategies are in coming to understand the lesson on factors and how these strategies can be used to collaborate with other students. In the post-interview associated with this lesson in particular, Karen noted how pleased she was with the students’ abilities to talk through the process. For example, when Karen was asked to describe her class session on factors of 1,100, she stated, “Well what I like was
working on our strategies, how to write them up. And everybody did a really good job of explaining what they were thinking.” For Karen, students’ explanations of their own reasoning, or of the reasoning of their group counted as good classroom conversations around important mathematical ideas, in this case factors and multiples. The process involved students simply explaining their ideas, rather than her using these explanations as a starting point to help students think more deeply about the mathematical concepts.

In response to the general question about the new curriculum, Karen responded:

Oh yes, um I like it [Investigations] cause it is not like a mindless type of thing. Like to me, math used to be very step-by-step. I, I felt like I had to tell the students what to do all the time. And this, I don’t feel like I have to tell what to do all the time. Um, they’re doing more thinking for themselves.

This last utterance from the interview with Karen suggests that it is largely due to the curriculum that Karen believes her students are doing more thinking for themselves. However, our perspective on her statement, “more thinking for themselves” is that the students are talking more, not necessarily thinking more. We were not able to decide whether or not the students were thinking more based on classroom observations because Karen did not ask students to clarify their strategies or challenge themselves to provide more information to other students in the class, not just Karen. The point here is to note the importance that is placed on the curriculum by Karen as the key to getting students to think for themselves. Karen believes that if she simply follows the curriculum, student reasoning and thinking will take care of themselves in the context of classroom conversations. That is, she believes that if students simply do the activities in the text and describe their strategies, they are thinking in a much more complex manner.
This statement from Karen is representative of the teachers’ beliefs about the effectiveness of the new curriculum. Like Karen, the other teachers expressed similar ideas about the mathematics involved in the new curriculum and its relationship to their instructional practices. The teachers seem to share the belief that following the guidelines and steps in the *Investigations* material implied that they had achieved a new orientation to teaching mathematical concepts (i.e. “a new way of teaching”). This new way, from the teachers’ perspective, seemed to be founded on the premise of getting students to think and reason in complex ways. But what constituted an effective strategy or evidence of complex reasoning and how this could be used to improve instruction remained very unclear.

A strong focus in the professional development sessions regarding students reasoning had been to guide teachers to pose questions in order to gauge student understanding. Throughout several workshop sessions, researchers created mathematical activities that would engage teachers in assuming the role of student as they worked with one another to complete mathematical tasks. When the teachers completed a task they presented their findings to the entire group. The sessions, therefore, modeled the potential range of responses that teachers might expect their own students to make. Teachers also were exposed to relevant questions designed to reveal ways in which students might reason on similar tasks. Over time, with the assistance and example of a very experienced teacher, they began to adopt some of the same dialogic strategies that they were observing. During the professional development sessions, the teachers developed a shared understanding of how to challenge one another during group presentations. However, this form of engagement was absent in their classroom practice because the
teachers did not promote a discourse of challenging students’ mathematical explanations or encourage students to challenge one another. Based on our classroom observations, however, student reasoning did seem to be emerging as a marginal resource for instructional decision-making. Teachers were clearly beginning to elicit student thinking but did not apparently understand how to make use of what they learned about student thinking to guide their next instructional moves.

Our perception was that somewhere along the way, in the professional development sessions and in their daily instruction, the teachers began to assume that following the *Investigations* curriculum automatically implied attention to student reasoning and using it as a resource to enhance their instruction. For Karen, allowing students the space to describe their strategies in a public forum was a significant departure from her previous methods and thus was, in her eyes, more than adequate as effective use of student reasoning.

It is important to note that this example does not imply that Karen is unable to make use of students’ mathematical contributions in their instructional practice. Also, the above analysis is not meant to conclude a complete lack of awareness on the teachers’ part to the ways in which their students might reason. Rather, Karen’s instructional reality is that from her perspective she was indeed attending to student reasoning. By asking students to generate strategies and share them with the rest of the class, Karen believed that she was incorporating student thinking as a resource in her classroom practice. This is evidenced by Karen’s response that math to her “used to be very step-by-step” and that she believed she had to “tell the students what to do all the time.” Our interpretation of her perspective on teaching with the new curriculum was that she has
had reconsidered the way she looks at student reasoning. She believes that because she has incorporated the new curriculum into instructional practice, student reasoning has become more of a central aspect in her practice. From our perspective, Karen does not make effective use of students’ contributions, nor does she inquire into these strategies as a means to challenge and critique. Our interpretation is that Karen, like the other teachers, views the curriculum as essentially presenting a way of teaching multiples and factors where attending to the details of student thinking, at least publicly, is not necessary. Karen believes she is engaging in new and effective instructional practice and that this practice enhances student learning.

The curriculum itself was taken for granted as the necessary and sufficient tool for teaching mathematics in a new and effective manner because, from the teachers’ perspective, it was more activity oriented and presented mathematics in a more conceptual manner. This was important for the teachers because they viewed this new way of teaching as eventually translating into increased student achievement and successful completion of standardized tests. As an example, when asked about the new curriculum and its effectiveness in the post-interview, Gloria stated:

Um, well, first of all, I like it I, I like the fact that somebody’s thought through it and it’s good that somebody’s thought through it for me. If somebody said ‘Okay, I want you to just stop and teach kids to think,’ ya know it’s not so easy. I, I thought I had always done that. I always asked a lot of questions. I always said why, I always said, but, but there’s a whole program established around that. Um, I like, it’s [Investigations] hands on, it gives kids more opportunity to solve things in different ways as opposed to just being computation based. Um, I just
it’s, it’s excited the kids. I like it, I like, it takes a lot of planning. Even though it’s all scripted it’s all, ya know, pretty much written out for you.

One interpretation of Gloria’s perception of the curriculum is that it allows her to teach the students how to think about and solve problems differently than before with the traditional curriculum. Like Karen, Gloria’s classroom practice suggested that each strategy was a mathematically meaningful contribution. During Gloria’s lesson, the strategies that students presented while solving problems about factors and multiples were never challenged or critiqued.

According to Gloria, the students were thinking differently and contributing more to the classroom discourse because of the new curriculum. From our perspective, Gloria’s perception of her students’ engagement was such that if they participated in whole class conversations and simply completed the work assigned to them, this meant they were participating and contributing more. She also mentioned that the new text alleviated major time constraints because it had been “thought out” for her. It is important to note, however, that this does not imply a lackadaisical approach to teaching mathematics; rather, she perceived the curriculum as reducing the time-consuming planning required by the previous curriculum. Gloria viewed the curriculum as containing already prepared lessons that should be enacted by following the steps provided by the text in each lesson. Therefore, from our perspective she gave agency to the curriculum because it was the lessons, how they were organized, and what the lessons referenced in terms of student thinking and participation, that served as foundation for Gloria’s instructional practice. She did not use her students’ reasoning to enhance her instruction because she did not challenge them to rethink particular strategies and clarify
aspects of these strategies so the class, as well as herself, could better understand what students were thinking. Like Gloria, the teachers relied on the text in the course of their daily instructional practices, not only to bring out student strategies, but also to reduce the amount time spent preparing for lessons. As a result, the teachers rarely discussed details of their instruction since the text was viewed as the authority on effective teaching practices.

When asked about *Investigations* in the post-interview, Claire mentioned, “It’s kinda hard to follow to a tee because it kinda tells you what to say and what to write on the board. Some of them are easy to write on the board but I find myself kinda going off on another way.” Although Claire somewhat agreed with Gloria about the step-by-step process the curriculum provided, she also noted that she diverged from the text at certain times. She later mentioned that this divergence depended upon the activity. When asked about what she meant by diverging, Claire described a future lesson connected to factors and multiples. This lesson had students hypothesize the amount of storage space a school would need for a certain number of pencils. They were to use graph paper in which each one-centimeter square would represent one pencil. They would then construct boxes out of the paper and find the volume of the needed space. The volume indicated the total number of pencils for each box. Students could then make conjectures about how many boxes the school would have to purchase, given the amount of available storage space. This lesson was connected to factors because students had to build on their knowledge of decomposing a certain number (total storage space) into more manageable numbers. For example, if a school could hold only 10,000 pencils, students would need to know the
respective factor pairs of 10,000 in order to construct a certain number of boxes and
determine how many pencils could fit into each box.

Claire noted, “Well, that’s a neat question to find out, but when you look at a
square and you look at a pencil, to me they’re a totally different size and so they’re
[students] gonna need a different size square. So I really didn’t think they [students]
could relate that.” This is an interesting suggestion because Claire did not focus on the
mathematical aspects of the lesson or how it might be presented to her students. For
example, transitioning between measures of area and volume to determine the appropriate
number of pencils could be a demanding conceptual leap for Claire’s students. In the
post interview, Claire did not discuss this issue and how her students might use these
concepts to approximate the amount of pencils a school could purchase. Rather, she
offered a more practical critique focusing on the recommended materials. By critique, I
mean making specific modifications in lesson plans to enhance student engagement. This
requires a certain level of knowledge regarding students’ current thinking and how
instruction could potentially be altered to meet students’ needs. In all the sets we
conducted at the beginning of the academic year, this was the first time that a teacher had
offered any criticism of the Investigations lessons. Claire was the only one who
mentioned aspects of the curriculum that she thought would be difficult for her students
to grasp or alternatively, would simply not be feasible, considering how she organized
her classroom activities.

Claire’s discussion of developing a new “path,” as she called it, in the way that
concepts were presented in Investigations was evidence that she also viewed the text as
the authority on how best to teach the students. In the pre interview when Claire was
asked to state what lesson she was going to teach during our classroom observations, she stated, “Um this is it right here. I, I was looking at it earlier and this is where we’re at. So we’re a little bit behind, one lesson. But I don’t know if it’s going to last a full hour. So when I was looking through it, I thought, well, cause I’m not, I’m just kinda blowing it.” In the initial portion of this utterance, Claire stated, “Um this is it, right here.” While she said this she lifted the Investigations booklet (Mathematical Thinking at Grade 5, lessons 2, 3, and 4 – Factor Pairs from 100 to 1000) she was using and set it down so that the interviewer could read the page. She then said, “I, I was looking at it earlier and this is where we’re at,” while moving her finger across the page, showing the interviewer the lesson. Claire seemed hesitant at this point to describe the lesson and expressed to the interviewer that she was “was blowing” it, meaning that she was not doing a good job with respect to following the lesson as it was presented in the text. In this case, our perception of Claire’s instructional reality is that she believed she had to follow the curriculum exactly in order to ensure that she that she would have successfully used the curriculum in her classroom. This example shows that Claire feels felt as though she were is “blowing it” if she does did not cover the curriculum in the amount of allotted time afforded by the text and in the manner that concepts are presented. Claire was hesitant to construct new “paths” in the curriculum because this implies a deviation from content. Therefore, from our perceptive, Investigations is regarded as the final say in whether or not Claire can continue with her own lesson plans.

Claire was concerned that her own ideas about how to engage students in mathematics were sometimes in conflict with suggestions offered by Investigations. The critique given by Claire is only somewhat related to the mathematics involved and is only
loosely connected with students reasoning. With respect to student reasoning, the
professional development sessions were developed to support teachers as they grappled
with how their students might think about core concepts and big mathematical ideas.
Claire’s issue with the lesson did not specifically address the potential difficulties or
successes that students might encounter with decomposing numbers into factors pairs,
using these values to construct one-dimensional grids to symbolize area, and finally,
building three-dimensional boxes to characterize volume. Claire’s focus on the need for
students to work with a one-to-one correspondence between the size of squares on grid
paper and the size of a pencil did not delve into these important mathematical ideas. It is
important to note, however, that this interpretation does not rest squarely on the inability
of Claire to critique *Investigations* on the basis of core concepts. Also, it may be that
what Claire is describing is actually mathematically important for her students. My
argument is that Claire hesitated to offer any critique that moved beyond superficial
issues and into the kinds of critiques that were demonstrated in professional development
sessions.

Although struggling in this first year, the teachers believed in general that the
information provided by the text was something to be learned. As Gloria’s noted, “If we
can just get through this year, we’ll know what is in the book.” This “coming to
understand the book” is evidence of their placing authority with the text and adhering to a
fidelity approach in its implementation. All three teachers believed that the
*Investigations* curriculum offered a “new way of teaching” mathematics. But this new
way became problematic during the spring semester.
When we performed the second set, the teachers were focusing on multiples. However, they had supplemented *Investigations* with the previous curriculum they were using, *Math Advantage*. During this time, all the teachers were preparing for the end-of-level test with their students, the Tennessee Comprehensive Assessment Program Achievement Tests (TCAP). One of the concerns expressed by all three teachers was that they were not moving through the Investigations curriculum as they had planned at the outset of the year. They had only covered the first three booklets in the new curriculum, out of a total of nine. Initially, one of our primary goals for conducting the second teaching set was to collect data that would allow us to track changes in practice over time as the teachers implemented the new curriculum. But when all three teachers told us that they had reincorporated the original text into their classroom practice sometime after the first teaching set, we believed it would be difficult to make any claims regarding change in the teachers’ use of *Investigations*. The conclusion derived from the analysis of the first teaching set was that the teachers gave agency to *Investigations* as the authority on how to best teach mathematics. The analysis below, however, demonstrates that the teachers gave agency to curriculum in general. By this, I mean that we initially believed it was *Investigations* that was acting as the authority; but the collective decision to revert back to *Math Advantage* suggested that the teachers actually gave agency to both texts, reform and traditional.

In the second teaching set, during the pre-interview, Karen was more critical of *Investigations* as an effective tool for promoting students understanding of mathematical
concepts. When she was asked to discuss the potential differences in how she organized her classroom practice between the first set and the second, she stated:

Well, I’m just, well first of all because we’re getting ready to roll into TCAP. We’re really looking at, what objectives are we teaching? Are we hitting, making sure that they understand everything that’s on there. Whereas in October, I was trying to get familiar with the book [Investigations], let’s go directly by the book, let’s make sure we stick to the book. Buts now it’s like, look okay, we gonna do this, and does this have, you know lookin’ at this, okay, is this gonna help me on TCAP, is this hittin’ some of my skills? Cause if it’s not, we gonna go on to the next thing. And that’s the reason I was liking the building on the numbers, you know, because it goes back to those add, subtract, and multiply, and divide fractions that they need. So, I was fine with that, I was like, ‘Okay, that’s good.’ Cause this is like a good review to me, and at this time, this is a good review at this time.

It seems that in order to gauge whether or not a lesson in Investigations is appropriate for her students, Karen feels she must determine if the concepts in the lessons correlate with the standards for TCAP. The teachers agreed that one problem with Investigations is that it did not effectively prepare students for TCAP questions on fractions. Fractions were covered in the Name That Portion booklet. When Gloria was asked why she used the old curriculum as opposed to Investigations, she stated:

Ah, we broke at the first of the year because we were a little panicked over fractions. So, we, we, there was no, the fractions that we had dealt with in Investigations had just assumed too much. It was just way beyond, so, other than
that we have been pretty steady, maybe a day when we got back and did
something from the [old] book. We have stuck with *Investigations*. We have not
moved it as fast as we needed to move it. We are at the end of the year and we’ve
only been through three books.

Gloria stated that the teachers began to use the old curriculum as early as the first part of
the year, reportedly because the teachers “were a little panicked over fractions.”

After Karen told me in the post interview that she had been using *Math Advantage*
for teaching fractions, I asked her if that was because she wanted to prepare for TCAP.

The following transcript is a portion of this brief conversation:

Karen: Yeah, and to supplement the fact that, um, the *Name that Portion*
does not really teach them how to compute the fractions.

Erik: That’s in *Investigations*?

K: That’s in *Investigations*. There’s no place for that there [“compute the
fractions”].

E: And what was it again that you used for the additional resource?

K: Oh we just used our, that regular textbook [*Math Advantage*], the other
text that we have used in the past…Just, okay, this is how you do it, let’s
work on it.

Karen apparently believes that *the Investigations* materials are useful for engaging
students in a conceptual understanding of the topics they cover. However, when
supporting students in computing problems, the old text is more useful. In the
professional development sessions, the teachers noted that one reason why they wanted to
use *Investigations* was because they believed that in the past their students had been
unable to engage in mathematics from a conceptual perspective, especially with fractions (i.e. their students were not able to answer such questions as, “Why do you invert and multiply when dividing two fractions?”). Given this initial concern, it interesting that both Karen and Gloria concluded that the old curriculum, which did not necessarily provide a conceptual approach to teaching fractions, was now more useful to them.

One interpretation of these transcripts is that the teachers were simply teaching to the test, and had TCAP not been a major issue, they would have continued to rely more heavily on *Investigations*. We do not dismiss this as a possible interpretation. However, I want to extend the analysis beyond the explanation of teaching to the test to include the notion of giving agency to the curriculum. From the analysis of the first teaching set, it was apparent that student reasoning was considered an important aspect of the teachers’ classroom practice. The teachers had also suggested that the new curriculum, offering a “new way of teaching,” promoted student reasoning in more complex ways than those supported by curricula they were used to. It was interesting that while the teachers believed student reasoning is important, and they believed that *Investigations* supported student reasoning, nonetheless, they slowly reverted back to the previous curriculum.

The decision to reintroduce the old curriculum suggested that while the teachers did view TCAP as a considerable constraint on their practices, the authority on how to best teach mathematics to ensure student success was the curriculum.
A key finding from the analysis of the first teaching set was that the teachers’ current understanding of their own practice considerably influenced the implementation of the new curriculum. The conclusion that the teachers gave agency to *Investigations* is derived from analyses of the *teachers’ perspective from the researcher’s perspective* (Simon & Tzur, 1999). For example, from our perspective, Karen believed that she was attending to student reasoning in her classroom discussion on factors and multiples. This was also expressed in the interviews. Her current understanding of what it meant to incorporate student reasoning as a resource for enhancing her instructional practice meant providing opportunities for her students to talk about, or explain, their thinking. Recall that Karen did not challenge her students’ explanations, nor did she attempt to ensure that other students in the class understood the explanations. Therefore, her current understanding of her own instructional practice regarding the use of student reasoning as an instructional resource was simply giving students the appropriate amount of time and space to express their strategies to the whole-class. Thus, students were not held accountable for their own strategies.

Karen’s currently held belief about student reasoning and teaching mathematics had a considerable influence on the ways in which she implemented the curriculum. Because she believed that the new curriculum was not “a mindless type of thing” and as a result her students were “doing more thinking for themselves,” she believed that
following the curriculum essentially meant she was making good use of student reasoning.

For Gloria, *Investigations* was considered a “whole program,” as she put it, established around teaching students to think. For Gloria, *Investigations* “gives kids more opportunity to solve things in different ways as opposed to just being computation based.” Gloria also mentioned that she believed she used to teach kids how to think but after using the new curriculum, she questioned her own instructional practice. From our perspective, this questioning resulted from the belief that it was in *Investigations* that Gloria found a new instructional practice established around student thinking. Her current understanding of her own practice, mainly derived from the interviews, was that she did not perceive student reasoning to be an important aspect of her practice. For her teaching mathematics was more or less telling her students how to solve problems. Gloria gave agency to the curriculum because she firmly believed that it presented a new way of teaching mathematics that was different from how she had taught in the past. Therefore, she followed the lessons in *Investigations* without question or critique because she believed this would enhance her instruction.

The analysis from Claire’s practice and the interviews suggested that she was extremely hesitant to develop new ways of presenting the mathematics in *Investigations* to her students. She also felt that she was not teaching the lessons well and expressed this concern by telling us that she thought she was “blowing it.” As noted earlier, during the first teaching set, Claire was the only teacher out of the three to critique *Investigations*. This critique was interesting because it suggested that perhaps, from Claire’s perceptive, the new curriculum was not the authority on how she should organize her practice.
However, further analysis of this critique suggested that it was not necessarily devoted to the mathematical aspects of *Investigations* and was somewhat superficial. Although she did take into account her students thinking and how they might engage with the task, her belief that she was “blowing it” and her hesitancy to develop new “paths” suggested that the curriculum remained the authority on how to teach mathematics.

The analysis of the second teaching set suggested that we needed to modify our original claim that the teachers gave agency *Investigations* to the claim that the teachers gave agency to curriculum in general. Our conclusion, therefore, was that the teachers used the curriculum as the primary resource for organizing their instructional practice. In this sense, curriculum is more than simply teaching materials. The teachers’ instructional practice was also influenced by the expectations of the school and district and their perception of the mathematics within TCAP. This was interesting because the teachers’ participation in the professional development workshop suggested that, over time, they began to see the importance of student reasoning as an essential resource for their instruction. This gave rise to a conflict between our interpretations of the teachers’ participation in the workshops and their current practice, and the teachers’ interpretation of the workshops and their practice. Data from this study suggests that, from their perspective, the teachers did see the importance of attending to student reasoning. However, it is one thing to view student reasoning as an important aspect of classroom practice; it is quite another to foster student reasoning. Regardless of what student reasoning meant to them, it was nevertheless an important focus of their instruction. Moreover, the teachers believed *Investigations* was a useful resource not only for enhancing student reasoning, but also supporting effective instructional practices for
promoting student thinking. But, the collective decision to reincorporate the previous curriculum was a confusing choice for us because they believed that Math Advantage was not an effective guide for their instruction. Therefore, this decision suggested that the teachers did not value the importance of student thinking, as we originally concluded from other analyses from professional development. However, from our perspective, we believe a more meaningful interpretation of the decision to revert back to the original curriculum was that when the teachers needed to prepare their students for computation-based examinations (e.g. TCAP), the traditional curriculum was the authority. When the teachers saw their primary goal as enhancing their students’ participation, reasoning, and conceptual understanding of mathematics, Investigations served as the authority. Our final conclusion, therefore, was that although the teachers perceived themselves as placing student reasoning at the forefront of instructional decision-making, our interpretations suggested that it was the curriculum that teachers placed at the center of their practice.
We agree with Saxe, Gearhart, & Nasir (2001) that “effective implementation of reform curriculum requires integrated and ongoing professional development” (p. 71). But we also believe that understanding the current perspective that teachers’ hold toward their practice is equally important to professional, long-term support when working closely with teacher in professional development settings. In this study, we found that the teachers’ current perception of their instructional practice influenced the ways in which they implemented the curriculum. Our interpretation was that the curriculum became the only resource for instruction. From our perspective, student reasoning was essentially a peripheral feature to their online classroom instruction, even though the teachers believed it to be central. This finding suggests that the common practice of codifying professional development and rapidly making it the responsibility of other teachers (the “trainer of trainers” models) may not be a viable model for spreading reform without distorting it. Researchers and professional development providers should make attempts at understanding how teaching is conceptualized from the perspective of teachers. There must also be sustained pedagogical support for teachers learning to incorporate reform curriculum into their current practice. Future research should take into account teachers’ current instructional reality as a means for providing additional support for teachers of mathematics within professional development settings.


Saxe, G. B., Gearhart, M., & Nasir, N. (2001). Enhancing students’ understanding of
mathematics: A study of three contrasting approaches to professional support. *Journal for Research in Teacher Education* 4, 55-79.


